Swarrnim Science College

CRITERIA 1

1.1.1 Summary table of course objectives for Curricular developed and implemented in the Swarrnim Science College, Swarrnim Startup & Innovation University have relevance to the local, regional, national and global developmental needs:

Sr. No.	Institute	Programme	No. of Course Objectives relevance to the local, regional developmental needs	No. of Course Objectives relevance to the national developmental needs	No. of Course Objectives relevance to the global developmental needs
1	Swarrnim Science College	B.Sc.	446	587	471
		M.Sc.	450	646	550

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Course Outcomes of B.Sc. Biotechnology					
Academic Year 2020-21					
Course with Code	**Name of CO**	**Description**	**Relevance to the**		
			Local / Regional	**National**	**Global**
Semester 1					
Introduction to Biotechnology 253010101	CO 1	Understand the historical development and interdisciplinary nature of biotechnology, and its branches.	✔	✔	✔
	CO 2	Explain the basic concepts of genes, and the chemical and physical nature of DNA and RNA.		✔	✔
	CO 3	Describe the structure and organization of DNA in eukaryotes, including types of DNA and RNA.		✔	✔
	CO 4	Understand the basic steps involved in genetic engineering and its significance in various fields.		✔	✔
	CO 5	Analyze the applications of biotechnology in forensics, transgenic crops, and transgenic animals.	✔	✔	✔
	CO 6	Evaluate the role of biotechnology in healthcare diagnostics, treatment, and industrial processes.	✔	✔	✔
Biotechnology Practicals 253010102	CO 1	Instrument Mastery: Proficiency in operating microscopes tailored for observing cell movement and motility-related instruments.	✔	✔	✔
	CO 2	pH Impact on Motility: Understand the direct influence of pH fluctuations on cell motility through controlled experiments.	✔	✔	✔
	CO 3	Staining Techniques for Motion: Apply stains to track and visualize cell movement patterns effectively under the microscope.	✔	✔	
	CO 4	Standard Solution Utilization: Prepare solutions known to affect cell motility, employing them in assays for quantification.	✔	✔	
	CO 5	Microscopic Analysis Skills: Acquire expertise in using microscopy to measure and analyze cell motility parameters like speed and direction.	✔	✔	✔

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	CO 6	Experimental Design and Analysis: Design experiments examining factors affecting cell motility, collect data, and draw conclusions on their impact.	✔	✔	✔
Semester 2					
Origin & Evolution of life 253010201	CO 1	Explain the origin and evolution of life, including major theories, Miller's experiments, and cell differentiation.		✔	✔
	CO 2	Understand the evolution and structural differences between prokaryotes, eukaryotes, mitochondria, and chloroplasts, and discuss the quest for extra-terrestrial life.		✔	✔
	CO 3	Describe the general characteristics, body organization, and adaptive features of plants, with an emphasis on the Plantae kingdom.	✔	✔	
	CO 4	Analyze the general features of animals, their evolutionary history, body organization, and adaptation to various environments, focusing on the Animalia kingdom.	✔	✔	
	CO 5	Illustrate the structure, reproduction, and classification of fungi, algae, protozoa, and discuss their economic importance.	✔	✔	
	CO 6	Understand the structure and replication of viruses, as well as the characteristics of prions, viroids, and virusoids, and their role in extreme environments.		✔	✔
Biotechnology Practicals 253010202	CO 1	Demonstrate proficiency in performing qualitative tests for the identification of various carbohydrates and interpreting the results effectively.	✔	✔	✔
	CO 2	Apply analytical techniques to detect and differentiate proteins in biological samples, enhancing understanding of protein structure and function.	✔	✔	
	CO 3	Develop the ability to perform lipid extraction and qualitative tests, fostering a deeper comprehension of lipid properties and their biological significance.	✔	✔	
	CO 4	Execute Cole's method for determining the viscosity of colloidal systems, gaining insight into molecular interactions in solutions.	✔	✔	
	CO 5	Investigate and evaluate different methods to observe and quantify cell motility, with an emphasis on understanding cellular dynamics and movement.	✔	✔	✔
	CO 6	Master various techniques for microbial culture preservation, ensuring the long-term viability and integrity of microorganisms for research and industrial applications.	✔	✔	✔
Semester 3					

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Cellular Biology 253010301	CO 1	Understand the chemistry and ultrastructure of various cell components, including cell walls, membranes, organelles (mitochondria, chloroplasts, Golgi bodies, etc.), and cytoskeletal structures, and analyze the cellular diversity among prokaryotes, archaea, and eukaryotes.	✔	✔	✔
	CO 2	Explain the fundamental concepts of cellular metabolism, including oxidation reduction reactions, energy generation, ATP synthesis, and the various metabolic pathways such as anabolism, catabolism, and respiration.	✔	✔	✔
	CO 3	Discuss the properties and mechanisms of enzymes, including catalysis and allosteric regulation, and how these enzymes coordinate cellular metabolism.	✔	✔	✔
	CO 4	Describe the processes of cell division, including the phases of mitosis, cell cycle regulation, and the role of cell growth, tumor development, senescence, and apoptosis.	✔	✔	✔
	CO 5	Explain the central dogma of molecular biology, the concept of genes, and the processes of transcription, translation, and gene expression, along with the operon model.	✔	✔	✔
	CO 6	Analyze the mechanisms of cell communication, including the roles of signaling molecules, receptors, junctions, plasmodesmata, and cell signaling pathways.	✔	✔	✔
Molecular Biology-I 253010302	CO 1	Understand the structure, properties, and features of prokaryotic DNA and explain the processes of unidirectional and bidirectional replication, including initiation, elongation, termination, the closed clamp, and rolling circle models.		✔	✔
	CO 2	Analyze the mechanisms of DNA damage and the DNA repair systems in prokaryotes to understand how cells maintain genomic stability.		✔	✔
	CO 3	Explain the process of prokaryotic transcription, including the roles of genes, promoters, and the stages of initiation, elongation, termination, and anti-termination, as well as post-transcriptional modifications.		✔	✔
	CO 4	Understand the operon concept and describe the regulation of gene expression in prokaryotes through the Lac and Trp operons.		✔	
	CO 5	Describe the genetic code, Wobble Hypothesis, and the steps of prokaryotic translation (initiation, elongation, termination), as well as the processes involved in post-translational modifications.		✔	✔

	CO 6	Understand the Restriction-Modification system in prokaryotes, including the types, nomenclature, properties, and functions of restriction enzymes such as EcoRI, BamHI, and SmaI.	✔	✔	✔
Biotechnology Practicals 253010303	CO 1	Perform various staining techniques to visualize bacterial flagella, endospores, and plant chloroplasts, enhancing the understanding of microbial structures and plant organelles.	✔	✔	
	CO 2	Identify and analyze the stages of mitosis through microscopy, developing proficiency in understanding cell division and structural organization within plant and microbial cells.	✔	✔	
	CO 3	Demonstrate skills in isolating and purifying DNA and RNA from plant tissues using appropriate techniques, contributing to molecular biology studies such as gene expression and plant genetics.		✔	✔
	CO 4	Understand bacterial motility by performing flagella staining, linking cellular structures to function through laboratory observations.	✔	✔	
	CO 5	Investigate Lac mutants to comprehend the principles of bacterial gene regulation, particularly the lac operon, and its role in controlling metabolic pathways.		✔	
	CO 6	Integrate various staining and isolation techniques to enhance understanding of both structural and functional aspects of cells and genetic material in microorganisms and plants.	✔	✔	✔
Semester 4					
Immunology-I 253010401	CO 1	Understand the structure and components of the immune system, including the process of hematopoiesis and the roles of key immune cells such as T cells, B cells, NK cells, and antigen-presenting cells (APCs)		✔	✔
	CO 2	Differentiate between the types of immunity, including innate vs. acquired, active vs. passive, and humoral vs. cell-mediated immunity, and explain the concepts of primary and secondary immune responses.		✔	✔
	CO 3	Define and classify antigens based on their properties, and understand the concepts of epitopes and haptens.		✔	✔
	CO 4	Understand the structure, types, and functions of antibodies, including their role in blood typing and the ABO and Rh blood group systems.	✔	✔	✔

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	CO 5	Explain the basic principles of antigen-antibody interactions, including the mechanisms of precipitation, agglutination, and cross-reactivity.	✔	✔	✔
	CO 6	Describe the techniques used to detect antigen-antibody interactions, including ELISA, RIA, and Western blotting, and understand their applications in immunological assays.	✔	✔	✔
Bioinstrumentation 253010402	CO 1	Understand the principles, instrumentation, and applications of UV-Visible spectroscopy, Atomic Absorption Spectroscopy, Flame Photometry, Nephlometry, Infra-Red Spectroscopy, and Mass Spectroscopy for protein characterization and identification.	✔	✔	✔
	CO 2	Explain the principles and types of electrophoresis, including its applications in protein and nucleic acid separation techniques such as PAGE, SDS-PAGE, Agarose Gel Electrophoresis, and Isoelectric Focusing (IEF).	✔	✔	✔
	CO 3	Understand the basic principles of sedimentation, and the types and applications of density gradient centrifugation (Rate Zonal and Isopycnic) and ultracentrifugation in biological sample analysis.		✔	✔
	CO 4	Understand the principles, types, and applications of various chromatographic techniques, including Paper Chromatography, Thin Layer Chromatography, Adsorption Chromatography, Ion Exchange Chromatography, Gas Liquid Chromatography, HPLC, and Affinity Chromatography.	✔	✔	✔
	CO 5	Understand the definition, branches, aims, and scope of bioinformatics, and its relevance in biological research.		✔	✔
	CO 6	Understand the types of bioinformatics databases (primary, secondary, tertiary, and composite) and database retrieval systems, and apply basic bioinformatics tools such as BLAST, sequence alignment, protein structure analysis, and utilize resources like NCBI and EBI.		✔	✔
Biotechnology Practicals 253010403	CO 1	Understand the effects of heavy metals, temperature, pH, and osmotic pressure on bacterial growth, analyzing microbial adaptability and survival mechanisms under various stress conditions.	✔	✔	✔
	CO 2	Examine the metabolic activity of E. coli and other bacteria, evaluating how environmental factors such as nutrients and stress affect microbial metabolism and energy production	✔	✔	

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	CO 3	Assess the effectiveness of antibiotics against Gram-positive and Gram-negative bacteria, understanding antibiotic resistance and sensitivity patterns.	✔	✔	✔
	CO 4	Cultivate anaerobic bacteria using the candle jar method, exploring the growth conditions and metabolic processes of anaerobes in the absence of oxygen	✔	✔	
	CO 5	Isolate, cultivate, and study moulds, understanding their growth patterns, morphological characteristics, and environmental significance.	✔	✔	
	CO 6	Master essential microbiological techniques for bacterial and fungal cultivation, including antibiotic sensitivity testing, anaerobic cultivation, and environmental impact studies on microbial growth.	✔	✔	✔
Semester 5					
Fermentation Technology-I 253010501	CO 1	Understand the fundamental concepts of fermentation, the historical development of industrial microbiology, and the various components and range of fermentation processes.		✔	✔
	CO 2	Describe the characteristics of industrially important microorganisms and apply techniques for primary and secondary screening for organic acid, antibiotic, enzyme, and growth factor producers.	✔	✔	✔
	CO 3	Understand the strategies for strain improvement, including the selection of induced mutants and recombinants, and apply preservation techniques and quality control for strain maintenance.		✔	✔
	CO 4	Explain the design and functions of a stirred-tank bioreactor, including its structural components, and describe devices used for aeration, agitation, and monitoring of pH, temperature, foam, and dissolved oxygen.	✔	✔	✔
	CO 5	Differentiate between types of fermentation processes, including submerged (batch, fed-batch, continuous) and solid-state fermentation.	✔	✔	✔
	CO 6	Understand the principles of fermentation media formulation, including the role of media ingredients, and explain the methods of sterilization and the principles for developing inoculum for bacterial, yeast, and fungal processes.	✔	✔	✔
	CO 1	Understand the concepts and applications of genomic and cDNA libraries, and explain the principles, types, and uses of PCR techniques, including basic PCR and RT-PCR.		✔	✔

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Molecular Techniques 253010502	CO 2	Explain various nucleic acid hybridization techniques, including colony and plaque hybridization, and techniques like Southern, Northern, and Western blotting, dot blotting, and differential screening	✔	✔	✔
	CO 3	Understand in situ hybridization and FISH, with both radioactive and non radioactive detection methods, and the principles and applications of autoradiography.		✔	✔
	CO 4	Describe molecular markers such as RFLP, RAPD, AFLP, SNP, and satellite DNA, and understand the DNA fingerprinting process and its applications.	✔	✔	✔
	CO 5	Explain the principles and methods of DNA sequencing, including chain termination, chemical cleavage, and automated sequencing techniques.		✔	✔
	CO 6	Understand the process of DNA foot printing, in vitro transcription and translation systems, and their applications in molecular biology research.		✔	✔
Environmental Biotechnology 253010503	CO 1	Understand the principles, strategies, and techniques of bioremediation, including both in situ and ex situ approaches, and explain the role of GMOs in enhancing bioremediation processes.	✔	✔	✔
	CO 2	Explain the processes involved in the bioremediation of metals and the use of phytoremediation in environmental cleanup.	✔	✔	✔
	CO 3	Understand the principles and mechanisms of biodegradation and detoxification, and explain the biodegradation of detergents, pesticides, lignin, hydrocarbons, and dyes.	✔	✔	✔
	CO 4	Explain the principles, mechanisms, and methods used to assess biodeterioration, and discuss the prevention and control strategies for biodeterioration of selected materials.	✔	✔	
	CO 5	Understand the principles and applications of biosensors, including their types, limitations, and use in environmental monitoring.	✔	✔	✔
	CO 6	Explain the concepts and technology behind bioplastics and bio transducers, and discuss their applications in solving environmental problems	✔	✔	✔
Genetic Engineering and Tissue culture 253010504	CO 1	Understand the characteristics of ideal vectors and explain the use of various vectors like plasmids (pBR322, pUC), bacteriophage lambda, and cosmids in recombinant DNA construction and transformation, including techniques such as antibiotic and blue-white selection.		✔	✔

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	CO 2	Explain the basic concepts of genetic engineering and describe the molecular tools used, including restriction endonucleases, DNA cutting and ligation techniques, and DNA modifying enzymes, as well as gene transfer methods.		✔	✔
	CO 3	Understand the fundamentals of tissue culture, with a focus on plant tissue culture (PTC), its methods, significance, and various applications in biotechnology.	✔	✔	✔
	CO 4	Explain the principles of animal tissue culture, including the differences between primary cultures and established cell lines, and the importance of equipment and materials in animal cell technology.		✔	✔
	CO 5	Describe the basic media formulations and techniques used in mammalian cell culture and their role in cell growth and maintenance.		✔	✔
	CO 6	Understand the manipulation and practical applications of animal and plant tissue culture techniques in research and biotechnology, including their potential uses in genetic modification and therapeutic applications.	✔	✔	✔
Biotechnology Practicals 253010505	CO 1	Understand the principles and techniques of alcohol estimation and production using baker's yeast, and their applications in industrial microbiology.	✔	✔	
	CO 2	Apply methods for the primary screening of microbial producers, including amylase enzymes, antibiotics, and organic acids, and understand their significance in biotechnology.	✔	✔	✔
	CO 3	Gain practical skills in utilizing bioinformatics databases like NCBI, DDBJ, and GenBank for sequence retrieval and analysis, and understand the basics of sequence alignment.		✔	✔
	CO 4	Understand and demonstrate the principles and applications of advanced molecular techniques such as RT-PCR and primer designing from cDNA libraries.		✔	✔
	CO 5	Analyze microbial biodeterioration and biodegradation processes, focusing on the breakdown of dyes by microorganisms and the impact of microorganisms on material degradation.	✔	✔	✔
	CO 6	Perform and understand environmental and plant tissue culture techniques, including the analysis of total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), and callus culture in plant tissue culture.	✔	✔	✔
Semester 6					

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Fermentation Technology-II 253010601	CO 1	Understand the principles of downstream processing, including methods for the removal of microbial cells and suspended solids such as foam separation, precipitation, filtration, and centrifugation, as well as cell disruption techniques.		✔	✔
	CO 2	Explain the processes involved in product concentration, purification, and finishing stages like liquid-liquid extraction, membrane processes, drying, crystallization, and effluent treatment	✔	✔	✔
	CO 3	Understand the methods for detecting and assaying fermentation products, including physical assays (titration, gravimetric analysis), chemical assays (chromatography, spectrophotometry), and biological assays (microbial assays).		✔	✔
	CO 4	Explain the microbial quality assurance methods used in fermentation, including sterility testing, the Limulus Amebocyte Lysate (LAL) test, and fermentation economics.	✔	✔	✔
	CO 5	Understand the fermentation processes involved in the production of industrial products such as alcohol, cheese, baker's yeast, glutamic acid, and citric acid.	✔	✔	
	CO 6	Explain the fermentative production of pharmaceuticals and industrial enzymes, including penicillin (and its conversion to semisynthetic derivatives), cyanocobalamin, steroids, amylase, and carotenoids.		✔	✔
Enzymology 253010602	CO 1	Understand the general characteristics, classification, and terminology related to enzymes, including holoenzymes, coenzymes, apoenzymes, cofactors, activators, inhibitors, and isoenzymes, as well as the concepts of turnover number and specific activity.		✔	✔
	CO 2	Explain the structure of enzyme active sites, the specificity of enzyme actions, and factors affecting enzyme activity, with a brief introduction to allosteric enzymes.		✔	✔
	CO 3	Derive and explain the Michaelis-Menten equation and its modifications, including various graphical methods like Lineweaver-Burk, Eadie-Hofstee, and Hanes-Woolf plots.		✔	✔
	CO 4	Understand the different types of enzyme inhibition, such as competitive, non-competitive, uncompetitive, mixed, and substrate inhibition, and their effects on enzyme kinetics.		✔	✔
	CO 5	Describe the types, methods, applications, advantages, and limitations of enzyme immobilization, with an introduction to reverse micelles.	✔	✔	✔

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	CO 6	Understand the sources and industrial applications of enzymes such as amylase, protease, and lipase in industries like detergent, leather, food, dairy, textile, and medical fields, including the industrial production of enzymes.	✔	✔	✔
Molecular Biology-II 253010603	CO 1	Understand the organization of the eukaryotic genome, DNA packaging, and the problems associated with eukaryotic replication, and explain the roles of various enzymes and proteins involved in the replication process.		✔	✔
	CO 2	Explain the central dogma of molecular biology, and describe the process of transcription in eukaryotes, including the roles of RNA polymerases, promoters, enhancers, and silencers in transcription initiation, elongation, and termination.		✔	✔
	CO 3	Understand post-transcriptional modifications, including the types of introns, RNA splicing, and the modification of 5' and 3' ends of tRNA and rRNA.		✔	✔
	CO 4	Explain the process of translation in eukaryotes, including the roles of ribosomes, initiation, elongation, termination, and the importance of post-translational modifications and protein targeting.		✔	✔
	CO 5	Understand the different types of mutations (spontaneous and induced), and describe their effects on protein-coding genes, including forward, reverse, and suppressor mutations.		✔	✔
	CO 6	Describe the various DNA repair mechanisms, including direct and indirect repair systems, SOS repair, and the structure and properties of transposable elements, as well as their application in transposon mutagenesis.		✔	✔
Biosafety, Bioethics & IPR 253010604	CO 1	Understand the fundamental concepts of biosafety, including standard laboratory practices, containment strategies, biosafety levels, biosafety guidelines in India, laboratory biosecurity, and risk assessment.	✔	✔	✔
	CO 2	Explain the principles of Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), and the basic concepts of Quality Control (QC) and Quality Assurance (QA), including guidelines for raw materials, sterilization, media, and product validation.	✔	✔	✔
	CO 3	Understand the role of culture collection centers, public health laboratories, and regulatory agencies in ensuring quality and safety in biological practices.	✔	✔	

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	CO 4	Comprehend the basics and principles of bioethics, regulatory concerns, international codes and guidelines in India, and the role of non-governmental organizations (NGOs) in biological regulations.	✔	✔	✔
	CO 5	Understand the different types of intellectual property rights (IPR) and their management, including the benefits and challenges associated with IPR in biotechnology.		✔	✔
	CO 6	Explain the patenting process, international harmonization of patent law, biotechnological process patents, and their protection, with a focus on the Indian scenario and case studies related to infringement.		✔	✔
Biotechnology Practicals 253010605	CO 1	Understand and apply sterility testing protocols for pharmaceutical products, ensuring compliance with safety and quality standards in microbiological assays.	✔	✔	✔
	CO 2	Demonstrate knowledge and skills in fermentation processes for the production of food products like cheese and sauerkraut, understanding the role of microbes in food biotechnology	✔	✔	
	CO 3	Perform isolation and analysis of biomolecules such as chloroplasts and eukaryotic DNA, gaining proficiency in essential cell biology and molecular biology techniques.		✔	✔
	CO 4	Apply immobilization techniques for cells and enzymes, including encapsulation, and understand their significance in industrial bioprocesses.		✔	✔
	CO 5	Analyze and quantify biomolecules such as streptomycin and paracetamol using chemical methods like sodium nitroprusside and colorimetry, and employ chromatography for purification.	✔	✔	✔
	CO 6	Demonstrate the use of advanced molecular biology techniques, such as agarose gel electrophoresis and the study of yeast artificial chromosomes, for DNA analysis and qualification.		✔	✔
			71	**120**	**99**

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Course Outcomes of B.Sc. Chemistry					
Academic Year 2020-21					
Course with Code	Name of CO	Description	Relevance to the		
			Local / Regional	National	Global
Semester 1					
253020101 - Basic Chemistry-I	CO 1	Identify the position of lanthanides and actinides in the periodic table and recall their electronic configurations.	✔	✔	
	CO 2	Describe the general mechanisms of organic reactions, including nucleophilic substitution, elimination, and addition reactions.	✔	✔	✔
	CO 3	Demonstrate the ability to write and balance chemical equations involving the combustion of alkanes.	✔	✔	✔
	CO 4	Analyze experimental data to identify the presence and quantity of elements in a compound.	✔	✔	✔
	CO 5	Apply the rules of Markovnikov and anti-Markovnikov additions to predict the products of addition reactions involving alkenes and alkynes.	✔	✔	✔
	CO 6	Design an experiment to measure the rate of a reaction and interpret the data to determine the reaction order and rate constant.	✔	✔	✔
253020102 - Chemistry Practicals	CO 1	List the cations belonging to each analytical group and recall the reagents used for their separation.	✔	✔	
	CO 2	Describe the concept of titration and the role of indicators in acid-base volumetric analysis.	✔	✔	✔
	CO 3	Perform systematic qualitative analysis to identify two unknown cations/anions in a given inorganic salt sample.	✔	✔	✔
	CO 4	Carry out acid-base titrations accurately, using appropriate indicators to determine the concentration of unknown solutions.	✔	✔	✔
	CO 5	Differentiate between similar cations based on their unique chemical behavior during group separation and confirmatory tests.	✔	✔	
	CO 6	Design a flow chart for the systematic identification of two unknown radicals in an inorganic salt.	✔	✔	
Semester 2					

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253020201 - Basic Chemistry-II	CO 1	Identify different types of chemical bonds (ionic, covalent, metallic, etc.) and recall the basic principles governing bond formation.	✔	✔	✔
	CO 2	Describe the basic principles of wave-particle duality and the Schrödinger equation in quantum chemistry.		✔	✔
	CO 3	Apply crystal field theory and ligand field theory to predict the geometry and magnetic properties of complex compounds.	✔	✔	✔
	CO 4	Analyze the stability and reactivity of coordination complexes based on their ligand and metal center interactions.	✔	✔	✔
	CO 5	Compare the stability of different conformations of simple organic molecules (e.g., ethane, butane) using Newman projections.	✔	✔	✔
	CO 6	Evaluate the energy barriers for conformational changes and predict the most stable conformer.	✔	✔	✔
253020202 - Chemistry Practicals	CO 1	Identify common organic compounds based on their physical properties such as color, odor, and texture.	✔	✔	
	CO 2	Explain the role of indicators in acid-base titrations and the concept of end-point determination.	✔	✔	✔
	CO 3	Perform spot tests to identify the presence of specific functional groups in an unknown organic sample.	✔	✔	✔
	CO 4	Carry out accurate volumetric titrations to determine the concentration of unknown acid or base solutions.	✔	✔	✔
	CO 5	Evaluate the accuracy and reliability of different organic spotting techniques based on experimental outcomes.	✔	✔	
	CO 6	Develop a protocol for a new volumetric analysis experiment, including the preparation of reagents, execution, and calculation of results.	✔	✔	✔
Semester 3					
253020301 - Fundamentals of Organic Chemistry	CO 1	Differentiate between various poly-nuclear hydrocarbons based on their chemical reactivity.	✔	✔	✔
	CO 2	Explain the atomicity and electronic properties of five- and six-membered hetero cycles.	✔	✔	✔
	CO 3	Evaluate the synthesis methods for heterocyclic compounds and their practical applications.	✔	✔	✔
	CO 4	Design synthetic routes for complex heterocyclic compounds used in pharmaceuticals.	✔	✔	✔
	CO 5	Analyze the reactivity of β–dicarbonyl compounds in different chemical environments.	✔	✔	✔

	CO 6	Identify and classify acids and bases according to the Bronsted-Lowry and Lewis definitions.	✔	✔	✔
253020302 - Fundamentals of Analytical Chemistry	CO 1	Explain the process of osazone formation and the role of carbohydrates in biological systems.	✔	✔	✔
	CO 2	Differentiate between different types of carbohydrates based on their structure and function.	✔	✔	✔
	CO 3	Describe the zwitterionic nature of amino acids and explain the concept of the isoelectric point.	✔	✔	✔
	CO 4	Predict the products of EAS (Electrophilic Aromatic Substitution) reactions given different aromatic substrates and electrophiles.	✔	✔	✔
	CO 5	Analyze the reactivity of β–dicarbonyl compounds in different chemical environments.	✔	✔	✔
	CO 6	Evaluate the synthesis methods for heterocyclic compounds and their practical applications.	✔	✔	✔
253020303 - Chemistry Practicals	CO 1	Explain the principles behind various organic separation techniques, such as distillation and extraction.	✔	✔	✔
	CO 2	Perform the separation and identification of compounds in an organic mixture using standard laboratory techniques.	✔	✔	✔
	CO 3	Interpret titration data to calculate the concentrations of calcium and magnesium ions in water.	✔	✔	✔
	CO 4	Analyze the factors affecting the completeness and accuracy of the precipitation reaction.	✔	✔	
	CO 5	Compare the results obtained from Mohr's and Volhard methods and discuss any discrepancies.	✔	✔	✔
	CO 6	Describe the principles behind argentometric titration and the role of indicators in these methods.	✔	✔	✔
Semester 4					
253020401 - Fundamentals of Inorganic Chemistry	CO 1	Solve basic quantum mechanical problems using the Schrödinger equation for simple systems like the particle in a box.		✔	✔
	CO 2	Analyze the behavior of quantum particles in different potential fields using wave mechanics.		✔	✔
	CO 3	Predict the magnetic and spectral properties of coordination compounds using Crystal Field Theory.	✔	✔	✔

	CO 4	Evaluate the role of non-aqueous solvents in industrial applications, such as in organic synthesis and electrochemistry.	✔	✔	✔
	CO 5	Apply bonding theories to predict molecular geometries and physical properties of molecules.	✔	✔	✔
	CO 6	Evaluate the suitability of different bonding models for explaining the behavior of complex molecules.	✔	✔	✔
253020402 - Fundamentals of Physical Chemistry	CO 1	Use qualitative and quantitative analysis methods to identify and quantify the components in various chemical samples.	✔	✔	✔
	CO 2	Analyze data from qualitative and quantitative analysis to interpret the composition and concentration of substances.	✔	✔	✔
	CO 3	Describe the process of redox titration, including the selection of appropriate indicators and the calculation of oxidation states.	✔	✔	✔
	CO 4	Analyze the environmental benefits and economic implications of adopting green chemistry practices in industrial and laboratory settings.	✔	✔	✔
	CO 5	Evaluate the suitability of precipitation titration and gravimetric analysis methods for different types of samples and compare their effectiveness with other quantitative analysis techniques.	✔	✔	✔
	CO 6	Conduct precipitation titrations and gravimetric analysis to quantitatively determine the concentration of analytes such as chloride or sulfate ions in a solution.	✔	✔	✔
253020403 - Chemistry Practical	CO 1	Explain the principles behind the systematic separation and identification of ions in an inorganic mixture.	✔	✔	✔
	CO 2	Measure the viscosity of different liquids using an Ostwald viscometer and calculate the viscosity coefficient.	✔	✔	✔
	CO 3	Explain how the concentration of water and methanol in a mixture influences its viscosity and how this can be measured.	✔	✔	✔
	CO 4	Analyze viscosity data to assess the proportional relationship between water concentration and the measured viscosity.	✔	✔	✔
	CO 5	Perform experiments to determine the reaction order for the hydrolysis of methyl acetate (first-order kinetics) and alkaline hydrolysis of ethyl acetate (second-order kinetics).	✔	✔	✔

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	CO 6	Evaluate the advantages and limitations of conductometric titration compared to other titration methods, such as pH-based titration, in determining the concentration of strong acids and bases.	✔	✔	✔
Semester 5					
253020501 - Organic Chemistry – C-I	CO 1	List the different classes of carbohydrates.	✔	✔	✔
	CO 2	Explain the structural differences between glucose and fructose.	✔	✔	✔
	CO 3	Demonstrate the formation of glycosidic bonds in the synthesis of disaccharides.	✔	✔	✔
	CO 4	Compare the chemical reactivity of aldoses and ketoses in various organic reactions.	✔	✔	✔
	CO 5	Evaluate the role of carbohydrates in biological processes like energy storage and cell signaling.	✔	✔	✔
	CO 6	Synthesize a carbohydrate derivative with potential applications in drug development.		✔	✔
253020502 – Inorganic Chemistry – C-I	CO 1	Identify the different symmetry elements and symmetry operations in molecules.	✔	✔	✔
	CO 2	Explain the significance of molecular symmetry in determining the physical and chemical properties of molecules.	✔	✔	✔
	CO 3	Use symmetry elements to classify molecules into different point groups.	✔	✔	✔
	CO 4	Analyze the relationship between molecular symmetry and spectroscopic selection rules.		✔	✔
	CO 5	Evaluate the role of symmetry in predicting molecular vibrations and their infrared/Raman activity.		✔	✔
	CO 6	Design a molecule with specific symmetry properties that could serve as a model for studying symmetry-related phenomena.			✔
253020503 – Physical Chemistry – C-I	CO 1	List the laws of thermodynamics and key thermodynamic terms.	✔	✔	✔
	CO 2	Explain the concept of entropy and how it relates to the spontaneity of a process.	✔	✔	✔
	CO 3	Calculate the change in Gibbs free energy for a chemical reaction and predict whether it will occur spontaneously.	✔	✔	✔
	CO 4	Analyze a phase diagram to determine the conditions under which different phases of a substance exist.	✔	✔	✔
	CO 5	Evaluate the efficiency of a heat engine or refrigeration cycle using thermodynamic principles.		✔	✔
	CO 6	Develop a new thermodynamic cycle that maximizes efficiency for a specific industrial process.			✔

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253020504 – Analytical Chemistry – C-I	CO 1	List the types of electronic transitions commonly observed in UV spectroscopy.	✔	✔	✔
	CO 2	Explain how the Beer-Lambert Law relates absorbance to concentration and path length in UV spectroscopy.	✔	✔	✔
	CO 3	Use UV spectra to determine the concentration of a compound in solution by applying the Beer-Lambert Law.	✔	✔	✔
	CO 4	Analyze the UV spectra of different conjugated systems to understand the effect of conjugation on absorption maxima.	✔	✔	✔
	CO 5	Evaluate the limitations of UV spectroscopy in determining the structure of complex molecules.		✔	✔
	CO 6	Design an experiment using UV spectroscopy to monitor the progress of a photochemical reaction.			✔
253020505 – Chemistry Practicals	CO 1	Analyze kinetics data using various methods and interpret solubility equilibrium data to assess factors affecting solubility in inorganic compounds.	✔	✔	✔
	CO 2	Explain the impact of factors like temperature, catalysts, and concentration on reaction rates, and the role of solubility equilibria in solutions.	✔	✔	✔
	CO 3	Use integrated rate laws and solubility principles to solve problems involving reaction kinetics and solubility equilibria.	✔	✔	✔
	CO 4	Apply solubility rules, precipitation methods, and flame tests to distinguish between different cations and anions in inorganic mixtures.	✔	✔	
	CO 5	Analyze and interpret qualitative tests and separate ions based on chemical properties in complex inorganic mixtures.	✔	✔	
	CO 6	Recall principles of cation and anion analysis, along with reagents and general procedures in inorganic qualitative analysis.	✔	✔	
Semester 6					
253020601 – Organic Chemistry - C-II	CO 1	Identify the key types of synthetic dyes.	✔	✔	✔
	CO 2	Explain the chemical processes involved in dye synthesis and application.	✔	✔	✔
	CO 3	Demonstrate the process of dyeing a textile with a synthetic dye.	✔	✔	
	CO 4	Compare and contrast synthetic dyes with natural dyes in terms of environmental impact and colorfastness.	✔	✔	✔
	CO 5	Assess the environmental impact of synthetic dye production.	✔	✔	✔

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	CO 6	Design a more sustainable synthetic dye with reduced toxicity.		✔	✔
253020602 – Inorganic Chemistry - C-II	CO 1	List the different types of chemical bonds.	✔	✔	✔
	CO 2	Explain the concept of hybridization and how it influences molecular geometry.	✔	✔	✔
	CO 3	Predict the molecular structure and bond angles of a given molecule using VSEPR theory.	✔	✔	✔
	CO 4	Compare the strengths and properties of different types of bonds in various compounds.	✔	✔	✔
	CO 5	Assess the impact of chemical bonding on the physical and chemical properties of substances.	✔	✔	✔
	CO 6	Design a molecule with specific properties by manipulating chemical bonds.		✔	✔
253020603 – Physical Chemistry - C-II	CO 1	List the laws of thermodynamics and key terms.	✔	✔	✔
	CO 2	Explain how the first and second laws of thermodynamics govern energy changes in chemical reactions.	✔	✔	✔
	CO 3	Calculate the Gibbs free energy change for a chemical reaction under standard conditions.	✔	✔	✔
	CO 4	Compare endothermic and exothermic reactions in terms of enthalpy and entropy changes.	✔	✔	✔
	CO 5	Assess the spontaneity of a chemical reaction by evaluating the signs of enthalpy, entropy, and Gibbs free energy.	✔	✔	✔
	CO 6	Design an experiment to measure the heat capacity of a substance and interpret the results using thermodynamic principles.		✔	✔
253020604 – Analytical Chemistry - C-II	CO 1	List the different types of errors in analytical chemistry.		✔	✔
	CO 2	Explain the significance of accuracy, precision, and sensitivity in analytical measurements.		✔	✔
	CO 3	Calculate the standard deviation and confidence interval for a set of analytical data.		✔	✔
	CO 4	Analyze a data set to identify possible sources of error and suggest ways to minimize them.		✔	✔
	CO 5	Evaluate the reliability and validity of analytical data by comparing it with known standards.		✔	✔
	CO 6	Develop a protocol for the systematic treatment of errors in a new analytical method.		✔	✔
253020605 – Chemistry Practicals	CO 1	Explain the steps involved in gravimetric analysis, including precipitation, filtration, drying, and weighing to determine the amount of radicals.		✔	✔
	CO 2	Analyze the gravimetric data obtained during experiments and interpret the results to evaluate the concentration of radicals in the sample.		✔	✔
	CO 3	Apply separation and identification techniques to organic mixtures such as acid-base, acid-phenol, and neutral-neutral using practical laboratory methods.	✔	✔	✔

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	CO 4	Analyze titration curves and stoichiometric relationships to interpret the amount of analyte present in a solution based on volumetric data.		✔	✔
	CO 5	Evaluate the efficiency of separation and identification techniques by comparing the physical and chemical properties of the separated compounds with known standards.		✔	✔
	CO 6	Explain the principles behind EDTA titrations and Mohr's method for the quantitative analysis of metal ions and chloride ions.	✔	✔	✔
		Total	96	117	109

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Course Outcomes of B.Sc. Mathematics					
Academic Year 2020-21					
Course with Code	**Number of CO**	**Description**	**Relevance to the**		
			Local / Regional	**National**	**Global**
		Semester 1			
Calculus and Algebra 253030101	CO 1	Recall standard results for the n^{th} derivative and Leibniz's Theorem. Define the limit of a sequence and understand the convergence/divergence of series.	✔	✔	
	CO 2	State Rolle's Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value Theorem, Taylor's and Maclaurin's Theorems.	✔	✔	
	CO 3	Analyze indeterminate forms and apply L'Hôpital's Rules to resolve them.	✔	✔	
	CO 4	Identify different types of matrices and recall basic operations and theorems related to matrices.	✔	✔	
	CO 5	Apply theorems and concepts of matrices to solve systems of simultaneous linear equations using Cramer's rule and matrix methods.	✔	✔	✔
	CO 6	Analyze the consistency of a system of simultaneous linear equations using relevant theorems.	✔	✔	✔
Mathematics Practical 253030102	CO 1	Practicals based on integral and successive differentiation	✔	✔	
	CO 2	Practicals based on convergence of infinite series, Mean Value Theorems, Expansions of functions, and L'Hôpital's Rule	✔	✔	
	CO 3	Practicals based on matrices and its applications	✔	✔	✔
	CO 4	Practicals based on tracing of curves	✔	✔	✔
	CO 5	Find some solutions using the Leibniz Theorems	✔	✔	
	CO 6	Practicals based on integrals and derivatives	✔	✔	
		Semester 2			
Differential Equation and Coordinate	**CO1**	Determine the suitability of a particular method for solving a given differential equation of the first order and first degree.	✔	✔	
	CO2	Assess the general and singular solutions of first-order higher-degree differential equations, including Clairaut's and Lagrange's differential equations.	✔	✔	

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Geometry 253030201	**CO3**	Identify and define linear differential equations of higher order and degree one with constant coefficients.	✔	✔	
	CO4	Describe the Cartesian and general equations of a sphere, and the properties of tangency and normality in relation to spheres.	✔	✔	✔
	CO5	Evaluate the conditions for orthogonality of spheres and the tangency of planes to spheres.	✔	✔	✔
	CO6	Analyze the different types of cones and cylinders and their equations, particularly the right circular cone and cylinder.	✔	✔	✔
Mathematics Practical 253030202	**CO1**	Apply methods for solving first-order differential equations (separation of variables, integrating factor, Bernoulli method).	✔	✔	
	CO2	Solve higher-degree first-order differential equations (solvable for y,x,p); Clairaut's and Lagrange's equations.	✔	✔	
	CO3	Analyze and solve linear differential equations of higher order (constant/variable coefficients; complementary functions, inverse operators, Euler form).	✔	✔	
	CO4	Perform geometric operations involving spheres in R3\mathbb{R}^3R3; intersections, tangent planes, normals.	✔	✔	✔
	CO5	Classify and analyze conicoids in R3; understand geometric properties and solve related problems.	✔	✔	✔
	CO6	Convert and apply polar coordinates in R2 and R3; solve problems involving cones and cylinders.	✔	✔	✔
		Semester 3			
Linear Algebra 253030301	**CO1**	Explain the concept of a limit and the process of differentiation, including the chain rule, and derivatives of inverse, implicit, parametric, exponential, and logarithmic functions.	✔	✔	
	CO2	Assess the correctness of derivative calculations for different functions, including implicit and parametric functions.	✔	✔	
	CO3	Explain the process of integration and how it applies to various types of functions, including trigonometric substitutions.	✔	✔	
	CO4	Calculate definite integrals using the fundamental theorem of calculus and apply it to solve real-world problems.	✔	✔	✔
	CO5	Explain the concept of differential equations and the specific methods used to solve first-order and first-degree equations.	✔	✔	

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	CO6	Evaluate the solutions to differential equations, ensuring they meet the initial conditions and are mathematically sound.	✔	✔	
Numerical Analysis 253030302	**CO1**	Explain the concepts of repeated or iterated integrals and the transformation of double and triple integrals, including the introduction to the Jacobian.	✔	✔	
	CO2	Evaluate the effectiveness of using multiple integrals in solving complex geometric and physical problems.	✔	✔	✔
	CO3	Explain the properties of Beta and Gamma functions and how they can be used to evaluate definite integrals.	✔	✔	
	CO4	Analyze complex vector fields using the integral theorems and apply them to solve real-world problems.	✔	✔	✔
	CO5	Explain the concepts of complete and particular integrals in first-order PDEs and Lagrange's method for solving linear equations.	✔	✔	
	CO6	Evaluate different solution methods for PDEs and assess their effectiveness in solving complex mathematical problems.	✔	✔	
Mathematics Practical 253030303	**CO1**	Apply the concept of limits to determine the continuity and behavior of polynomial, rational, and trigonometric functions.	✔	✔	
	CO2	Solve integration problems using standard methods such as substitution, including trigonometric substitution, and integration by parts.	✔	✔	
	CO3	Classify and solve first-order and first-degree differential equations using methods like variable separation and understand their applications in real-world modeling.	✔	✔	✔
	CO4	Evaluate double and triple integrals and interpret their geometric significance, applying these concepts to solve practical problems in multiple dimensions.	✔	✔	✔
	CO5	Utilize Beta and Gamma functions to evaluate definite integrals and understand their properties.	✔	✔	
	CO6	Apply and verify Green's, Gauss's divergence, and Stokes's theorems to solve line, surface, and volume integrals, interpreting the physical implications of the results.	✔	✔	✔
		Semester 4			
Advanced Calculus 253030401	**CO1**	Apply numerical methods such as the Bisection Method, Iteration Method, Aitken's Δ^2 Process, and Method of False Position to find roots of algebraic and transcendental equations.	✔	✔	✔

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	CO2	Utilize the Newton-Raphson method to solve nonlinear equations and understand its application in various scientific and engineering problems.	✔	✔	✔
	CO3	Perform interpolation using forward, central, and backward differences, and utilize symbolic relations of operators to detect and correct errors in difference tables.	✔	✔	
	CO4	Compute differences of polynomials and apply Newton's forward and backward formulae for interpolation in uniformly spaced data.	✔	✔	
	CO5	Use advanced interpolation techniques such as Gauss forward/backward, Bessel's, Stirling's, and Everett's formulae for complex interpolation problems.	✔	✔	
	CO6	Apply Lagrange's interpolation method to solve problems involving unequally spaced data points; understand its real-world applications.	✔	✔	✔
Algebra and Statistical mathematics 253030402	**CO1**	Apply numerical methods (Newton's forward/backward, Gauss's method) to determine max/min values of a tabulated function.	✔	✔	✔
	CO2	Implement numerical integration techniques (Trapezoidal, Simpson's 1/3 and 3/8 rules) to approximate definite integrals.	✔	✔	✔
	CO3	Solve ODEs using Romberg, Taylor's series, Picard's, Euler's, modified Euler's, and second-order Runge-Kutta methods.	✔	✔	✔
	CO4	Comprehend the definition and properties of linear transformations and apply them in various mathematical contexts.	✔	✔	
	CO5	Analyze the relationship between matrices and linear maps; construct matrices for linear transformations and vice versa using practical examples.	✔	✔	
Mathematics Practical 253030403	**CO1**	Apply numerical differentiation (Newton's forward/backward, Gauss) and numerical integration (Trapezoidal, Simpson's 1/3 and 3/8 rules).	✔	✔	✔
	CO2	Solve ODEs using Romberg integration, Taylor's series, Picard's method, Euler's methods, and Runge-Kutta up to second order.	✔	✔	✔
	CO3	Comprehend the definition and properties of linear transformations and apply them in mathematical contexts.	✔	✔	
	CO4	Analyze the relationship between matrices and linear maps, construct matrices for linear transformations, and vice versa using practical examples.	✔	✔	
	CO5	Apply Newton-Raphson for root-finding; perform interpolation using various finite differences, understand symbolic operators, and detect errors using difference tables.	✔	✔	✔

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	CO6	Perform interpolation with unequally spaced data using Lagrange's formula, divided differences, Newton's general formula, inverse interpolation, and successive approximations.	✔	✔	✔
		Semester 5			
Complex Analysis 253030501	**CO1**	Understand and apply the basic properties of complex numbers, including their moduli, conjugates, and polar coordinates.	✔	✔	
	CO2	Analyze and apply De Moivre's theorem to find the roots of complex numbers and perform operations in exponential form.	✔	✔	
	CO3	Evaluate the convergence of sequences and series in the context of complex numbers, including trigonometric and hyperbolic functions.	✔	✔	
	CO4	Apply theorems related to limits, continuity, and differentiation in complex functions, including the use of Cauchy-Riemann equations.	✔	✔	
	CO5	Understand and analyze analytic and harmonic functions; apply principles of mapping and conformal mapping using elementary functions.	✔	✔	✔
	CO6	Evaluate and compute line integrals in the complex plane, and apply Cauchy's integral formula and Liouville's theorem in practical contexts.	✔	✔	✔
Operation Research 253030502	**CO1**	Understand the concepts of convex sets and linear programming problems, including extreme points, convex combinations, and theorems on convexity.	✔	✔	
	CO2	Apply formulation techniques to LP problems and solve them using the Simplex method, Big-M method, and Two-Phase method.	✔	✔	✔
	CO3	Analyze duality in LP, formulate dual problems, and evaluate relationships between primal and dual solutions.	✔	✔	
	CO4	Apply the dual simplex method to solve LP problems and interpret the results.	✔	✔	
	CO5	Understand and apply concepts of transportation and assignment problems, including formulation, initial feasible solutions, and optimality tests (MODI, Hungarian Method).	✔	✔	✔
	CO6	Solve unbalanced transportation and assignment problems using appropriate methods and evaluate the efficiency of solutions.	✔	✔	✔
	CO1	Identify relations and functions, including binary operations and their significance in algebraic structures.	✔	✔	

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Discrete Mathematics 253030503	**CO2**	Illustrate the structure of different graphs (simple graphs, digraphs, etc.) and apply graph theory concepts such as paths, trails, walks, circuits, and cycles.	✔	✔	✔
	CO3	Apply lattice theory to understand meet and join operations, and explore sublattices, order-preserving functions, and isomorphisms.	✔	✔	
	CO4	Explain the properties of Boolean algebra and its role in the analysis of switching circuits.	✔	✔	✔
	CO5	Explore advanced topics like Boolean homomorphisms, isomorphisms, and the Stone Representation Theorem for practical and theoretical purposes.	✔	✔	
	CO6	Construct and analyze subgraphs and multiple paths in practical scenarios.	✔	✔	✔
Abstract Algebra 253030504	**CO1**	Explain binary operations, the division algorithm, and congruence modulo relation in the set of integers.	✔	✔	
	CO2	Analyze the structure and properties of subgroups, including normalizers, centralizers, cyclic groups, and lattice diagrams of finite groups.	✔	✔	
	CO3	Apply Lagrange's theorem, Euler's theorem, and Fermat's theorem to solve problems related to group theory.	✔	✔	
	CO4	Define and work with permutations, including cycles, transpositions, and the distinction between even and odd permutations.	✔	✔	
	CO5	Understand the structure of symmetric and alternating groups, and analyze quotient groups and normal subgroups.	✔	✔	
	CO6	Apply the concepts of isomorphism and homomorphism in groups, understanding their definitions and properties.	✔	✔	
Mathematics Practical 253030505	**CO1**	Solve Linear Programming Problems (LPP) using the Simplex, Big-M, and Two-Phase methods.	✔	✔	✔
	CO2	Solve dual problems using the Dual Simplex method and interpret the relationship between primal and dual solutions.	✔	✔	✔
	CO3	Solve balanced and unbalanced assignment problems using the Hungarian method.	✔	✔	✔
	CO4	Perform operations such as sum, product, and roots of complex numbers in polar and exponential forms.	✔	✔	
	CO5	Solve problems involving differentiability, continuity, and harmonic functions.	✔	✔	
	CO6	Solve conformal mapping problems using elementary and Möbius transformations.	✔	✔	
		Semester 6			

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	CO1	Formulate Linear Programming (LP) problems and recognize different problem-solving techniques, including the Simplex, Big-M, and Two-Phase methods.	✔	✔	✔
	CO2	Solve LP problems using the Simplex method, Big-M (Penalty) method, and Two-Phase method.	✔	✔	✔
	CO3	Compare and interpret the solutions of primal and dual problems, and solve them using the Dual Simplex method.	✔	✔	✔
	CO4	Formulate and solve transportation problems using methods such as North-West Corner Rule, Least Cost Method, and Vogel's Approximation Method.	✔	✔	✔
	CO5	Conduct an optimality test using the MODI method and address issues like degeneracy and unbalanced problems.	✔	✔	✔
	CO1	Define and apply binary operations and algebraic structures, and understand their operations on functions.	✔	✔	✔
	CO2	Define different types of graphs such as simple graphs, digraphs, and random graphs, and analyze their properties.	✔	✔	✔
	CO3	Apply concepts such as paths, subgraphs, circuits, cycles, and equivalence relations in solving graph theory problems.	✔	✔	✔
	CO4	Define and explore properties of relations, including reflexive, symmetric, antisymmetric, transitive, and equivalence relations.	✔	✔	✔
	CO5	Analyze partially ordered sets (posets), Hasse diagrams, and lattice structures, including meet and join operations, lattice homomorphism, and isomorphism.	✔	✔	✔
Analysis-III 253030603	**CO1**	Explain congruence modulo relation in integers and describe groups with examples.	✔	✔	✔
	CO2	Distinguish between commutative and non-commutative groups and create group tables for finite groups.	✔	✔	✔
	CO3	Apply Lagrange's theorem and Euler's theorem in solving group-related problems, and understand Fermat's theorem.	✔	✔	✔
	CO4	Define and work with permutations, cycles, and transpositions, and differentiate between even and odd permutations.	✔	✔	✔
	CO5	Calculate the order of a permutation and work with symmetric and alternating groups.	✔	✔	✔
	CO6	Understand the kernel of a homomorphism and apply the fundamental theorem of homomorphisms.	✔	✔	✔

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Graph Theory 253030604	**CO1**	Apply the Fundamental Theorem of Calculus, integration by parts, and change of variable in solving problems.	✔	✔	✔
	CO2	Use advanced tests such as Condensation Test and Pringsheim's Test for series with positive terms.	✔	✔	
	CO3	Analyze and apply the ratio and root tests using lim sup and lim inf for absolute convergence.	✔	✔	
	CO4	Apply Merten's theorem in the context of series and study power series expansions.	✔	✔	
	CO5	State and apply Taylor's theorem with Lagrange and Cauchy forms of the remainder.	✔	✔	✔
	CO6	Expand functions like exponential, logarithmic, and trigonometric using Taylor and Binomial series.	✔	✔	✔
Mathematics Practical 253030605	**CO1**	Compute and interpret Riemann sums for various functions and intervals.	✔	✔	✔
	CO2	Use comparison tests, condensation tests, and Pringsheim's test to analyze the convergence of series with positive terms.	✔	✔	
	CO3	Understand and use advanced concepts such as Cauchy product and Merten's theorem in series analysis.	✔	✔	
	CO4	Expand functions like exponential, logarithmic, and trigonometric functions into Taylor series.	✔	✔	✔
	CO5	Simplify Boolean expressions and design switching circuits based on Boolean algebra principles.	✔	✔	✔
	CO6	Solve problems involving permutations, normal subgroups, and homomorphisms using practical examples.	✔	✔	✔
			117	117	60

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Course Outcomes of B.Sc. Microbiology					
Academic Year 2020-21					
Course with Code	**Name of CO**	**Description**	**Relevance to the**		
			Local / Regional	**National**	**Global**
		Semester 1			
Introduction to the Microbial world 253040101	CO 1	Explain the historical developments in microbiology, including the discovery of microbes, theory of biogenesis, and key advances in pure culture techniques, germ theory, and vaccination.	✔	✔	✔
	CO 2	Compare the characteristics and habitats of prokaryotic and eukaryotic organisms, and evaluate the significance and applications of microbiology in various fields.	✔	✔	✔
	CO 3	Demonstrate understanding of pure culture techniques, including methods of isolation, preservation, and the role of culture collections in microbiological research.	✔	✔	✔
	CO 4	Apply various microscopy techniques, such as light, dark field, phase contrast, fluorescence, and electron microscopy, to study microbial structures and characteristics.		✔	✔
	CO 5	Analyze the chemistry and mechanism of dyes and stains, and their role in microbiological staining techniques for observing microorganisms	✔	✔	
	CO 6	Evaluate the practical uses of microbiological techniques in applied microbiology, genetic engineering, and biotechnology	✔	✔	✔
Microbiology Practicals 253040102	CO 1	Demonstrate the correct use of microbiological instruments such as autoclave, laminar air fl, hot air oven, colony counter, and shaker in laboratory experiments.	✔	✔	
	CO 2	Perform proper cleaning and sterilization of glassware to ensure contamination-free experiments.	✔	✔	
	CO 3	Apply standard protocols for the safe disposal of laboratory waste and microbial cultures, maintaining biosafety standards.	✔	✔	✔

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	CO 4	Develop basic microbial handling skills, including aseptic techniques and inoculation methods, to work safely with microorganisms	✔	✔	✔
	CO 5	Prepare various types of microbiological media and broth, understanding their composition and role in microbial growth.	✔	✔	
	CO 6	Conduct negative staining techniques to observe microbial cell morphology and differentiate bacterial structures.	✔	✔	
		Semester 2			
Basic Bacteriology 253040201	CO 1	Explain the principles of bacterial taxonomy, including the binomial system of nomenclature and various classification systems for typical prokaryotes.		✔	✔
	CO 2	Analyze the cellular organization of bacteria, including their size, shape, arrangement, and structures involved in spore formation, sporulation, and germination		✔	✔
	CO 3	Describe the structural components of a bacterial cell, including surface appendages (flagella, pili, fimbriae, prosthecae, and stalks), surface layers (capsule, slime layer, cell wall), and internal organelles (cytoplasmic membrane, ribosome, plasmids).	✔	✔	✔
	CO 4	Evaluate the nutritional requirements and diversities in bacteria, and explain the formulation, ingredients, and types of culture media used for bacterial cultivation.	✔	✔	
	CO 5	Identify and compare the various methods of microbial control, including the use of physical agents (heat, radiation, filtration) and chemical agents (phenols, halogens, surfactants, alcohols, heavy metals, and gaseous agents).	✔	✔	✔
	CO 6	Apply the principles of microbial control and understand the significance of killing, inhibition, and removal methods in preventing microbial growth.	✔	✔	✔
Microbiology Practicals 253040202	CO 1	Explain the techniques of microbial staining, including fixation and smear preparation.	✔	✔	
	CO 2	Perform Gram staining to differentiate between Gram-positive and Gram-negative bacteria.	✔	✔	✔
	CO 3	Apply the streak plate method to isolate pure bacterial colonies.	✔	✔	

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	CO 4	Utilize the spread plate technique for the enumeration of microbial cells.	✔	✔	
	CO 5	Implement the pour plate technique to culture and quantify microbial populations.	✔	✔	
	CO 6	Identify bacterial species based on staining and morphological characteristics.	✔	✔	✔
		B.Sc. Semester III			
Microbial Physiology 253040301	CO 1	Describe the chemical structure, properties, classification, and biological significance of biomolecules including carbohydrates, proteins, lipids, and nucleic acids.		✔	✔
	CO 2	Explain the structure, function, and classification of enzymes, including their physical and chemical properties, and mechanisms of enzyme action.		✔	✔
	CO 3	Analyze the factors affecting enzyme activity and differentiate between competitive and non-competitive enzyme inhibition.	✔	✔	✔
	CO 4	Classify bacteria based on environmental growth requirements and compare different modes of nutrient uptake in bacteria.	✔	✔	✔
	CO 5	Explain the processes of microbial metabolism, including anabolism, catabolism, and the role of reducing power, precursor metabolites, and energy-rich compounds.	✔	✔	✔
Soil & Water Microbiology 253040302	CO 1	Describe the physicochemical characteristics of soil, methods for studying soil microflora, and the microbial interactions in soil, including neutral, positive, and negative associations.	✔	✔	✔
	CO 2	Explain the role of microorganisms as biogeochemical agents, including their involvement in the nitrogen, sulfur, carbon, iron, and phosphorus cycles.	✔	✔	✔
	CO 3	Analyze the significance of the rhizosphere, mycorrhiza, and microbial interactions with plant roots in enhancing soil fertility and biofertilizer production.	✔	✔	✔
	CO 4	Evaluate the sources of contamination in natural water, microbial indicators of fecal pollution, and the methods used for bacteriological examination of drinking water.	✔	✔	✔

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	CO 5	Interpret the microbiological and chemical characteristics of wastewater, including the role of BOD, COD, and TOD in assessing water quality.	✔	✔	✔
	CO 6	Apply methods of wastewater treatment, including primary, secondary, and advanced treatment processes, and explain the role of microorganisms in solid waste processing such as anaerobic sludge digestion and composting.	✔	✔	✔
Microbiology Practicals 253040303	CO 1	Perform microbial diversity analysis in soil using the Winogradsky column and analyze the results to understand different microbial niches.	✔	✔	✔
	CO 2	Demonstrate the buried slide method to study soil microflora and interpret the microbial interactions and diversity present in the soil sample.	✔	✔	✔
	CO 3	Conduct microbiological analysis of soil and water, including Standard Plate Count (SPC) and Most Probable Number (MPN) methods, to evaluate bacterial abundance and quality.	✔	✔	✔
	CO 4	Measure the moisture content in soil samples and estimate macromolecules such as carbohydrates (using the DNSA method) and proteins (using the Folin-1ry method) in biological samples.	✔	✔	
	CO 5	Analyze bacterial growth curves through laboratory experiments and interpret the effects of various factors on bacterial growth dynamics.	✔	✔	
	CO 6	Evaluate the effect of antibiotics on bacterial growth and assess their efficiency in inhibiting microbial proliferation by performing susceptibility tests.	✔	✔	✔
		B.Sc. Semester IV			
Bacterial Diversity 253040401	CO 1	Perform microbial diversity analysis in soil using the Winogradsky column and analyze the results to understand different microbial niches.	✔	✔	✔
	CO 2	Demonstrate the buried slide method to study soil microflora and interpret the microbial interactions and diversity present in the soil sample.	✔	✔	✔
	CO 3	Conduct microbiological analysis of soil and water, including Standard Plate Count (SPC) and Most Probable Number (MPN) methods, to evaluate bacterial abundance and quality.	✔	✔	✔

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	CO 4	Measure the moisture content in soil samples and estimate macromolecules such as carbohydrates (using the DNSA method) and proteins (using the Folin-1ry method) in biological samples.	✔	✔	
	CO 5	Analyze bacterial growth curves through laboratory experiments and interpret the effects of various factors on bacterial growth dynamics.	✔	✔	
	CO 6	Evaluate the effect of antibiotics on bacterial growth and assess their efficiency in inhibiting microbial proliferation by performing susceptibility tests.	✔	✔	✔
Food & Dairy Microbiology 253040402	CO 1	Identify the microbial flora present in various food sources such as fruits, vegetables, meat, eggs, and milk, and explain how food serves as a substrate for microorganisms.	✔	✔	✔
	CO 2	Analyze the intrinsic and extrinsic factors that influence the types and numbers of microorganisms in food.	✔	✔	✔
	CO 3	Differentiate between foodborne infections caused by bacteria, viruses, and protozoa, and describe their sources, incubation periods, and clinical characteristics.	✔	✔	✔
	CO 4	Examine the role of microorganisms like *Staphylococcus aureus*, *Clostridium botulinum*, and *Salmonella* spp. in food poisoning, and discuss the role of molds in food toxicity, including agents like *Aspergillus* and *Claviceps purpurea*.	✔	✔	✔
	CO 5	Evaluate methods of microbial food spoilage and preservation, including pasteurization, sterilization, refrigeration, and the use of preservatives, assessing their effectiveness in preventing spoilage in various foods.	✔	✔	✔
	CO 6	Discuss the role of microbes in the production of fermented foods, probiotics, and prebiotics, and apply microbiological techniques to the examination and analysis of food and milk products, following food safety standards and certification practices in India.	✔	✔	✔
Microbiology Practicals 253040403	CO 1	Isolate and identify fungi from environmental and clinical samples using appropriate techniques and demonstrate proficiency in fungal staining methods.	✔	✔	✔

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	CO 2	Analyze the skin flora by isolating and identifying common microorganisms found on human skin and evaluate their significance in health and disease.	✔	✔	✔
	CO 3	Perform cell wall staining procedures to visualize and interpret the structural components of microbial cell walls.	✔	✔	
	CO 4	Apply acid-fast staining techniques to distinguish acid-fast bacteria from non-acid-fast organisms, and assess their role in microbial identification.	✔	✔	✔
	CO 5	Execute the Methylene Blue Reduction Test (MBRT) to determine the microbial quality and spoilage potential of milk samples.	✔	✔	
	CO 6	Conduct microbiological analysis of food and milk, including quantitative analysis using Standard Plate Count (SPC), and interpret results to assess food safety and quality.	✔	✔	✔
		B.Sc. Semester V			
Fermentation technology-I 253040501	CO 1	Understand the fundamental concepts of fermentation, the historical development of industrial microbiology, and the various components and range of fermentation processes.	✔	✔	✔
	CO 2	Describe the characteristics of industrially important microorganisms and apply techniques for primary and secondary screening for organic acid, antibiotic, enzyme, and growth factor producers.	✔	✔	✔
	CO 3	Understand the strategies for strain improvement, including the selection of induced mutants and recombinants, and apply preservation techniques and quality control for strain maintenance.	✔	✔	✔
	CO 4	Explain the design and functions of a stirred-tank bioreactor, including its structural components, and describe devices used for aeration, agitation, and monitoring of pH, temperature, foam, and dissolved oxygen.		✔	✔
	CO 5	Differentiate between types of fermentation processes, including submerged (batch, fed-batch, continuous) and solid-state fermentation.	✔	✔	✔
	CO 6	Understand the principles of fermentation media formulation, including the role of media ingredients, and explain the methods of sterilization and the principles for developing inoculum for bacterial, yeast, and fungal processes.	✔	✔	✔

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Bacterial Metabolism 253040502	CO 1	Explain enzyme kinetics by applying the Michaelis-Menten equation and analyze the significance of the Lineweaver-Burk plot in determining enzyme activity parameters.		✔	✔
	CO 2	Evaluate the types and significance of metabolic regulation, and assess the various modes of ATP generation in biological systems.	✔	✔	✔
	CO 3	Demonstrate the catabolism of glucose, fatty acids, and proteins, and explain the steps of the TCA cycle and its role in energy production.	✔	✔	✔
	CO 4	Differentiate between chemoheterotrophic, chemoautotrophic, and phototrophic metabolism, and illustrate the process of cyclic and non-cyclic photophosphorylation in ATP generation.		✔	✔
	CO 5	Describe the Calvin-Benson cycle for CO_2 fixation and explain how chemoautotrophs generate ATP and reducing power.		✔	✔
	CO 6	Summarize the principles governing biosynthesis, and analyze the pathways involved in the biosynthesis of fatty acids, phospholipids, and the assimilation of nitrogen and sulfur compounds.	✔	✔	✔
Enzymology 253040503	CO 1	Explain the general characteristics, classification, and terminology related to enzymes, including holoenzymes, coenzymes, apoenzymes, and inhibitors, and differentiate between first-order and zero-order reactions.		✔	✔
	CO 2	Describe the structure and specificity of enzyme active sites, and analyze the factors affecting enzyme activity, including turnover number, specific activity, and allosteric regulation.		✔	✔
	CO 3	Apply the Michaelis-Menten equation and its modifications (Lineweaver-Burk, Eadie-Hofstee, and Hanes-Woolf plots) to enzyme kinetics, and distinguish between types of enzyme inhibition (competitive, non-competitive, uncompetitive, mixed, and substrate inhibition).		✔	✔
	CO 4	Evaluate different methods of enzyme immobilization, and assess their applications, advantages, and limitations in industrial and biochemical processes, including reverse micelles and whole-cell immobilization.	✔	✔	✔

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	CO 5	Identify the industrial applications of key enzymes such as amylase, protease, and lipase in various sectors (detergent, leather, food, dairy, textile, and medical), and explain their roles in these industries.	✔	✔	✔
	CO 6	Demonstrate the methods for industrial production of enzymes and examine the relevance of enzyme sources in large-scale industrial applications.	✔	✔	✔
Biosafety, Bioethics & IPR 253040504	CO 1	Understand the fundamental concepts of biosafety, including standard laboratory practices, containment strategies, biosafety levels, biosafety guidelines in India, laboratory biosecurity, and risk assessment.	✔	✔	✔
	CO 2	Explain the principles of Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), and the basic concepts of Quality Control (QC) and Quality Assurance (QA), including guidelines for raw materials, sterilization, media, and product validation.	✔	✔	✔
	CO 3	Understand the role of culture collection centers, public health laboratories, and regulatory agencies in ensuring quality and safety in biological practices.	✔	✔	✔
	CO 4	Comprehend the basics and principles of bioethics, regulatory concerns, international codes and guidelines in India, and the role of non-governmental organizations (NGOs) in biological regulations.	✔	✔	✔
	CO 5	Understand the different types of intellectual property rights (IPR) and their management, including the benefits and challenges associated with IPR in biotechnology.		✔	✔
	CO 6	Explain the patenting process, international harmonization of patent law, biotechnological process patents, and their protection, with a focus on the Indian scenario and case studies related to infringement.		✔	✔
Microbiology Practicals 253040505	CO 1	Demonstrate the process of alcohol production using baker's yeast and perform alcohol estimation through microbial fermentation techniques.	✔	✔	✔
	CO 2	Perform primary screening techniques for the identification of microbial producers of amylase, antibiotics, and organic acids, and evaluate their potential for industrial applications.	✔	✔	✔

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	CO 3	Explain the structure and functionality of bioinformatics databases such as NCBI, DDBJ, and GenBank, and apply these tools for biological data retrieval and analysis.		✔	✔
	CO 4	Conduct enzyme immobilization experiments and analyze the factors affecting enzyme activity, including temperature, pH, and substrate concentration, to determine optimal conditions for enzymatic reactions.	✔	✔	✔
	CO 5	Investigate the effect of temperature and pH on bacterial growth, and apply these concepts in microbial growth regulation for biotechnological processes.	✔	✔	
	CO 6	Evaluate the procedures for sterility testing in pharmaceutical products, and analyze case studies of patent law, including patent infringement and its implications in biotechnology.		✔	✔
		B.Sc. Semester VI			
Fermentation Technology-II 253040601	CO 1	Understand the principles of downstream processing, including methods for the removal of microbial cells and suspended solids such as foam separation, precipitation, filtration, and centrifugation, as well as cell disruption techniques.	✔	✔	✔
	CO 2	Explain the processes involved in product concentration, purification, and finishing stages like liquid-liquid extraction, membrane processes, drying, crystallization, and effluent treatment.	✔	✔	✔
	CO 3	Understand the methods for detecting and assaying fermentation products, including physical assays (titration, gravimetric analysis), chemical assays (chromatography, spectrophotometry), and biological assays (microbial assays).	✔	✔	✔
	CO 4	Explain the microbial quality assurance methods used in fermentation, including sterility testing, the Limulus Amebocyte Lysate (LAL) test, and fermentation economics.	✔	✔	✔
	CO 5	Understand the fermentation processes involved in the production of industrial products such as alcohol, cheese, baker's yeast, glutamic acid, and citric acid.	✔	✔	✔

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	CO 6	Explain the fermentative production of pharmaceuticals and industrial enzymes, including penicillin (and its conversion to semisynthetic derivatives), cyanocobalamin, steroids, amylase, and carotenoids.	✔	✔	✔
Medical Microbiology 253040602	CO 1	Describe the normal microflora of the human body, nosocomial infections, and the role of carriers, pathogenicity, and virulence factors in disease, and explain septicemia, septic shock, and biosafety levels.	✔	✔	✔
	CO 2	Identify morphology, pathogenesis, diagnosis, and treatment of diseases caused by gram-positive bacteria (e.g., *S. aureus*, *C. tetani*, *B. anthracis*).	✔	✔	✔
	CO 3	Explain principles of bioethics and biosafety guidelines for safe handling and disposal of infectious materials in labs and clinics.	✔	✔	✔
	CO 4	Analyze and propose diagnosis and treatments for gram-negative bacterial infections (e.g., *E. coli*, *V. cholera*, *Y. pestis*).	✔	✔	✔
	CO 5	Understand antigen-antibody properties, MHC recognition, and monoclonal antibodies with clinical applications.	✔	✔	✔
	CO 6	Classify bacterial diseases by system (e.g., respiratory, digestive, nervous) and describe relevant diagnosis and treatment.	✔	✔	✔
Immunology-II 253040603	CO 1	Explain components of innate immunity: phagocytosis, complement, inflammation, cytokines, acute phase proteins, and immune tissues/organs.	✔	✔	✔
	CO 2	Understand antigens, haptens, CD molecules, and differentiate humoral vs. cell-mediated immunity.	✔	✔	✔
	CO 3	Analyze T cell biology, receptors, activation, and role in immune response.	✔	✔	✔
	CO 4	Describe structure and function of antibodies, and perform antigen-antibody interaction tests (e.g., agglutination, precipitation).	✔	✔	✔
	CO 5	Understand immune disorders: immunodeficiency, hypersensitivity, autoimmune diseases, and their clinical relevance.	✔	✔	✔
	CO 6	Explain transplant immunology: graft types, rejection, immune surveillance of tumors, and graft-versus-host disease.	✔	✔	✔
	CO 1	Explain nitrogen fixation (symbiotic/asymbiotic), nitrogenase structure/function, and role of Azotobacter & Rhizobia in agriculture.	✔	✔	✔

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Environmental Microbiology 253040604	CO 2	Describe biodeterioration and bioremediation of materials and pollutants (wood, paint, metal, petroleum hydrocarbons, etc.).	✔	✔	✔
	CO 3	Understand xenobiotics, recalcitrance, biomagnification, and degradation of pollutants (ABS, hydrocarbons, plastics).	✔	✔	✔
	CO 4	Explain biofuels (biogas, hydrogen, alcohol), their production, microbes involved, and pros/cons of biogas.	✔	✔	✔
	CO 5	Understand microbial insecticides, their mode of action, and effectiveness in pest control.	✔	✔	✔
	CO 6	Describe bioremediation principles, specific pollutant treatment, and evaluate environmental cleanup strategies.	✔	✔	✔
			97	113	96

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Course Outcomes - B.Sc. Physics					
Academic Year 2020-21					
Course with Code	Name of CO	Description	Relevance to the		
			Local / Regional	National	Global
Semester 1					
Basic Physics 253050101	**CO 1**	Analyze wave propagation in various media		✔	✔
	CO 2	Perform vector algebra and analysis operations.	✔	✔	✔
	CO 3	Study optical phenomena using Fermat's principle and thin film interference.		✔	✔
	CO 4	Evaluate ultrasonic wave generation, detection, and applications.	✔	✔	
	CO 5	Apply matrix methods to optics problems.		✔	✔
	CO 6	Explain laser principles and their applications.		✔	✔
Physics Practicals 253050102	**CO 1**	Perform experimental procedures to measure and analyze physical quantities such as wavelength, capacitance, and inductance.		✔	✔
	CO 2	Apply theoretical principles to verify experimental relationships and constants, such as P/L and T/l^2, in various practical setups.		✔	✔
	CO 3	Utilize resonance and rectification techniques to determine frequencies, efficiencies, and load characteristics in electrical circuits.	✔	✔	
	CO 4	Conduct experiments to understand the behavior of materials under stress, including measuring Young's Modulus and analyzing transformer performance.	✔	✔	
	CO 5	Demonstrate proficiency in digital electronics by constructing and testing logic gates and interpreting their truth tables and voltage levels.		✔	✔
	CO 6	Analyze and determine the efficiency of solar cells and other electronic components through practical experiments and data analysis.		✔	✔
Seemster 2					
Basic Physics-II 253050201	**CO 1**	Analyze and determine the electrostatic potential and field due to various charge distributions, including spherical shells and rings.		✔	✔
	CO 2	Apply Gauss's law, Poisson's and Laplace's equations to solve electrostatic field and potential problems.		✔	✔

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	CO 3	Evaluate diode circuits, including rectifiers and filter circuits, using load line analysis and performance metrics.	✔	✔	
	CO 4	Understand and describe the characteristics, behaviors, and diagnostic methods of plasmas, including their applications and instabilities.		✔	✔
	CO 5	Solve problems involving RL, RC, and L-C-R circuits in both DC and AC conditions, including bridge circuits.	✔	✔	
	CO 6	Apply radioactive decay laws and dating techniques to determine age, equilibrium states, and the characteristics of radioactive materials.		✔	✔
Physics Practicals 253020202	**CO 1**	Perform experimental procedures to measure and analyze physical quantities such as wavelength, capacitance, and inductance.		✔	✔
	CO 2	Apply theoretical principles to verify experimental relationships and constants, such as P/L and T/l², in various practical setups.		✔	✔
	CO 3	Utilize resonance and rectification techniques to determine frequencies, efficiencies, and load characteristics in electrical circuits.	✔	✔	
	CO 4	Conduct experiments to understand the behavior of materials under stress, including measuring Young's Modulus and analyzing transformer performance.	✔	✔	
	CO 5	Demonstrate proficiency in digital electronics by constructing and testing logic gates and interpreting their truth tables and voltage levels.		✔	✔
	CO 6	Analyze and determine the efficiency of solar cells and other electronic components through practical experiments and data analysis.		✔	✔
Semester 3					
Physics-301 253050301	**CO 1**	Recall the fundamental characteristics of transistors and semiconductor devices.		✔	✔
	CO 2	Explain the underlying principles of transistor operation and quantum mechanics concepts.		✔	✔
	CO 3	Apply transistor principles to design basic amplifier circuits and voltage regulator circuits.	✔	✔	✔
	CO 4	Analyze the performance characteristics of transistor amplifiers and voltage regulator circuits under different conditions.	✔	✔	✔
	CO 5	Critically evaluate the limitations of classical models and assess the suitability of different semiconductor devices for specific applications.		✔	✔
	CO 6	Design innovative transistor amplifier configurations and propose experimental setups to explore advanced topics in wave optics.		✔	✔

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Physics-302 253050302	**CO 1**	Recall the fundamental concepts of dielectrics, including polarization and types of dielectric materials.		✔	✔
	CO 2	Explain the laws of electrostatics in the presence of dielectrics and analyze the behavior of electric fields and energies.		✔	✔
	CO 3	Apply the principles of magnetostatics to analyze the behavior of magnetic fields in different materials and media.	✔	✔	✔
	CO 4	Analyze the motion of particles in central force fields and collisions, including elastic and inelastic scattering phenomena.		✔	✔
	CO 5	Evaluate the effectiveness of different nuclear particle detectors and particle accelerators in experimental setups.		✔	✔
	CO 6	Design experimental setups utilizing nuclear magnetic resonance (NMR) techniques and propose experiments to explore various nuclear physics phenomena.		✔	✔
Physics Practicals 253050303	**CO 1**	Recall the fundamental principles and techniques involved in experimental methods such as Koenig's method, Newton's ring, Hartmann formula, and Desauty's method.	✔	✔	
	CO 2	Understand the concepts behind resolving power, figure of merit, absorption coefficient, electron diffraction, resonance, and Fourier analysis as applied in experimental setups.	✔	✔	✔
	CO 3	Apply numerical methods to analyze oscillatory motion and determine parameters such as C1/C2 for electrical circuits and h-parameters for transistor configurations.	✔	✔	✔
	CO 4	Analyze the performance characteristics of devices and systems, such as telescope resolving power, load line determination for BJTs, and resonance in pendulum experiments.	✔	✔	
	CO 5	Evaluate the effectiveness of different experimental techniques and methods in achieving desired outcomes, such as the use of Zener diodes as voltage regulators or liquid lenses in optical systems.	✔	✔	✔
	CO 6	Design and conduct experiments utilizing various techniques learned in the course, and propose innovative applications or modifications to existing setups to achieve specific experimental goals.	✔	✔	✔
Semester 4					
Physics-401 253050401	**CO 1**	Explain lattice vibrations and phonon quantization in solids.		✔	✔
	CO 2	Apply classical and quantum theories to analyze thermal properties of solids.		✔	✔
	CO 3	Analyze entropy and thermodynamic principles in pure substances.	✔	✔	✔

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	CO 4	Evaluate transistor biasing techniques and their impact on circuit stability.	✔	✔	
	CO 5	Convert and compare different number systems used in digital electronics.	✔	✔	
	CO 6	Analyze atomic spectra and explain phenomena like Zeeman and Stark effects.		✔	✔
Physics-402 253050402	**CO 1**	Calculate reverberation time and analyze acoustics in architectural spaces.	✔	✔	✔
	CO 2	Explain the principles of polarization, double refraction, and analyze polarized light.	✔	✔	✔
	CO 3	Analyze macroscopic and microscopic states, and apply principles of statistical mechanics.		✔	✔
	CO 4	Apply the special theory of relativity to explain relativistic phenomena like time dilation and mass-energy equivalence.		✔	✔
	CO 5	Solve the Schrödinger equation for various potential systems and interpret wave functions.		✔	✔
	CO 6	Explain the general formalism of wave mechanics, including eigenvalues, eigenfunctions, and the uncertainty principle.		✔	✔
Physics Practicals 253050403	**CO 1**	Apply Searl's goniometer to measure angles and analyze the properties of crystals.	✔	✔	✔
	CO 2	Evaluate the resolving power of telescopes using optical principles.	✔	✔	✔
	CO 3	Analyze diffraction patterns and determine the wavelength of light using different methods.	✔	✔	✔
	CO 4	Measure and analyze phonon dispersion in a monoatomic lattice.		✔	✔
	CO 5	Study and interpret FET characteristics and their applications in circuits.	✔	✔	✔
	CO 6	Apply Thevenin's theorem to verify the maximum power transfer in electrical circuits.	✔	✔	✔
Semester 5					
Mathematical Physics, Quantum & Classical Mechanics – I 253050501	**CO 1**	Apply the method of separation of variables to solve partial differential equations in various coordinate systems.	✔	✔	✔
	CO 2	Analyze and solve second-order differential equations using series solutions and the Frobenius method.	✔	✔	✔
	CO 3	Formulate and solve problems in classical mechanics using Lagrangian methods and conservation laws.	✔	✔	✔
	CO 4	Explain and apply the principles of rigid body motion, including Euler's equations and nutational motion.	✔	✔	✔
	CO 5	Solve quantum mechanical problems using exactly soluble eigenvalue methods, including the harmonic oscillator.		✔	✔

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	CO 6	Analyze angular momentum in quantum systems with spherical symmetry and interpret spherical harmonics.		✔	✔
Electronic Spectra-1, Solid State Physics & Stat. Mech-1 253050502	**CO 1**	Apply the Born-Oppenheimer approximation to explain molecular energy states and types of molecular spectra.		✔	✔
	CO 2	Analyze the characteristics of rotational and vibrational-rotational spectra and their experimental setups.		✔	✔
	CO 3	Explain the Raman effect using classical and quantum theories and compare it with infrared spectra.	✔	✔	✔
	CO 4	Evaluate the mechanisms of fluorescence and phosphorescence, distinguishing them from Raman spectra.		✔	✔
	CO 5	Formulate and apply quantum statistics to Bose-Einstein and Fermi-Dirac distributions, including partition functions.		✔	✔
	CO 6	Analyze the properties of free electron Fermi gas and the electrical and thermal conductivity in metals.	✔	✔	✔
Nuclear Physics-1 & Electrodynamics-1 253050503	**CO 1**	Explain the concepts of hysteresis and Maxwell's equations in electromagnetic induction.	✔	✔	✔
	CO 2	Analyze the propagation of electromagnetic waves in different media and evaluate the effects of polarization and skin effect.		✔	✔
	CO 3	Apply the principles of electromagnetic radiation to determine the fields and potentials of moving charges.		✔	✔
	CO 4	Explain the mechanisms of alpha and beta decay, including the Pauli's neutrino hypothesis and Fermi's theory.		✔	✔
	CO 5	Evaluate the energy levels and decay processes in gamma-ray emission and internal conversion.	✔	✔	✔
	CO 6	Analyze the liquid drop model of the nucleus and its application to nuclear stability and decay processes.		✔	✔
Linear Electronic Circuits-I 253050504	**CO 1**	Explain the fundamental concepts and characteristics of amplifiers, including gain, efficiency, and distortion.	✔	✔	✔
	CO 2	Analyze the frequency response of transistor amplifiers at both low and high frequencies, including the impact of various circuit components.	✔	✔	✔

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	CO 3	Design and simplify digital circuits using Boolean algebra, Karnaugh maps, and understand the working principles of different flip-flops.		✔	✔
	CO 4	Apply network theorems, including Thevenin's and Norton's theorems, to simplify and solve complex electrical networks.	✔	✔	
	CO 5	Evaluate the performance of resonant circuits by calculating Q factor, bandwidth, and analyzing resonance behavior in series and parallel circuits.	✔	✔	✔
	CO 6	Design transistor amplifier circuits and evaluate their performance through the analysis of harmonic distortion and frequency response.	✔	✔	✔
Physics Practicals 253050505	**CO 1**	Demonstrate the ability to measure physical quantities such as gravity, temperature, and electrical properties using standard experimental techniques.	✔	✔	✔
	CO 2	Analyze experimental data to determine physical constants and properties, such as melting point, dielectric constant, and viscosity.	✔	✔	✔
	CO 3	Use various instruments and techniques to investigate and characterize properties of materials and electronic components.	✔	✔	✔
	CO 4	Evaluate the performance of electronic circuits and devices by measuring their characteristics and responses.	✔	✔	✔
	CO 5	Interpret experimental results to understand fundamental principles in physics, such as interference, resonance, and electromagnetic effects.	✔	✔	✔
	CO 6	Develop skills in using and calibrating scientific instruments for precise measurement and analysis in laboratory experiments.	✔	✔	✔
Semester 6					
Mathematical Physics, Quantum & Classical Mechanics – II 253050601	**CO 1**	Apply the method of separation of variables to solve partial differential equations in various coordinate systems.	✔	✔	✔
	CO 2	Analyze and solve second-order differential equations using series solutions and the Frobenius method.	✔	✔	✔
	CO 3	Formulate and solve problems in classical mechanics using Lagrangian methods and conservation laws.	✔	✔	✔
	CO 4	Explain and apply the principles of rigid body motion, including Euler's equations and nutational motion.	✔	✔	✔

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	CO 5	Solve quantum mechanical problems using exactly soluble eigenvalue methods, including the harmonic oscillator.		✔	✔
	CO 6	Analyze angular momentum in quantum systems with spherical symmetry and interpret spherical harmonics.		✔	✔
Electronic Spectra-2, Solid State Physics & Stat. Mech-2 253050602	**CO 1**	Apply the Born-Oppenheimer approximation to explain molecular energy states and types of molecular spectra.		✔	✔
	CO 2	Analyze the characteristics of rotational and vibrational-rotational spectra and their experimental setups.		✔	✔
	CO 3	Explain the Raman effect using classical and quantum theories and compare it with infrared spectra.	✔	✔	✔
	CO 4	Evaluate the mechanisms of fluorescence and phosphorescence, distinguishing them from Raman spectra.		✔	✔
	CO 5	Formulate and apply quantum statistics to Bose-Einstein and Fermi-Dirac distributions, including partition functions.		✔	✔
	CO 6	Analyze the properties of free electron Fermi gas and the electrical and thermal conductivity in metals.	✔	✔	✔
Nuclear Physics-2 & Electrodynamics-2 253050603	**CO 1**	Explain the concepts of hysteresis and Maxwell's equations in electromagnetic induction.	✔	✔	✔
	CO 2	Analyze the propagation of electromagnetic waves in different media and evaluate the effects of polarization and skin effect.		✔	✔
	CO 3	Apply the principles of electromagnetic radiation to determine the fields and potentials of moving charges.		✔	✔
	CO 4	Explain the mechanisms of alpha and beta decay, including the Pauli's neutrino hypothesis and Fermi's theory.		✔	✔
	CO 5	Evaluate the energy levels and decay processes in gamma-ray emission and internal conversion.	✔	✔	✔
	CO 6	Analyze the liquid drop model of the nucleus and its application to nuclear stability and decay processes.		✔	✔
Linear Electronic	**CO 1**	Explain the fundamental concepts and characteristics of amplifiers, including gain, efficiency, and distortion.	✔	✔	✔

Circuits-II 253050604	**CO 2**	Analyze the frequency response of transistor amplifiers at both low and high frequencies, including the impact of various circuit components.	✔	✔	✔
	CO 3	Design and simplify digital circuits using Boolean algebra, Karnaugh maps, and understand the working principles of different flip-flops.		✔	✔
	CO 4	Apply network theorems, including Thevenin's and Norton's theorems, to simplify and solve complex electrical networks.	✔	✔	
	CO 5	Evaluate the performance of resonant circuits by calculating Q factor, bandwidth, and analyzing resonance behavior in series and parallel circuits.	✔	✔	✔
	CO 6	Design transistor amplifier circuits and evaluate their performance through the analysis of harmonic distortion and frequency response.	✔	✔	✔
Physics Practicals 253050505	**CO 1**	Demonstrate the ability to measure physical quantities such as gravity, temperature, and electrical properties using standard experimental techniques.	✔	✔	✔
	CO 2	Analyze experimental data to determine physical constants and properties, such as melting point, dielectric constant, and viscosity.	✔	✔	✔
	CO 3	Use various instruments and techniques to investigate and characterize properties of materials and electronic components.	✔	✔	✔
	CO 4	Evaluate the performance of electronic circuits and devices by measuring their characteristics and responses.	✔	✔	✔
	CO 5	Interpret experimental results to understand fundamental principles in physics, such as interference, resonance, and electromagnetic effects.	✔	✔	✔
	CO 6	Develop skills in using and calibrating scientific instruments for precise measurement and analysis in laboratory experiments.	✔	✔	✔
Total Count			65	120	107

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Swarrnim Science College

Course Outcomes of M.Sc. Biotechnology					
Academic Year 2020-21					
Course with Code	**Name of CO**	**Description**	**Relevance to the**		
			Local / Regional	**National**	**Global**
Semester I					
Gene structure and Function 256010101	**CO 1**	Understand the chemistry, structure, and forces stabilizing DNA, including Watson Crick and Hoogsteen base pairing, and analyze the physical properties of dsDNA.		✔	✔
	CO 2	Explain DNA topology, supercoiling, and the role of DNA topoisomerases in regulating DNA structure and gene expression in both prokaryotes and eukaryotes.		✔	✔
	CO 3	Explore DNA-protein interactions, focusing on helix-turn-helix, B-sheet, and zinc finger motifs, and their roles in regulating genetic processes.		✔	✔
	CO 4	Analyze the organization and packaging of DNA into chromosomes in prokaryotes and eukaryotes, including nucleosome assembly and chromatin modification.	✔	✔	✔
	CO 5	Describe the mechanisms of DNA replication, including the role of DNA polymerases, replisome assembly, telomerase function, and inhibitors of DNA replication.		✔	✔
	CO 6	Evaluate the processes of transcription, translation, and gene regulation in prokaryotes and eukaryotes, focusing on operon models and posttranslational modifications.		✔	✔
Bioinstrumentation 256010102	**CO 1**	Understand the principles of electrochemistry, including pH, buffers, potentiometric and conductometric titrations, and their applications in biological systems	✔	✔	✔
	CO 2	Explore the principles and applications of various microscopy techniques, such as light, electron, and fluorescence microscopy, along with sample preparation methods.	✔	✔	✔
	CO 3	Analyze the methodologies and applications of chromatography techniques, including gel-filtration, ion-exchange, affinity, thin layer, gas, and HPLC chromatography.	✔	✔	✔
	CO 4	Explain the principles and applications of electrophoresis techniques such as Native and SDS PAGE, agarose, and 2D gel electrophoresis for biomolecule separation.	✔	✔	✔

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	CO 5	Evaluate the principles and applications of spectroscopy techniques (UV, IR, NMR, ESR) and their relevance in studying biomolecular structures and functions.	✔	✔	✔
	CO 6	Apply the principles of centrifugation, radioactive isotope techniques, and biosensors in biological research and biopolymer analysis, with emphasis on radiation dosimetry and tracer methods.		✔	✔
Microbial Diversity 256010103	**CO 1**	Understand the principles and concepts of microbial diversity, including both culturable and non-culturable microbes and the methodologies to study them.	✔	✔	✔
	CO 2	Explore the principles of metagenomics and its role in understanding microbial diversity, as well as strategies for the conservation of microbial diversity.		✔	✔
	CO 3	Analyze the metabolic diversity in bacteria and the systematics of various bacterial groups, with an emphasis on molecular and conventional approaches.	✔	✔	✔
	CO 4	Examine the diversity of actinomycetes, cyanobacteria, and fungi, focusing on their classification, reproduction, and ecological significance.	✔	✔	
	CO 5	Evaluate the systematics, occurrence, and adaptive features of different groups of archaea (Halophiles, Thermophiles, Alkalophiles, Acidophiles) and their applications.		✔	✔
	CO 6	Assess the industrial and ecological roles of yeast, moulds, and mycorrhizal fungi, including their economic importance and contribution to various ecosystems.	✔	✔	
Biogeohydrotechnology and Biofuels 256010104	**CO 1**	Understand the classification and characterization of different types of waste and the principles and mechanisms involved in waste treatment.	✔	✔	✔
	CO 2	Analyze biological methods for treating liquid and solid waste, focusing on the principles and applications of these methods in waste management.	✔	✔	✔
	CO 3	Explore the marine environment, including bacterial diversity, and the cultivation and enumeration of marine bacteria for various applications.		✔	✔
	CO 4	Apply indicators for marine microbial enzymes, polysaccharides, antimicrobial peptides, and carotenoids to assess their potential uses in marine biotechnology.			✔
	CO 5	Examine the processes of bioleaching, bio-oxidation, and biogeohydrotechnology for handling sulphidic minerals, including methods and factors affecting these processes.	✔	✔	✔

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	CO 6	Evaluate fuel biotechnology concepts including types of energy resources, production of biofuels (biogas, bioethanol, biodiesel, bio-hydrogen) , and their desirable and undesirable features, energy crops, and microbial enhanced oil recovery (MEOR).	✔	✔	✔
Biotechnology Practicals 256010105	**CO 1**	Manipulate basic laboratory instruments and perform sterilization and decontamination of lab equipment and media with precision and adherence to safety protocols.	✔	✔	
	CO 2	Execute Gram staining procedures for bacterial identification and apply the Folin 1ry method for protein estimation, demonstrating accurate technique.	✔	✔	
	CO 3	Carry out carbohydrate quantification using the Coles method and conduct DNA quantification using the DPA method, ensuring careful sample handling and measurement.	✔	✔	
	CO 4	Operate Agarose Gel Electrophoresis for DNA analysis and isolate Actinomycetes and fungi from samples using appropriate culturing techniques.	✔	✔	✔
	CO 5	Cultivate yeast cultures and demonstrate the process of column chromatography packing, ensuring the correct setup for effective separation.	✔	✔	
	CO 6	Assess the physical characteristics of wastewater, measure phosphate levels, and isolate antibiotic-resistant mutants using the replica plate technique, applying experimental accuracy and precision.	✔	✔	✔
		Semester II			
Microbial Genetics 256010201	**CO 1**	Explain the types, mechanisms, and repair pathways of mutations, including spontaneous mutations, DNA damage, and repair systems.		✔	✔
	CO 2	Describe plasmid biology, including types, replication, control of copy number, and plasmid segregation.	✔	✔	✔
	CO 3	Discuss the principles of recombination, including homologous and site-specific recombination, and their biological roles.		✔	✔
	CO 4	Analyze bacterial conjugation, focusing on processes involving the F-factor, Hfr conjugation, and plasmid-based conjugation.	✔	✔	✔
	CO 5	Understand Agrobacterium genetics, including Ti-plasmid function and interkingdom gene transfer mechanisms.		✔	✔

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	CO 6	Explore transformation and transduction mechanisms in bacteria and viruses, including applications and measurement techniques.		✔	✔
Immunology 256010202	**CO 1**	Understand the principles of innate and adaptive immunity, including inflammation, roles of cells, receptors, and proteins.		✔	✔
	CO 2	Describe the cells and organs of the immune system, including hematopoiesis and the function of primary and secondary lymphoid organs.		✔	✔
	CO 3	Explain the properties of antigens and antibodies, including their structure, classes, biological activities, and antibody diversity.		✔	✔
	CO 4	Analyze antigen-antibody interactions and the complement system, including its components, activation, regulation, and related diseases.		✔	✔
	CO 5	Discuss the Major Histocompatibility Complex (MHC) and its role in antigen presentation, including MHC organization, antigen processing, and disease susceptibility.		✔	✔
	CO 6	Explore T-cell and B-cell maturation, activation, differentiation, cytokines, and the mechanisms of cell-mediated cytotoxicity, hypersensitivity, and immune tolerance.		✔	✔
Bioprocess technology 256010203	**CO 1**	Understand the principles of isolation, preservation, and improvement of industrially important microorganisms.	✔	✔	✔
	CO 2	Describe substrates for fermentation processes and methods for 2 optimizations.	✔	✔	
	CO 3	Explain bioreactor design, including laboratory, pilot, and large-scale reactors, as well as sterilization of media and air.		✔	✔
	CO 4	Discuss mass transfer of oxygen in bioprocesses, including agitation, aeration, determination of KLa, and factors affecting it.		✔	✔
	CO 5	Analyze bioprocess kinetics, focusing on growth and substrate utilization in batch, fed-batch, and continuous systems.	✔	✔	✔
	CO 6	Explore the control of process parameters, including instrumentation, sensors, controllers, fermentation control systems, and dynamic modeling of fermentation processes.		✔	✔
Tools and techniques in synthetic	**CO 1**	Understand the principles of light microscopy, including optical corrections, types of objectives, oculars, and illumination methods.	✔	✔	✔

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microbiology 256010204	**CO 2**	Differentiate between types of light microscopes (bright field, dark field, fluorescence, phase contrast, polarizing, differential interference contrast) and understand micrometry.	✔	✔	✔
	CO 3	Describe the basic components of electron microscopes, including thermionic and field emission electron guns, and differentiate between TEM, SEM, STEM, ESEM, and HVEM.		✔	✔
	CO 4	Explain fixation and storage techniques, including classification of fixatives, procedures, and factors affecting fixation for plant, animal, and microbial samples.	✔	✔	
	CO 5	Demonstrate preparation techniques for biological samples for light and electron microscopy, including sectioning, staining, and photomicrography.	✔	✔	
	CO 6	Apply histochemical and cytochemical techniques to localize metabolites, enzymes, and ultra-structural components in biological samples, including immunocytochemistry.		✔	✔
Biotechnology Practicals 256010205	**CO 1**	Perform cell wall and spirochete staining techniques with precision, and isolate and identify fungi and soil bacteria (actinomycetes).	✔	✔	
	CO 2	Skillfully conduct endospore staining and primary screening for amylase producers, and apply the encapsulation technique for yeast cell immobilization.	✔	✔	
	CO 3	Proficiently carry out fermentation processes for alcohol and amylase production, and determine amylase activity and ethanol concentration in samples.	✔	✔	
	CO 4	Demonstrate techniques such as agglutination, paper chromatography, and the serodiagnosis of diseases like syphilis (RPR test) and enteric fever (Widal test).	✔	✔	
	CO 5	Develop expertise in enzyme immobilization, sauerkraut production, double immunodiffusion (ring test), and studying biodeterioration of given samples.	✔	✔	
	CO 6	Execute advanced laboratory techniques such as HPLC, gas chromatography, and agarose gel electrophoresis with accuracy and precision.		✔	✔
		Semester III			
Microbial biotechnology 256010301	**CO 1**	Understand the microbial production processes for primary metabolites such as amino acids (glutamic acid, lysine), enzymes (proteases, amylases), organic acids (citric acid, acetic acid), and industrial alcohol.	✔	✔	✔

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	CO 2	Explain the production methods and applications of secondary metabolites, including antibiotics (penicillin, streptomycin), vitamins (B12, B2), ergot alkaloids, and carotenoid pigments (β-carotene, lycopene).		✔	✔
	CO 3	Describe microbial production techniques for other products and biotransformation, including microbial polysaccharides (xanthan, alginate, dextran), beverages (beer, wine), polyhydroxyalkanoates (PHA, PHB), biosurfactants, and steroid transformation.	✔	✔	✔
	CO 4	Analyze the methods and applications of fungal biomass production, including baker's yeast and single cell oil, and evaluate their industrial uses.	✔	✔	✔
	CO 5	Discuss mushroom cultivation techniques and the use of algal biomass, including their applications in various industries.	✔	✔	✔
	CO 6	Identify the microbial production techniques for food and feed, emphasizing their benefits and challenges in industrial settings.	✔	✔	✔
Enzymology 256010302	**CO 1**	Understand the historical developments in enzymology, protein structure (primary, secondary, tertiary, and quaternary), and the techniques used in enzyme characterization.		✔	✔
	CO 2	Explain enzyme classification according to the IUB system, and describe the principles and techniques of enzymatic analysis, including factors affecting enzyme activity, extraction, and purification strategies.	✔	✔	✔
	CO 3	Analyze enzyme kinetics, including single substrate kinetics (equilibrium and steady state kinetics, Km, Vmax, Kcat), multisubstrate kinetics (general rate equations, mechanisms), and thermal kinetics (temperature effects, Arrhenius equation).		✔	✔
	CO 4	Discuss enzyme inhibition and its kinetics, covering reversible and irreversible inhibition, competitive, noncompetitive, uncompetitive, mixed, partial, substrate, and allosteric inhibition.		✔	✔
	CO 5	Describe the mechanisms of enzyme action, including enzyme activators, coenzymes, cofactors, specificity, and experimental approaches to determining enzyme mechanisms. Analyze specific enzyme mechanisms and allosteric regulation.		✔	✔
	CO 6	Explore enzyme engineering techniques, including chemical modification of enzymes, enzyme immobilization, the use of enzymes in non-conventional media, enzyme sensors, and their applications as analytical reagents.	✔	✔	✔

r-DNA technology 256010303	**CO 1**	Understand the concept and importance of genetic engineering, including general strategies, steps involved in gene cloning, and the extraction and purification of DNA from bacterial, plant, and animal cells.	✔	✔	✔
	CO 2	Describe the roles of restriction enzymes, DNA ligase, and other enzymes in gene cloning, and explain the processes of mRNA and cDNA preparation.		✔	✔
	CO 3	Explain the chemical synthesis of genes and DNA cloning and expression vectors, including plasmids, bacteriophages, phagemids, cosmids, YACs, BACs, and MACs, and the expression of cloned genes in heterologous hosts.		✔	✔
	CO 4	Outline the techniques for recombinant selection and screening, including Southern blotting, Northern analysis, Western blotting, various electrophoresis methods, and protein activity assays (e.g., yeast-one hybrid, yeast-two hybrid).	✔	✔	✔
	CO 5	Discuss advanced methods for gene characterization and mapping, such as restriction mapping, DNA sequencing, nucleic acid microarrays, metagenomics, and gene therapy, as well as molecular markers and genomic mapping techniques.		✔	✔
	CO 6	Analyze recombinant products, including recombinant hormones, DNA vaccines, transgenic plants and animals, and understand the guidelines for genetic engineering, including physical and biological containment levels and Indian guidelines	✔	✔	✔
Animal Tissue Culture and Pharmaceutical Biotechnology 256010304	**CO 1**	Understand the principles of animal tissue culture, including primary culture and established cell line cultures, equipment and material for cell technology, basic media and techniques, and manipulation and application of animal cell culture.	✔	✔	✔
	CO 2	Analyze bioprocess economics, including expenses for industrial materials, equipment, product recovery, effluent treatments, cost recovery from waste usage and recycling, and the principles of IPR and patent processes	✔	✔	✔
	CO 3	Describe the benefits, problems, and management of IPR, international harmonization of patent law, and the protection of biotechnological processes, with a focus on the Indian scenario.	✔	✔	✔
	CO 4	Explain regulatory affairs related to pharmacopoeia, good microbiological techniques, good laboratory practice (GLP), quality control (QA) and quality assurance (QC), validation studies, and the roles of culture collection centres and regulatory agencies.		✔	✔

	CO 5	Discuss biosafety and bioethics, including biosafety guidelines, risk assessment, biosafety levels, laboratory biosecurity concepts, drug design, pre-clinical and clinical trials, and bioethics principles, including international codes and guidelines in India.		✔	✔
	CO 6	Evaluate the ethical considerations and guidelines in the post-genomic era, and understand the implications for biosafety and bioethics in modern research and applications.		✔	✔
Biotechnology Practicals 256010305	**CO 1**	Understand the principles of animal tissue culture, including primary culture and established cell line cultures, equipment and material for cell technology, basic media and techniques, and manipulation and application of animal cell culture.	✔	✔	✔
	CO 2	Analyze bioprocess economics, including expenses for industrial materials, equipment, product recovery, effluent treatments, cost recovery from waste usage and recycling, and the principles of IPR and patent processes.	✔	✔	✔
	CO 3	Describe the benefits, problems, and management of IPR, international harmonization of patent law, and the protection of biotechnological processes, with a focus on the Indian scenario.	✔	✔	✔
	CO 4	Explain regulatory affairs related to pharmacopoeia, good microbiological techniques, good laboratory practice (GLP), quality control (QA) and quality assurance (QC), validation studies, and the roles of culture collection centers and regulatory agencies.		✔	✔
	CO 5	Discuss biosafety and bioethics, including biosafety guidelines, risk assessment, biosafety levels, laboratory biosecurity concepts, drug design, pre-clinical and clinical trials, and bioethics principles, including international codes and guidelines in India.		✔	✔
	CO 6	Evaluate the ethical considerations and guidelines in the post-genomic era, and understand the implications for biosafety and bioethics in modern research and applications.		✔	✔
Semester IV					
Plant Biotechnology 256010401	**CO 1**	Understand the principles and techniques of cell and tissue culture in plants, including callus cultures, in-vitro morphogenesis, organogenesis, embryogenesis, artificial seeds, micropropagation, and haploidy.	✔	✔	✔

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	CO 2	Describe the methods for protoplast isolation, culture, fusion, somatic hybridization, and cybrids, and explain somaclonal variation, in-vitro mutation methods, virus elimination, pathogen indexing, and cryopreservation.	✔	✔	✔
	CO 3	Analyze the production of secondary metabolites in plants, including sources, criteria for cell selection, factors affecting culture, bioreactors used, biochemical pathways, and biotransformation processes.	✔	✔	✔
	CO 4	Explain the principles and methods of genetic engineering in agriculture, including genetic transformation techniques such as Agrobacterium tumefaciens, A. rhizogenes, PEG-mediated transformation, microinjection, particle bombardment, and electroporation.		✔	✔
	CO 5	Discuss the importance of molecular markers in plant breeding, including Marker Assisted Selection (MAS) and the use of molecular markers for genetic transformation and transgenic plant production.		✔	✔
	CO 6	Examine molecular plant pathology, focusing on mechanisms of disease resistance, signaling pathways, and molecular events during pathogen-plant interactions, and understand the implications of biotechnology and intellectual property rights (IPR) in plant genetic resources.	✔	✔	✔
Environmental Biotechnology 256010402	**CO 1**	Understand environmental monitoring techniques, including the use of bio-indicators, biomarkers, biosensors, and toxicity testing, and analyze environmental impacts, conservation strategies, and environmental laws and policies in India.	✔	✔	✔
	CO 2	Explain the principles and strategies of bioremediation, including in situ and ex situ techniques, and discuss bioremediation of metals, phytoremediation, and the role and impact of GMOs in bioremediation processes.	✔	✔	✔
	CO 3	Describe the principles of biodegradation and mechanisms of detoxification, focusing on the biodegradation of detergents, pesticides, lignin, hydrocarbons, and dyes.	✔	✔	✔
	CO 4	Analyze the principles and mechanisms of biodeterioration, including methodologies for assessing biodeterioration and strategies for its prevention and control.	✔	✔	✔
	CO 5	Evaluate the environmental impacts of various pollutants and the effectiveness of different bioremediation and biodegradation techniques in mitigating these impacts.	✔	✔	✔

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	CO 6	Discuss the integration of rDNA technology in environmental monitoring and bioremediation, and understand the role of conservation strategies and environmental policies in addressing environmental problems.	✔	✔	✔
Biotechnology Practicals 256010403	**CO 1**	Demonstrate Polymerase Chain Reaction (PCR) and perform Agarose Gel Electrophoresis.	✔	✔	✔
	CO 2	Estimate sulfate, Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), and chloride in given samples.		✔	✔
	CO 3	Study dye degradation and analyze the results.		✔	✔
	CO 4	Isolate DNA and RNA from given samples.	✔	✔	✔
	CO 5	Perform Native SDS-PAGE for protein analysis.	✔	✔	✔
	CO 6	Apply and interpret techniques for nucleic acid and protein isolation and analysis.	✔	✔	✔
Dissertation 256010404	**CO 1**	Design and execute an independent research project by formulating testable hypotheses, selecting appropriate biotechnological methodologies, and maintaining accurate documentation.		✔	✔
	CO 2	Analyze and interpret experimental data using statistical/biocomputational tools, and critically evaluate results in the context of existing scientific literature.		✔	✔
	CO 3	Demonstrate ethical research practices, including proper biosafety protocols, data integrity, and adherence to intellectual property (IPR) guidelines.	✔	✔	✔
	CO 4	Communicate research findings effectively through a written dissertation, oral presentations, and scientific visualizations suitable for peer and public audiences.	✔	✔	✔
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Course Outcomes of M.Sc. Chemistry					
Academic Year 2020-21					
Course with Code	Name of CO	Description	Relevance to the		
			Local / Regional	National	Global
Semester I					
256020101- Organic Chemistry -I	CO 1	Understand the E1, E2, E1CB elimination reaction mechanisms, stereochemistry, and factors affecting reactivity and orientation		✔	✔
	CO 2	Analyze mixed SN1, SN2, SET mechanisms and nucleophilic substitution, focusing on substrate structures and stereochemistry		✔	✔
	CO 3	Explain the concept of aromaticity using resonance, Huckel's rule, and molecular orbitals, and distinguish between aromatic, anti-aromatic, and homoaromatic compounds		✔	✔
	CO 4	Understand acid-base concepts, pKa, and the effect of structure on acidity and basicity		✔	✔
	CO 5	Examine the structure, stability, and fate of reactive intermediates such as carbocations, carbanions, carbenes, free radicals, and nitrenes		✔	✔
	CO 6	Analyze carbon-carbon and carbon-nitrogen migration reactions, including pinacol-pinacolone, Curtius, Schmidt, and Baeyer-Villiger rearrangements		✔	✔
256020102 - Inorganic Chemistry -I	CO 1	Understand and apply the principles of quantum mechanics to atomic structure, including solving Schrödinger wave equations and interpreting hydrogenic orbitals.		✔	✔
	CO 2	Analyze and apply group theory to molecular symmetry, focusing on character tables and their relevance to physical and chemical properties.		✔	✔
	CO 3	Evaluate the principles of magnetochemistry, understanding Curie and Curie-Weiss laws and analyzing diamagnetic and antiferromagnetic properties in materials.		✔	✔
	CO 4	Apply the concept of metalloporphyrins and bio-inorganic chemistry to understand their role in biological systems, such as hemoglobin, myoglobin, and enzymes.	✔	✔	✔
	CO 5	Investigate coordination compounds used in medicine, focusing on chelation therapy, platinum-based anticancer drugs, and radiodiagnostic agents.	✔	✔	✔
	CO 6	Develop skills in the use of approximation methods in quantum mechanics.		✔	✔
	CO 1	Understand and apply the principles of quantum mechanics to atomic structure, including solving Schrödinger wave equations and interpreting hydrogenic orbitals.		✔	✔

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256020103 -: Physical Chemistry - I	**CO 2**	Analyze and apply group theory to molecular symmetry, focusing on character tables and their relevance to physical and chemical properties.		✔	✔
	CO 3	Evaluate the principles of magnetochemistry, understanding Curie and Curie–Weiss laws and analyzing diamagnetic and antiferromagnetic properties in materials.		✔	✔
	CO 4	Apply the concept of metalloporphyrins and bio-inorganic chemistry to understand their role in biological systems, such as hemoglobin, myoglobin, and enzymes.	✔	✔	✔
	CO 5	Investigate coordination compounds used in medicine, focusing on chelation therapy, platinum-based anticancer drugs, and radiodiagnostic agents.	✔	✔	✔
	CO 6	Develop skills in the use of approximation methods in quantum mechanics, including the variation method and perturbation theory, applied to atomic systems.		✔	✔
256020104 - Analytical Chemistry - I	**CO 1**	Understand the scope of analytical science, qualitative/quantitative analysis, and data handling.		✔	✔
	CO 2	Learn error analysis, significance testing, and precision/accuracy in experimental results.		✔	✔
	CO 3	Develop competence in GLP, standard operating procedures, and quality control/assurance.	✔	✔	✔
	CO 4	Understand sampling, calibration methods, and calibration curve construction.	✔	✔	✔
	CO 5	Demonstrate mastery in spectrophotometry fundamentals, including Beer's law and photometric accuracy.		✔	✔
	CO 6	Apply advanced spectrophotometric techniques to real-world problems such as equilibrium constant measurement.		✔	✔
256020105 - Chemistry Practical	**CO 1**	Understand the mechanisms and applications of nitration, bromination, and acylation reactions.		✔	✔
	CO 2	Demonstrate the reduction and oxidation reactions and analyze their role in organic synthesis.		✔	✔
	CO 3	Gain proficiency in condensation reactions (Aldol, Cannizzaro) and their synthetic importance.	✔	✔	✔
	CO 4	Conduct diazotization and Friedel-Crafts reactions, understanding their industrial and lab applications.	✔	✔	✔
	CO 5	Master experimental techniques for the synthesis of organic compounds through various methodologies.	✔	✔	✔

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	CO 6	Develop innovative approaches to solving organic chemistry problems through reaction mechanism analysis.		✔	✔
Semester II					
256020201 - Organic Chemistry -II	**CO 1**	Demonstrate expertise in spectroscopy and heterocyclic chemistry, including detailed knowledge of structure determination and photochemistry.		✔	✔
	CO 2	Perform independent research on mass spectrometry fragmentation patterns and advanced organic reactions.		✔	✔
	CO 3	Analyze the reactivity of heterocycles and stereochemistry in organic compounds, focusing on specific reagents and reaction mechanisms.		✔	✔
	CO 4	Solve complex reaction mechanisms related to photochemical and heterocyclic reactions, employing advanced problem-solving techniques.		✔	✔
	CO 5	Utilize spectroscopy techniques (NMR, IR, UV) in structure determination, particularly with heterocyclic compounds and functional groups.		✔	✔
	CO 6	Demonstrate effective communication of scientific results through written reports on spectroscopy and organic reactions, adhering to professional standards.		✔	✔
256020202 - Inorganic Chemistry -II	**CO 1**	Demonstrate comprehensive understanding of chemical bonding theories.		✔	✔
	CO 2	Apply symmetry principles to molecular orbitals, IR/Raman spectral data interpretation, and hybrid orbital formation.		✔	✔
	CO 3	Understand the structure and reactivity of organometallic compounds, especially π-bonded and electron-ligand complexes.		✔	✔
	CO 4	Analyze reaction mechanisms in square planar complexes and electron transfer processes in oxidation-reduction reactions.		✔	✔
	CO 5	Demonstrate problem-solving skills in analyzing kinetic effects in substitution reactions and electron transfer mechanisms.		✔	✔
	CO 6	Effectively communicate the applications of chemical bonding, organometallic chemistry, and reaction mechanisms in catalysis and materials science.		✔	✔
256020203 - Physical Chemistry -II	**CO 1**	Understand the distribution of molecules and thermodynamic probability in statistical thermodynamics.		✔	✔
	CO 2	Apply nuclear chemistry principles to nuclear models, radioactive decay, and nuclear reactions.		✔	✔

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	CO 3	Analyze the kinetics and mechanisms of polymerization processes, and the properties of polymers.	✔	✔	✔
	CO 4	Conduct experiments to determine dissociation constants and apply electrochemical principles to real-world problems.	✔	✔	✔
	CO 5	Demonstrate proficiency in using laboratory tools for the characterization of polymers and electrochemical measurements.	✔	✔	✔
	CO 6	Effectively communicate the principles and findings in statistical thermodynamics, nuclear chemistry, polymer chemistry, and electrochemistry.		✔	✔
256020204 - Analytic Chemistry-II	**CO 1**	Understand distribution of molecules and thermodynamic probability in statistical thermodynamics.		✔	✔
	CO 2	Apply nuclear chemistry concepts including nuclear models, decay, and reactions.		✔	✔
	CO 3	Analyze kinetics and mechanisms in polymer processes and characterize polymers.	✔	✔	✔
	CO 4	Perform electrochemical experiments like conductometry and potentiometry for determining dissociation constants.	✔	✔	✔
	CO 5	Use laboratory tools for polymer and electrochemical measurements, emphasizing technical and research skills.	✔	✔	✔
	CO 6	Communicate findings in multiple chemical domains; focuses on scientific communication and interdisciplinary understanding.		✔	✔
256020205 - Chemistry Practical	**CO 1**	Analyze and separate solid mixtures using physical and chemical methods.	✔	✔	
	CO 2	Perform conductometric, potentiometric, and pH-metric titrations to verify theoretical laws (e.g., Ostwald's law).		✔	✔
	CO 3	Apply adsorption, kinetics, and distribution principles to determine reaction order and complex formulas.		✔	✔
	CO 4	Analyze and separate liquid mixtures using physical and chemical methods.	✔	✔	
	CO 5	Estimate saponification, iodine, acid values of oils; perform EDTA titrations.	✔	✔	
	CO 6	Use TLC to separate amino acids, drugs, and dyes, and interpret results.		✔	✔
Semester III					
256020301 - Natural	**CO 1**	Understand classification and biosynthesis of natural pigments (anthocyanins, flavones, flavanols).		✔	✔

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Products and Bio molecules	**CO 2**	Study chemistry, synthesis, and biochemical role of alkaloids and vitamins (quinine, vitamin B & C).	✔	✔	✔
	CO 3	Explore structure and biochemical role of steroids and hormones (cholesterol, estrogens, etc.).		✔	✔
	CO 4	Analyze structure and synthesis of terpenoids and carotenoids (abietic acid, farnesol, etc.).		✔	✔
	CO 5	Apply structure determination methods for natural compounds and steroids.		✔	✔
	CO 6	Investigate biosynthetic pathways and solve advanced biochemical problems through theoretical and experimental methods.		✔	✔
256020302 - Medicinal Chemistry	**CO 1**	Understand antibiotics interfering with bacterial cell wall biosynthesis (β-lactam & non-lactam).		✔	✔
	CO 2	Analyze SAR of penicillins & tetracyclines; study antibiotics affecting protein biosynthesis.		✔	✔
	CO 3	Study psychoactive drugs: CNS depressants, sedatives, hypnotics; synthesis of key drugs.		✔	✔
	CO 4	Investigate modern antimalarial chemotherapy; synthesis and SAR of chloroquine, etc.	✔	✔	✔
	CO 5	Analyze synthesis and roles of antituberculosis drugs (isoniazid, ethionamide, etc.).	✔	✔	✔
	CO 6	Examine synthesis and function of cardiovascular, diuretic, and hypoglycemic agents.		✔	✔
256020303 - Organic Spectroscopy	**CO 1**	List types of errors in analytical chemistry			✔
	CO 2	Explain accuracy, precision, and sensitivity in analytical measurements		✔	✔
	CO 3	Calculate standard deviation and confidence interval for analytical data		✔	✔
	CO 4	Analyze data to identify sources of error and suggest corrective measures		✔	✔
	CO 5	Evaluate reliability and validity of data by comparing with standards		✔	✔
	CO 6	Develop a protocol for systematic error treatment in new analytical methods		✔	✔
256020304 - Industrial Chemistry	**CO 1**	Understand process design, batch vs. continuous operations, safety management, and flow chart preparation	✔	✔	✔
	CO 2	Apply nitration, sulfonation, halogenation, amination, and alkylation in industrial processes (aromatic chemicals)	✔	✔	✔
	CO 3	Analyze and apply the 12 principles of Green Chemistry for sustainable process development		✔	✔
	CO 4	Use of green solvents (e.g., ionic liquids) and named reactions (Wurtz, Wittig-Horner, Michael) in industry		✔	✔

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	CO 5	Understand green catalysts and sustainable reactions like hydrogenation, Diels-Alder, o-/N-alkylation		✔	✔
	CO 6	Study agrochemical manufacture and use (insecticides, weedicides, etc.) with a focus on sustainability and environmental impact	✔	✔	✔
256020305 - Organic Chemistry Practicals	**CO 1**	Analyze kinetics and solubility equilibrium data		✔	✔
	CO 2	Explain effects of temperature, catalysts, and concentration on reaction rates; solubility equilibria		✔	✔
	CO 3	Use rate laws and solubility principles to solve problems		✔	✔
	CO 4	Apply solubility rules, precipitation, and flame tests for ion identification	✔	✔	
	CO 5	Analyze qualitative tests and separation of ions in complex mixtures	✔	✔	
	CO 6	Recall principles and procedures of cation/anion analysis	✔	✔	
Semester IV					
256020401 - Advanced Organic Chemistry	**CO 1**	Apply Sandmeyer reaction: mechanism, purification, characterization		✔	✔
	CO 2	Apply Pechmann, Skraup, Riemer-Tiemann, Kolbe-Smith, Claisen-Smith reactions		✔	✔
	CO 3	Apply Hofmann, Diels-Alder, Green bromination reactions; mechanism and product analysis		✔	✔
	CO 4	Perform sulpha drug assays with understanding of method and importance	✔	✔	
	CO 5	Apply non-aqueous titration, nitrite value estimation, drug dissolution methods	✔	✔	
	CO 6	Integrate synthesis and analysis for solving problems in industrial and pharmaceutical chemistry		✔	✔
256020402 - Advanced Organic Synthesis	**CO 1**	Understand and apply protection/deprotection of hydroxyl, amino, carbonyl, and carboxylic groups		✔	✔
	CO 2	Apply synthetic equivalents, control stereochemistry in multi-step synthesis		✔	✔
	CO 3	Use disconnection and functional group interconversion strategies		✔	✔
	CO 4	Apply C–C disconnection to alcohols, carbonyls; explore regioselectivity, nitro compounds		✔	✔
	CO 5	Synthesize saturated/aromatic heterocycles; study stereochemistry and regioselective ring closures		✔	✔
	CO 6	Integrate disconnection, protection, and ring strategies in complex synthesis		✔	✔
	CO 1	Understand water's role in biomolecular interactions, buffering, and biological reactions		✔	✔
	CO 2	Explore chemistry and functions of vitamins in absorption, transport, and mobilization		✔	✔

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256020403 - Bio-Organic Chemistry	**CO 3**	Examine proteins, peptide formation, sequencing, and oxygen-binding proteins like hemoglobin and myoglobin		✔	✔
	CO 4	Analyze enzyme activity, specificity, regulation, and inhibition using examples like chymotrypsin, hexokinase, lysozyme		✔	✔
	CO 5	Understand carbohydrate structures, derivatives, and biological roles of glucoconjugates		✔	✔
	CO 6	Investigate lipid structures, including fatty acids, membrane lipids, and their biological roles		✔	✔
256020404 - Selected Topics in Medicinal Chemistry	**CO 1**	Understand drug design process including lead compound modification, clinical trials, and SAR theories		✔	✔
	CO 2	Explore pharmacokinetics: absorption, distribution, metabolism, and elimination of drugs		✔	✔
	CO 3	Analyze pharmacodynamics: enzyme inhibition/stimulation and drug metabolism		✔	✔
	CO 4	Understand dosage forms, administration routes, and modern methods of pharmaceutical analysis and quality control		✔	✔
	CO 5	Investigate applications of computers in chemistry, including online data search and pharmaceutical software	✔	✔	✔
	CO 6	Study nanomaterials in medicine: drug delivery, cancer treatment, and nanotech in medical devices		✔	✔
256020405 - Dissertation	**CO 1**	Understand disaster management strategies and their theoretical foundations	✔	✔	✔
	CO 2	Conduct research and develop methodologies for assessing risks and vulnerabilities	✔	✔	✔
	CO 3	Critically evaluate disaster scenarios and company responses using complex data	✔	✔	✔
	CO 4	Develop disaster preparedness and response plans for real-world company operations	✔	✔	✔
	CO 5	Integrate knowledge from engineering, environmental science, and risk management	✔	✔	✔
	CO 6	Collaborate on emergency management protocols ensuring ethical compliance	✔	✔	✔
			36	119	112

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Course Outcomes of M.Sc. Mathematics					
Academic Year 2020-21					
Course with Code	Number of CO	Description	Relevance to the		
			Local / Regional	National	Global
		Semester 1			
Abstract Algebra - I 253030101	**CO1**	Understand the definition and examples of groups, subgroups, normal subgroups, quotient groups, and cyclic groups.	✔	✔	✔
	CO2	Apply the concept of group homomorphisms and understand the fundamental theorem of homomorphisms.	✔	✔	✔
	CO3	Explain conjugacy relations and their applications within a group.	✔	✔	
	CO4	Comprehend and apply Cauchy's theorem for both abelian and finite groups.	✔	✔	
	CO5	Understand the structure of finite abelian groups through Sylow's theorems.	✔	✔	
	CO6	Examine and construct composition series for solvable groups.	✔	✔	
Real Analysis 253030102	**CO1**	Understand the concept of Lebesgue outer measure, algebra, σ-algebra of sets, Borel sets, and measurable sets, along with the construction of the Lebesgue measure.	✔	✔	
	CO2	Explain measurable functions, Littlewood's three principles, and Egoroff's theorem, and compare Riemann and Lebesgue integration methods.	✔	✔	
	CO3	Apply the concept of the Lebesgue integral for bounded functions, understand the bounded convergence theorem, and differentiate it from Riemann integration.	✔	✔	
	CO4	Analyze the integration of non-negative measurable functions using Fatou's lemma, monotone convergence theorem, and Lebesgue's convergence theorem.	✔	✔	
	CO5	Evaluate the differentiation of measurable functions, monotone functions, and functions of bounded variation, and explore absolutely continuous functions and their properties.	✔	✔	
	CO6	Understand the relationship between indefinite integrals and absolutely continuous functions through the differentiation of integrals.	✔	✔	
Statistical Methods 253030103	**CO1**	Understand the fundamental concepts of statistics, including summarizing qualitative and quantitative data, and apply various measures of location, variability, and association between two variables in business and economics.	✔	✔	✔

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	CO2	Analyze data using descriptive statistical methods, such as the stem-and-leaf display, cross-tabulation, scatter diagrams, and detect outliers through measures of distribution shape and relative location.	✔	✔	✔
	CO3	Apply basic probability concepts to determine the probability of events using classical, relative frequency, and subjective methods, and solve problems involving conditional probability and Bayes' theorem.	✔	✔	
	CO4	Understand different types of probability distributions, including binomial, Poisson, and normal distributions, and compute expected value and variance for discrete and continuous random variables.	✔	✔	
	CO5	Apply sampling methods, and understand sampling distribution, point and interval estimation, and hypothesis testing for population means and proportions, including tests about differences between two populations.	✔	✔	✔
	CO6	Understand and apply simple linear regression models using the least squares method for estimation and prediction, and evaluate model assumptions, residual analysis, outliers, and influential observations to validate the regression model.	✔	✔	✔
Advanced Linear Algebra 253030104	**CO1**	Understand the algebra of linear transformations, characteristic roots, and vectors, and apply the concept of diagonalization of matrices.	✔	✔	✔
	CO2	Analyze triangular canonical forms and apply related theorems to solve problems involving nilpotent linear transformations.	✔	✔	
	CO3	Comprehend and apply the decomposition theorem and understand the concept of Jordan canonical forms for linear transformations.	✔	✔	
	CO4	Apply rational canonical forms in matrix theory and calculate determinants for solving various matrix-related problems.	✔	✔	
	CO5	Comprehend and apply the decomposition theorem and understand the concept of Jordan canonical forms for linear transformations. *(Same as CO3)*	✔	✔	
	CO6	Apply rational canonical forms in matrix theory and calculate determinants for solving various matrix-related problems. *(Same as CO4)*	✔	✔	
	CO1	Demonstrate an understanding of key vocabulary from selected stories and effectively apply grammar concepts such as active/passive voice, tenses, prepositions, and determiners.	✔	✔	✔

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Mathematics Practical 253030105	**CO2**	Analyze the structure and usage of active and passive voice in different contexts and apply them in writing tasks.	✔	✔	✔
	CO3	Apply the correct use of tenses, prepositions (place, time, direction), and determiners in both written and spoken communication.	✔	✔	✔
	CO4	Develop letter-writing skills, adhering to proper format and tone for various formal communications.	✔	✔	✔
	CO5	Write applications for different purposes, demonstrating clarity, coherence, and appropriate use of grammar and vocabulary.	✔	✔	✔
	CO6	Synthesize the understanding of grammar rules and vocabulary from the stories to effectively communicate ideas in writing and speaking.	✔	✔	✔
		Semester 2			
Advanced Abstract Algebra - II 253030201	**CO1**	Understand the definitions and properties of fields, subfields, rings, and principal ideals, and apply conditions for subfields and the embedding of rings.	✔	✔	✔
	CO2	Analyze the concepts of Euclidean rings and unique factorization domains (UFDs), and apply the unique factorization theorem and Eisenstein's criterion of irreducibility.	✔	✔	
	CO3	Understand and apply the concepts of field extensions, simple extensions, and algebraic extensions, and explore algebraically closed fields.	✔	✔	
	CO4	Comprehend the properties of root fields, splitting fields, and apply the concepts of normal and separable extensions in field theory.	✔	✔	
	CO5	Understand the fundamental concepts of fields, subfields, rings, and principal ideals, and apply conditions for subfields, characteristics of rings and fields, and the embedding of rings.	✔	✔	✔
	CO6	Analyze the properties of Euclidean rings, unique factorization domains (UFDs), algebraic extensions, and normal and separable extensions, and apply these concepts to solve problems.	✔	✔	
Complex Analysis 253030202	**CO1**	Understand the properties of complex numbers, their polar and exponential forms, and analyze regions in the complex plane, continuity, differentiability, and analytic functions using Cauchy-Riemann equations.	✔	✔	✔

	CO2	Apply the properties of elementary functions such as exponential, trigonometric, hyperbolic, and logarithmic functions, and solve complex line and contour integrals using Cauchy's theorem.	✔	✔	✔
	CO3	Explore important theorems in complex analysis, including Cauchy's integral formula, Morera's theorem, Liouville's theorem, and apply Taylor and Laurent series expansions for analytic functions.	✔	✔	
	CO4	Analyze singularities, poles, and zeros of analytic functions, and apply the residue theorem for the evaluation of improper integrals.	✔	✔	✔
	CO5	Understand the harmonic functions of two variables and their relationship to analytic functions in complex analysis.	✔	✔	
	CO6	Evaluate improper integrals using residues at poles and apply the residue theorem to solve complex integration problems in advanced mathematics.	✔	✔	
Special Function 253030203	**CO1**	Understand the definition and general solution of Legendre's equation, and apply orthogonal properties, recurrence formulas, and generating functions of Legendre polynomials $P_n(x)$ and $Q_n(x)$.	✔	✔	✔
	CO2	Analyze hypergeometric functions, including their series definitions, particular cases, and solutions, and apply integral formulas and theorems such as Kummer's and Gauss's theorems.	✔	✔	
	CO3	Explore confluent hypergeometric functions, their integral representations, and differentiation techniques, and understand their continuous nature.	✔	✔	
	CO4	Solve boundary value problems using Hermite polynomials, including understanding Hermite's differential equation, generating functions, orthogonal properties, and recurrence formulas.	✔	✔	✔
	CO5	Apply Chebyshev polynomials to solve differential equations, prove that $T_n(x)$ and $U_n(x)$ are independent solutions, and use generating functions and recurrence formulas for these polynomials.	✔	✔	✔
	CO6	Compute and analyze the first few Hermite and Chebyshev polynomials, and apply their orthogonal properties and recurrence relations in practical problems.	✔	✔	✔

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Ordinary Differential Equations 253030204	**CO1**	Understand and apply the concepts of singular solutions and extraneous loci in ODEs, and review simultaneous ODEs of the first order and linear differential equations of the second order.	✔	✔	✔
	CO2	Solve non-linear differential equations of particular forms and apply techniques for total differential equations.	✔	✔	✔
	CO3	Analyze ordinary and singular points of differential equations, and apply series solutions to Cauchy-Euler equations and regular singular points.	✔	✔	
	CO4	Implement numerical methods for solving ordinary differential equations, including Euler's method for initial value problems.	✔	✔	✔
	CO5	Apply the Runge-Kutta method (both one-stage and two-stage) to obtain numerical solutions for ODEs and analyze their accuracy.	✔	✔	✔
	CO6	Compare and evaluate the effectiveness of different numerical methods, such as Euler's method and Runge-Kutta methods, in solving ordinary differential equations.	✔	✔	
Mathematics Practical 253030205	**CO1**	Solve systems of linear equations, compute eigenvalues and eigenvectors, and apply the Cayley-Hamilton theorem in matrix analysis.	✔	✔	✔
	CO2	Work with orthogonal and unitary matrices, compute matrix norms, and apply these concepts in matrix problem-solving.	✔	✔	✔
	CO3	Analyze and solve problems involving bilinear, quadratic, and Hermitian forms, including their applications.	✔	✔	
	CO4	Compute measures, work with measurable sets and functions, and apply these concepts in real-world scenarios.	✔	✔	
	CO5	Apply Hölder's and Minkowski's inequalities, compute derived numbers, and solve practical problems involving these concepts.	✔	✔	
	CO6	Solve differential equations using various methods, including Lagrange's equation and Jacobi's methods, addressing initial and boundary value problems.	✔	✔	✔
		Semester 3			
Functional Analysis 253030301	**CO1**	Understand and apply the concepts of normed linear spaces, Banach spaces, and quotient spaces, including completeness and bounded linear transformations.	✔	✔	
	CO2	Apply key theorems related to normed and Banach spaces, including the Hahn-Banach theorem, dual spaces, and the open mapping and closed graph theorems.	✔	✔	

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	CO3	Define and analyze inner product spaces and Hilbert spaces, including their properties, orthogonal complements, and orthonormal sets, and apply Bessel's inequality.	✔	✔	
	CO4	Understand and use the concepts of conjugate spaces and Riesz representation theorem in the context of Hilbert spaces.	✔	✔	
	CO5	Analyze operators on Hilbert spaces, including understanding the adjoint of an operator, and applying concepts of self-adjoint, normal, and unitary operators.	✔	✔	
	CO6	Solve problems involving bounded linear transformations and operators on normed and Banach spaces, and apply theoretical results to practical scenarios.	✔	✔	✔
Mathematical Modeling 253030302	**CO1**	Understand the scope and limitations of mathematical modeling, classify different types of models, and apply techniques for dimensional homogeneity in various models such as gravity, population growth, and diffusion.	✔	✔	✔
	CO2	Analyze and interpret two-species population models, including prey-predator dynamics, competition models, and various epidemic models (SI, SIS, ISI, and models with removal).	✔	✔	✔
	CO3	Develop and analyze biological models including diffusion of glucose, genetics models (Hardy-Weinberg, blood groups), and business models (EOQ, price adjustment).	✔	✔	✔
	CO4	Apply mathematical techniques to traffic models, including macroscopic and microscopic models, and analyze linear and non-linear car-following models to determine stopping distances.	✔	✔	✔
	CO5	Evaluate the stability and geometric interpretations of population dynamics and epidemic models, and apply these evaluations to practical scenarios in biology and epidemiology.	✔	✔	✔
	CO6	Develop and solve mathematical models for real-world applications, including biological processes, business optimization, and traffic flow, using appropriate modeling techniques and analysis methods.	✔	✔	✔
Partial Differential Equation 253030303	**CO1**	Understand the origin and formulation of second-order partial differential equations (PDEs), including linear PDEs with constant coefficients, and solve equations involving polynomial, exponential, and trigonometric functions.	✔	✔	✔
	CO2	Classify second-order PDEs, convert to canonical form, apply Monge's method to solve nonlinear PDEs, and understand solutions for both special and general cases.	✔	✔	✔
	CO3	Solve second-order PDEs with variable coefficients using methods like variable changes and analyze specific equation solutions.	✔	✔	✔

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	CO4	Apply separation of variables method to solve Laplace, wave, and diffusion equations in various coordinate systems.	✔	✔	✔
	CO5	Analyze and solve boundary value problems (Dirichlet, Neumann), and apply maximum/minimum principles, Harnack's theorem, and Green's function.	✔	✔	✔
	CO6	Develop and solve PDEs using classification, variable change, separation of variables, and boundary value problem approaches.	✔	✔	✔
Topology – I 253030304	**CO1**	Understand the concepts of topological spaces, including basis and subbasis, order topology, subspace topology, and the properties of closed sets and limit points.	✔	✔	✔
	CO2	Analyze continuous functions and homeomorphisms, apply the pasting lemma, understand mappings into product spaces, and explore the metric topology and the uniform limit theorem.	✔	✔	✔
	CO3	Define and analyze connected spaces, path-connected spaces, and connected sets in the real line. Understand components, path components, and the relationship between local connectedness and path connectedness.	✔	✔	✔
	CO4	Examine compact spaces and compact sets in the real line, including limit point compactness and locally compact spaces. Understand the concept of one-point compactification.	✔	✔	✔
	CO5	Apply the sequence lemma to understand convergence in topological spaces and investigate the quotient topology in relation to continuous functions and homeomorphisms.	✔	✔	✔
	CO6	Develop and apply techniques for analyzing topological properties such as connectedness and compactness, and use these concepts to solve problems in various topological spaces.	✔	✔	✔
Mathematics Practical 253030305	**CO1**	Implement examples to understand topological spaces, closed sets, limit points, and explore connected and compact spaces.	✔	✔	✔
	CO2	Perform simulations for population models, epidemic models, and business models to analyze dynamics and outcomes.	✔	✔	✔
	CO3	Solve second-order partial differential equations (PDEs) using methods such as separation of variables and analyze solutions for Laplace, Wave, and Diffusion equations.	✔	✔	✔
	CO4	Investigate properties of continuous functions, including homeomorphisms and uniform limits, through practical examples.	✔	✔	✔
	CO5	Perform hypothesis testing, regression analysis, and work with various probability distributions in statistical analysis.	✔	✔	✔

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	CO6	Analyze and implement deterministic inventory control models, queuing models, equipment replacement policies, and sequencing problems using optimization techniques.	✔	✔	✔
		Semester 4			
Number Theory 253030401	**CO1**	Understand and apply fundamental concepts of number theory, including the division algorithm, greatest common divisor, Euclidean algorithm, and Diophantine equations.	✔	✔	✔
	CO2	Analyze properties of congruences, solve linear congruences, and apply the Chinese Remainder Theorem. Utilize number-theoretic functions and apply Fermat's, Wilson's Theorems, and Mobius inversion.	✔	✔	✔
	CO3	Explore Euler's Phi function, determine primitive roots, understand indices, Euler's criterion, and the Legendre symbol.	✔	✔	✔
	CO4	Apply the quadratic reciprocity law to solve quadratic congruences with composite moduli. Solve problems involving quadratic congruences and x2+y2=z2x^2 + y^2 = z^2x2+y2=z2.	✔	✔	✔
	CO5	Study Fermat's Last Theorem and implications in number theory. Analyze representations of numbers as sums of squares.	✔	✔	✔
	CO6	Develop and apply methods for solving various problems in number theory, including congruences, factorization, and representation of numbers.	✔	✔	✔
Research Methodology 253030402	**CO1**	Understand the definition, scope, and methods of data collection, classification, and tabulation. Present data graphically and diagrammatically and apply measures of central tendency, dispersion, and standard error.	✔	✔	✔
	CO2	Analyze and apply probability distributions, including binomial, Poisson, and normal distributions, to various statistical problems.	✔	✔	✔
	CO3	Conduct hypothesis testing, understand types of errors and levels of significance, and apply various statistical tests, including Chi-square goodness of fit.	✔	✔	✔
	CO4	Perform simple linear regression and correlation analysis to determine relationships between variables and interpret results.	✔	✔	✔
	CO5	Develop skills in scientific writing and research, including creating research proposals, papers, review papers, theses, and conference reports. Understand formatting and content requirements for research documentation.	✔	✔	✔

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	CO6	Prepare and deliver scientific presentations, including formatting research reports and theses, and include sections such as title pages, certificates, declarations, acknowledgements, lists of tables and figures, and references.	✔	✔	✔
Integral Transforms 253030403	**CO1**	Understand the definition and properties of the Laplace transform, including rules of shifting, Laplace transforms of derivatives and integrals, and the convolution theorem. Apply the complex inversion formula to solve problems.	✔	✔	✔
	CO2	Analyze and apply Fourier transforms, including definitions and properties of Fourier sine, cosine, and complex transforms. Utilize convolution theorems, inversion theorems, and Fourier transforms of derivatives in practical applications.	✔	✔	✔
	CO3	Study the definition and elementary properties of the Mellin transform. Apply Mellin transforms to derivatives and integrals and use the inversion and convolution theorems in solving problems.	✔	✔	✔
	CO4	Explore the definition and properties of the Henkel transform, including transforms of derivatives and integrals. Apply the inversion and convolution theorems to various problems.	✔	✔	✔
	CO5	Develop a comprehensive understanding of the interrelationships between different integral transforms (Laplace, Fourier, Mellin, and Henkel) and their applications in solving differential equations and other mathematical problems.	✔	✔	✔
	CO6	Apply integral transforms to practical problems in engineering and applied mathematics, including the solution of boundary value problems and signal processing.	✔	✔	✔
Topology – II 253030404	**CO1**	Understand and identify different separable axioms, including T_0, T_1, T_2 spaces, and concepts of first countable, second countable, Lindelöf, and separable spaces.	✔	✔	✔
	CO2	Analyze and characterize regular and normal spaces, including completely normal and completely regular spaces, and apply concepts such as one-point compactification in topological spaces.	✔	✔	✔
	CO3	Explore product and quotient topologies, including weak topologies, product spaces, Tychonoff topology, and Tychonoff's theorem, and apply these concepts to solve problems in topology.	✔	✔	✔

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	CO4	Study sequences and nets in topological spaces, including direct sets, residual subsets, and convergence properties of nets and ultrasets. Understand filters, filter bases, and ultrafilters, and analyze convergence and cluster points of filters.	✔	✔	✔
	CO5	Develop an understanding of advanced topological concepts such as compactification, separation properties, and convergence theories. Apply these concepts to solve complex problems in topology.	✔	✔	✔
	CO6	Apply theoretical concepts of topological spaces to practical problems, including the use of filters and nets in analyzing convergence and clustering properties within various topological structures.	✔	✔	✔
Mathematics Practical 253030405	**CO1**	Apply the Laplace transform to solve ordinary differential equations and analyze systems with given initial conditions. Demonstrate understanding of the properties, rules, and convolution theorem.	✔	✔	✔
	CO2	Utilize Fourier transforms to solve problems involving signal processing, differential equations, and boundary value problems. Apply Fourier sine, cosine, and complex transforms, as well as convolution and inversion theorems.	✔	✔	✔
	CO3	Implement the Mellin transform in solving differential equations and analyzing functions, including applying the inversion and convolution theorems to practical problems.	✔	✔	✔
	CO4	Use the Henkel transform to address problems in applied mathematics, including its definition, properties, and application of convolution and inversion theorems.	✔	✔	✔
	CO5	Investigate separable and countable axioms in topological spaces, including practical problems involving T_0, T_1, T_2 spaces, and separability properties.	✔	✔	✔
	CO6	Analyze and apply concepts of regularity and normality in topological spaces, including one-point compactification. Solve problems involving product spaces, quotient topologies, and Tychonoff's theorem.	✔	✔	✔
			120	120	84

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Course Outcomes of M.Sc. Microbiology					
Academic Year 2020-21					
Course with Code	**Name of CO**	**Description**	**Relevance to the**		
			Local / Regional	**National**	**Global**
		Semester 1			
Gene Structure and Function 256030101	**CO 1**	Understand the chemistry, structure, and forces stabilizing DNA, including Watson Crick and Hoogsteen base pairing, and analyze the physical properties of dsDNA		✓	✓
	CO 2	Explain DNA topology, supercoiling, and the role of DNA topoisomerases in regulating DNA structure and gene expression in both prokaryotes and eukaryotes.		✓	✓
	CO 3	Explore DNA-protein interactions, focusing on helix-turn-helix, B-sheet, and zinc finger motifs, and their roles in regulating genetic processes.			✓
	CO 4	Analyze the organization and packaging of DNA into chromosomes in prokaryotes and eukaryotes, including nucleosome assembly and chromatin modification.		✓	✓
	CO 5	Describe the mechanisms of DNA replication, including the role of DNA polymerases, replisome assembly, telomerase function, and inhibitors of DNA replication.		✓	✓
	CO 6	Evaluate the processes of transcription, translation, and gene regulation in prokaryotes and eukaryotes, focusing on operon models and posttranslational modifications.	✓	✓	✓
Bioinstrumentation 256030102	**CO 1**	Understand the principles of electrochemistry, including pH, buffers, potentiometric and conductometric titrations, and their applications in biological systems	✓	✓	
	CO 2	Explore the principles and applications of various microscopy techniques, such as light, electron, and fluorescence microscopy, along with sample preparation methods.		✓	✓
	CO 3	Analyze the methodologies and applications of chromatography techniques, including gel-filtration, ion-exchange, affinity, thin layer, gas, and HPLC chromatography.		✓	✓
	CO 4	Explain the principles and applications of electrophoresis techniques such as Native and SDS PAGE, agarose, and 2D gel electrophoresis for biomolecule separation.		✓	✓
	CO 5	Evaluate the principles and applications of spectroscopy techniques (UV, IR, NMR, ESR) and their relevance in studying biomolecular structures and functions.			✓

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	CO 6	Apply the principles of centrifugation, radioactive isotope techniques, and biosensors in biological research and biopolymer analysis, with emphasis on radiation dosimetry and tracer methods.		✓	✓
Microbial Diversity256030103	**CO 1**	Understand the principles and concepts of microbial diversity, including both culturable and non-culturable microbes and the methodologies to study them	✓	✓	✓
	CO 2	Explore the principles of metagenomics and its role in understanding microbial diversity, as well as strategies for the conservation of microbial diversity.	✓	✓	✓
	CO 3	Analyze the metabolic diversity in bacteria and the systematics of various bacterial groups, with an emphasis on molecular and conventional approaches.		✓	✓
	CO 4	Examine the diversity of actinomycetes, cyanobacteria, and fungi, focusing on their classification, reproduction, and ecological significance.	✓	✓	✓
	CO 5	Evaluate the principles and applications of spectroscopy techniques (UV, IR, NMR, ESR) and their relevance in studying biomolecular structures and functions.			✓
	CO 6	Assess the industrial and ecological roles of yeast, moulds, and mycorrhizal fungi, including their economic importance and contribution to various ecosystems.	✓	✓	✓
Biogeohydrotechnology and Biofuels 256030104	**CO 1**	Understand the classification and characterization of different types of waste and the principles and mechanisms involved in waste treatment.	✓	✓	✓
	CO 2	Analyze biological methods for treating liquid and solid waste, focusing on the principles and applications of these methods in waste management.	✓	✓	✓
	CO 3	Explore the marine environment, including bacterial diversity, and the cultivation and enumeration of marine bacteria for various applications.		✓	✓
	CO 4	Examine the diversity of actinomycetes, cyanobacteria, and fungi, focusing on their classification, reproduction, and ecological significance.Apply indicators for marine microbial enzymes, polysaccharides, antimicrobial peptides, and carotenoids to assess their potential uses in marine biotechnology	✓	✓	✓
	CO 5	Examine the processes of bioleaching, bio-oxidation, and biogeohydrotechnology for handling sulphidic minerals, including methods and factors affecting these processes		✓	✓
	CO 6	Evaluate fuel biotechnology concepts including types of energy resources, production of biofuels (biogas, bioethanol, biodiesel, bio-hydrogen), and their desirable and undesirable features, energy crops, and microbial enhanced oil recovery (MEOR)	✓	✓	✓

Microbiology Practical 256030105	**CO 1**	Manipulate basic laboratory instruments and perform sterilization and decontamination of lab equipment and media with precision and adherence to safety protocols	✓	✓	
	CO 2	Execute Gram staining procedures for bacterial identification and apply the Folin 1ry method for protein estimation, demonstrating accurate technique.	✓	✓	
	CO 3	Carry out carbohydrate quantification using the Coles method and conduct DNA quantification using the DPA method, ensuring careful sample handling and measurement.		✓	
	CO 4	Operate Agarose Gel Electrophoresis for DNA analysis and isolate Actinomycetes and fungi from samples using appropriate culturing techniques.		✓	✓
	CO 5	Cultivate yeast cultures and demonstrate the process of column chromatography packing, ensuring the correct setup for effective separation.		✓	✓
	CO 6	Assess the physical characteristics of wastewater, measure phosphate levels, and isolate antibiotic-resistant mutants using the replica plate technique, applying experimental accuracy and precision.	✓	✓	✓
		Semester 2			
Microbial Genetics 256030201	**CO 1**	Explain the types, mechanisms, and repair pathways of mutations, including spontaneous mutations, DNA damage, and repair systems.		✓	✓
	CO 2	Describe plasmid biology, including types, replication, control of copy number, and plasmid segregation.		✓	✓
	CO 3	Discuss the principles of recombination, including homologous and site-specific recombination, and their biological roles.		✓	✓
	CO 4	Analyze bacterial conjugation, focusing on processes involving the F-factor, Hfr conjugation, and plasmid-based conjugation.		✓	✓
	CO 5	Understand Agrobacterium genetics, including Ti-plasmid function and interkingdom gene transfer mechanisms.	✓	✓	✓
	CO 6	Explore transformation and transduction mechanisms in bacteria and viruses, including applications and measurement techniques.		✓	✓
Immunology 256030202	**CO 1**	Understand the principles of innate and adaptive immunity, including inflammation, roles of cells, receptors, and proteins.		✓	✓

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	CO 2	Describe the cells and organs of the immune system, including hematopoiesis and the function of primary and secondary lymphoid organs.		✓	✓
	CO 3	Explain the properties of antigens and antibodies, including their structure, classes, biological activities, and antibody diversity.		✓	✓
	CO 4	Analyze antigen-antibody interactions and the complement system, including its components, activation, regulation, and related diseases.		✓	✓
	CO 5	Discuss the Major Histocompatibility Complex (MHC) and its role in antigen presentation, including MHC organization, antigen processing, and disease susceptibility.		✓	✓
	CO 6	Explore T-cell and B-cell maturation, activation, differentiation, cytokines, and the mechanisms of cell-mediated cytotoxicity, hypersensitivity, and immune tolerance.		✓	✓
Bioprocess Technology 256030203	**CO 1**	Understand the principles of isolation, preservation, and improvement of industrially important microorganisms.	✓	✓	✓
	CO 2	Describe substrates for fermentation processes and methods for 2 optimizations.	✓	✓	✓
	CO 3	Explain bioreactor design, including laboratory, pilot, and large-scale reactors, as well as sterilization of media and air.		✓	✓
	CO 4	Discuss mass transfer of oxygen in bioprocesses, including agitation, aeration, determination of KLa, and factors affecting it.		✓	✓
	CO 5	Analyze bioprocess kinetics, focusing on growth and substrate utilization in batch, fed-batch, and continuous systems		✓	✓
	CO 6	Explore the control of process parameters, including instrumentation, sensors, controllers, fermentation control systems, and dynamic modeling of fermentation processes.		✓	✓
Tools and techniques in synthetic microbiology 256030204	**CO 1**	Understand the principles of light microscopy, including optical corrections, types of objectives, oculars, and illumination methods	✓	✓	✓
	CO 2	Differentiate between types of light microscopes (bright field, dark field, fluorescence, phase contrast, polarizing, differential interference contrast) and understand micrometry.	✓	✓	✓

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	CO 3	Describe the basic components of electron microscopes, including thermionic and field emission electron guns, and differentiate between TEM, SEM, STEM, ESEM, and HVEM.		✓	✓
	CO 4	Explain fixation and storage techniques, including classification of fixatives, procedures, and factors affecting fixation for plant, animal, and microbial samples.	✓	✓	✓
	CO 5	Demonstrate preparation techniques for biological samples for light and electron microscopy, including sectioning, staining, and photomicrography		✓	✓
	CO 6	Apply histochemical and cytochemical techniques to localize metabolites, enzymes, and ultra-structural components in biological samples, including immunocytochemistry.		✓	✓
Microbiology Practical 256030205	**CO 1**	Perform cell wall and spirochete staining techniques with precision, and isolate and identify fungi and soil bacteria (actinomycetes).	✓	✓	
	CO 2	Skillfully conduct endospore staining and primary screening for amylase producers, and apply the encapsulation technique for yeast cell immobilization.	✓	✓	
	CO 3	Proficiently carry out fermentation processes for alcohol and amylase production, and determine amylase activity and ethanol concentration in samples.	✓	✓	✓
	CO 4	Demonstrate techniques such as agglutination, paper chromatography, and the serodiagnosis of diseases like syphilis (RPR test) and enteric fever (Widal test)	✓	✓	
	CO 5	Develop expertise in enzyme immobilization, sauerkraut production, double immunodiffusion (ring test), and studying biodeterioration of given samples.	✓	✓	✓
	CO 6	Execute advanced laboratory techniques such as HPLC, gas chromatography, and agarose gel electrophoresis with accuracy and precision.		✓	✓
		Semester 3			
Microbial Biotechnology 256030301	**CO 1**	Understand the microbial production processes for primary metabolites such as amino acids (glutamic acid, lysine), enzymes (proteases, amylases), organic acids (citric acid, acetic acid), and industrial alcohol.	✓	✓	✓
	CO 2	Explain the production methods and applications of secondary metabolites, including antibiotics (penicillin, streptomycin), vitamins (B12, B2), ergot alkaloids, and carotenoid pigments (β-carotene, lycopene).		✓	✓

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	CO 3	Describe microbial production techniques for other products and biotransformation, including microbial polysaccharides (xanthan, alginate, dextran), beverages (beer, wine), polyhydroxyalkanoates (PHA, PHB), biosurfactants, and steroid transformation.	✓	✓	✓
	CO 4	Analyze the methods and applications of fungal biomass production, including baker's yeast and single cell oil, and evaluate their industrial uses.	✓	✓	
	CO 5	Discuss mushroom cultivation techniques and the use of algal biomass, including their applications in various industries.	✓	✓	✓
	CO 6	Identify the microbial production techniques for food and feed, emphasizing their benefits and challenges in industrial settings.	✓	✓	✓
Enzymology 256030302	**CO 1**	Understand the historical developments in enzymology, protein structure (primary, secondary, tertiary, and quaternary), and the techniques used in enzyme characterization	✓	✓	✓
	CO 2	Explain enzyme classification according to the IUB system, and describe the principles and techniques of enzymatic analysis, including factors affecting enzyme activity, extraction, and purification strategies.	✓	✓	✓
	CO 3	Analyze enzyme kinetics, including single substrate kinetics (equilibrium and steady state kinetics, Km, Vmax, Kcat), multisubstrate kinetics (general rate equations, mechanisms), and thermal kinetics (temperature effects, Arrhenius equation).		✓	✓
	CO 4	Discuss enzyme inhibition and its kinetics, covering reversible and irreversible inhibition, competitive, noncompetitive, uncompetitive, mixed, partial, substrate, and allosteric inhibition		✓	✓
	CO 5	Describe the mechanisms of enzyme action, including enzyme activators, coenzymes, cofactors, specificity, and experimental approaches to determining enzyme mechanisms. Analyze specific enzyme mechanisms and allosteric regulation.	✓	✓	✓
	CO 6	Explore enzyme engineering techniques, including chemical modification of enzymes, enzyme immobilization, the use of enzymes in non-conventional media, enzyme sensors, and their applications as analytical reagents	✓	✓	✓

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FOOD & DAIRY MICROBIOLOGY 256030303	**CO 1**	Understand the scope of food microbiology and recognize microorganisms such as bacteria, yeast, and molds important in food microbiology, while analyzing the factors influencing microbial growth in food.	✓	✓	✓
	CO 2	Explain the general principles underlying food spoilage, including the spoilage of canned food, sugar products, vegetables, fruits, meat, milk, fish, seafood, and poultry, and assess the contamination risks involved.	✓	✓	✓
	CO 3	Analyze foodborne pathogens and the processes involved in bacterial foodborne infections and intoxications caused by Clostridium, Escherichia, Salmonella, and Shigella, while evaluating general diagnostic and preventive methods.	✓	✓	✓
	CO 4	Apply the principles of food preservation techniques such as asepsis, microbial removal, and temperature control, and evaluate the use of chemical and biological preservatives along with food additives.	✓	✓	✓
	CO 5	Evaluate the role of food packaging and labeling, genetically modified foods, and biosensors in food research, while comparing recent foodborne outbreaks and their impacts.	✓	✓	✓
	CO 6	Analyze food safety regulations, including HACCP, Codex Alimentarius, PFA, FPO, MFPO, BIS, and AGMARK, and assess microbiological testing procedures for water, milk, and food plant sanitation.	✓	✓	✓
Agricultural Microbiology256030304	**CO 1**	Understand the composition of the lithosphere and analyze the role of soil microbes, along with the factors influencing soil microbial populations	✓	✓	✓
	CO 2	Explain the distribution, abundance, and nutritional groups of soil bacteria, actinomycetes, fungi, algae, protozoa, and viruses, and evaluate their ecological significance in the soil environment.	✓	✓	✓
	CO 3	Assess microbial transformations of minerals like phosphorus, sulfur, iron, and other elements, focusing on the processes of mineralization, immobilization, and oxidation/reduction	✓	✓	✓
	CO 4	Analyze the types, production, and applications of biofertilizers, including nitrogen fixing organisms (Azotobacter, Azospirillum, cyanobacteria), phosphate-solubilizing microbes, and their role in plant growth and integrated nutrient management.	✓	✓	✓

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	CO 5	Evaluate plant pathogenic microorganisms, including their entry modes and factors affecting disease incidence, as well as plant disease resistance mechanisms and control measures.	✓	✓	✓
	CO 6	Understand the history and application of biopesticides (viral, bacterial, fungal, protozoan) and their interaction with plant pathogens, and assess the potential of biopesticides in sustainable agriculture.	✓	✓	✓
Microbiology Practicals 256030305	**CO 1**	Perform primary screening of amylase and organic acid-producing microorganisms, demonstrating proper microbial handling and culturing techniques	✓	✓	✓
	CO 2	Execute experiments to measure the effect of temperature, pH, and substrate concentration on enzyme activity with precision and accuracy	✓	✓	✓
	CO 3	Conduct the isolation of DNA from plant cells and demonstrate gel electrophoresis techniques, ensuring the correct handling of samples and equipment.	✓	✓	✓
	CO 4	Demonstrate the processes of PCR and animal tissue culture with adherence to procedural steps and safety protocols in a laboratory setting	✓	✓	✓
	CO 5	Carry out sterility testing of pharmaceutical products and study protein structure using PDB, following standard laboratory practices.	✓	✓	✓
	CO 6	Operate bioinformatics databases (NCBI, DDBJ, GenBank) for sequence alignment and analysis, and design primers from a cDNA library, applying computational tools efficiently.	✓	✓	✓
Semester 4					
Environmental Microbiology 256030401	**CO 1**	Understand the global environmental problems, including global warming, ozone depletion, acid rain, and their impacts on ecosystems and infectious diseases	✓	✓	✓
	CO 2	Explain the sources and types of water pollution, including microbial indicators, eutrophication, and control methods, along with the mechanisms of biodeterioration of wood and metals.	✓	✓	✓
	CO 3	Analyze the biogeochemical cycles of carbon, nitrogen, sulfur, iron, and phosphorus, along with the detrimental effects of biogeochemical cycle diversions, such as acid mine drainage and nitrate pollution.	✓	✓	✓

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	CO 4	Discuss biological nitrogen fixation, including asymbiotic, symbiotic, and associative nitrogen fixation, with emphasis on the structure, function, and genetic regulation of nitrogenase.	✓	✓	✓
	CO 5	Evaluate the mechanisms and factors affecting the biodegradation of organic pollutants, and examine bioremediation techniques for oil spills, heavy metal pollution, and the use of GMOs in bioremediation	✓	✓	✓
	CO 6	Describe bioleaching of metals, microbial insecticides, and biofertilizers, along with their industrial applications in biomining, pest management, and enhanced oil recovery processes.	✓	✓	✓
r-DNA Technology 256030402	**CO 1**	Understand the concept and importance of genetic engineering, including general strategies, steps involved in gene cloning, and the extraction and purification of DNA from bacterial, plant, and animal cells.	✓	✓	✓
	CO 2	Describe the roles of restriction enzymes, DNA ligase, and other enzymes in gene cloning, and explain the processes of mRNA and cDNA preparation..	✓	✓	✓
	CO 3	Explain the chemical synthesis of genes and DNA cloning and expression vectors, including plasmids, bacteriophages, phagemids, cosmids, YACs, BACs, and MACs, and the expression of cloned genes in heterologous hosts.	✓	✓	✓
	CO 4	Outline the techniques for recombinant selection and screening, including Southern blotting, Northern analysis, Western blotting, various electrophoresis methods, and protein activity assays (e.g., yeast-one hybrid, yeast-two hybrid)	✓	✓	✓
	CO 5	Discuss advanced methods for gene characterization and mapping, such as restriction mapping, DNA sequencing, nucleic acid microarrays, metagenomics, and gene therapy, as well as molecular markers and genomic mapping techniques	✓	✓	✓
	CO 6	Analyze recombinant products, including recombinant hormones, DNA vaccines, transgenic plants and animals, and understand the guidelines for genetic engineering, including physical and biological containment levels and Indian guidelines.	✓	✓	✓
Microbiology Practicals 256030403	**CO 1**	Perform Polymerase Chain Reaction (PCR) technique, demonstrating the ability to accurately amplify specific DNA sequences.	✓	✓	✓
	CO 2	Operate Agarose Gel Electrophoresis for the separation and visualization of DNA fragments based on size	✓	✓	✓

	CO 3	Execute the detection of Treponema pallidum antibodies for syphilis diagnosis through appropriate serological testing	✓	✓	✓
	CO 4	Conduct the Widal test to diagnose malaria antibody, demonstrating precision in antigen-antibody reactions.	✓	✓	✓
	CO 5	Measure and estimate the concentration of sulfate, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), and chloride in given samples, following proper laboratory protocols.	✓	✓	✓
	CO 6	Isolate and purify DNA and RNA from biological samples and use Native SDS PAGE for protein analysis, exhibiting accurate technique and analysis skills.	✓	✓	✓
Dissertation 256010404	**CO 1**	Design and execute an independent research project by formulating testable hypotheses, selecting appropriate biotechnological methodologies, and maintaining accurate documentation.	✓	✓	✓
	CO 2	Analyze and interpret experimental data using statistical/biocomputational tools, and critically evaluate results in the context of existing scientific literature.	✓	✓	✓
	CO 3	Demonstrate ethical research practices, including proper biosafety protocols, data integrity, and adherence to intellectual property (IPR) guidelines.	✓	✓	✓
	CO 4	Communicate research findings effectively through a written dissertation, oral presentations, and scientific visualizations suitable for peer and public audiences.	✓	✓	✓
			73	109	104

Course Outcomes-M.Sc. Physics

Academic Year 2020-21

Course with Code	Name of CO	Description	Relevance to the		
			Local / Regional	National	Global
Semester 1					
Quantum Mechanics–I and Mathematical Physics–I256040101	**CO 1**	Apply the concepts of Laplace transforms to solve differential equations and model physical problems.	✔	✔	
	CO 2	Analyze group theory principles to understand group representations and their role in quantum mechanics.		✔	✔

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	CO 3	Evaluate the tensor algebra and its applications in transforming between different coordinate systems.		✔	✔
	CO 4	Apply approximation methods such as perturbation theory and the variational method to solve stationary state quantum systems.		✔	✔
	CO 5	Develop solutions to quantum mechanical problems using the WKB approximation and time evolution techniques.		✔	✔
Classical Mechanics–I and Statistical Mechanics256040102	**CO 1**	Apply the theory of small oscillations to analyze coupled oscillations and normal modes in physical systems.	✔	✔	✔
	CO 2	Evaluate the principles of canonical transformations and Hamilton–Jacobi theory to solve advanced dynamical systems.		✔	✔
	CO 3	Analyze critical phenomena and phase transitions using mathematical models like the Ising Model and Curie–Weiss theory.		✔	✔
	CO 4	Develop an understanding of fluctuations by applying Langevin theory and Wiener–Khinchin theorem in the study of random motion.		✔	✔
	CO 5	Apply the concepts of Brownian motion and noise theories to explain time-dependent fluctuations and their effects in physical systems.		✔	✔
Electrodynamics--I and Programming in C--I 256040103	**CO 1**	Analyze the propagation, reflection, and transmission of electromagnetic waves in various media, including conducting and dielectric materials.		✔	✔
	CO 2	Apply wave propagation principles in waveguides (rectangular/co-axial) to solve practical problems.	✔	✔	✔
	CO 3	Evaluate scattering phenomena and dispersion in materials, and how permittivity, permeability, and conductivity vary with frequency.		✔	✔
	CO 4	Understand and apply plasma physics concepts like moment equations, MHD, and thermonuclear reactions.		✔	✔
	CO 5	Analyze plasma confinement, heating, and energy loss in fusion processes, including Lawson criterion.		✔	✔
Solid State Physics & Plasma Physics 256040104	**CO 1**	Analyze the origin of energy gaps and apply models like the Nearly Free Electron Model and Kronig–Penney Model to understand energy bands.		✔	✔
	CO 2	Evaluate the construction of Fermi surfaces and understand electron, hole, and open orbits in various zone schemes.		✔	✔

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	CO 3	Apply vacuum techniques, including pumps and gauges, for practical measurement and handling of vacuum systems.	✔	✔	✔
	CO 4	Understand and utilize X-ray and electron diffraction to study crystal structures and solid-state properties.	✔	✔	✔
	CO 5	Analyze neutron scattering and its application in studying properties of solids, including s-wave and elastic scattering phenomena.		✔	✔
Physics Practicals 256040105	**CO 1**	Recall the fundamental principles, components, and theoretical foundations relevant to each experiment.	✔	✔	
	CO 2	Explain the underlying concepts and methodologies associated with the experiments.	✔	✔	
	CO 3	Demonstrate the ability to set up and conduct experiments using appropriate techniques and equipment.	✔	✔	✔
	CO 4	Interpret experimental data to derive meaningful conclusions and validate theoretical predictions.	✔	✔	✔
	CO 5	Assess the accuracy and reliability of experimental results by comparing them with established standards or theoretical models.		✔	✔
Semester 2					
Quantum Mechanics--II and Mathematical Physics--II256040201	**CO1**	Apply complex variable techniques, including contour integrals and the residue theorem, to solve definite integrals and understand conformal mapping.	✔	✔	✔
	CO2	Analyze integral equations and Green's functions to solve boundary value problems in one and three dimensions.	✔	✔	✔
	CO3	Evaluate quantum dynamics using Schrödinger and Heisenberg pictures to understand the motion of atoms and molecules.		✔	✔
	CO4	Understand and apply the Pauli exclusion principle and spin functions to study multi-electron atoms, including the Helium atom.		✔	✔
	CO5	Analyze Einstein's quantum theory of radiation, including quantum electrodynamics, perturbation theory, and the interaction of radiation with matter.		✔	✔
	CO1	Analyze non-linear oscillations and the emergence of chaotic behavior using mathematical models and examples. (Analysis)	✔	✔	✔

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Classical Mechanics--ll and Statistical Mechanics256040202	**CO2**	Apply the principles of relativistic electrodynamics and classical field theory to understand the dynamics of continuous systems and field transformations.		✔	✔
	CO3	Evaluate various magnetic phenomena, including diamagnetism, paramagnetism, and ferromagnetic domains, using models like the Heisenberg and Neel models.		✔	✔
	CO4	Understand and apply the BCS theory and other principles of superconductivity to explain phenomena like the Meissner effect, flux quantization, and Josephson effects.		✔	✔
	CO5	Analyze the thermodynamic and quantum mechanical aspects of superconductors, including the London equation and 3–TC superconductors.		✔	✔
Semiconductor Physics and Devices 256040203	**CO1**	Understand energy bands in metals, semiconductors, and insulators, and analyze carrier concentration under thermal equilibrium conditions. (Understanding & Analysis)	✔	✔	✔
	CO2	Apply the principles of p–n junctions to explain equilibrium Fermi levels, depletion regions, and current–voltage characteristics. (Application)	✔	✔	✔
	CO3	Evaluate the performance and characteristics of field-effect transistors (JFET and MOSFET) in various amplifier configurations. (Evaluation)		✔	✔
	CO4	Analyze the working principles and structures of optoelectronic devices such as LEDs, semiconductor lasers, and photodiodes.	✔	✔	✔
	CO5	Understand the operation and characteristics of different digital IC families, including TTL, MOS, and CMOS, and their interfacing techniques.	✔	✔	✔
Analog Electronics 256040204	**CO1**	Understand the working principles of IC voltage regulators, including 723, positive, negative, and 3/1 voltage regulators, and analyze current booster and fold-back current limiting circuits.	✔	✔	✔
	CO2	Apply operational amplifiers in various configurations such as active filters, sample and hold circuits, and logarithmic/antilogarithmic amplifiers.	✔	✔	✔
	CO3	Analyze the performance of tuned and wide-band amplifiers, including single and double-tuned transformers, pulse response, and bandwidth requirements.		✔	✔
	CO4	Understand the basic operation of Phase-Locked Loop (PLL) circuits and apply them for AM and FM detection.	✔	✔	✔

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	CO5	Evaluate the design and functionality of power amplifiers and multivibrators, including class A, class B, and Schmitt trigger circuits, with detailed analysis.	✔	✔	✔
Physics Practicals 256040205	**CO1**	Recall fundamental concepts, components, and theoretical principles related to the experiments.	✔	✔	
	CO2	Describe the working principles and methodologies of the experiments.	✔	✔	✔
	CO3	Demonstrate proficiency in setting up and performing the experiments using appropriate techniques.	✔	✔	✔
	CO4	Process and interpret experimental data to draw meaningful conclusions.	✔	✔	✔
	CO5	Assess experimental results by comparing them with established theoretical expectations.	✔	✔	✔
Semester 3					
Course Code	**CO No.**	**Course Outcome Statement**	**Local Need**	**National Need**	**Global Need**
Advanced Quantum Mechanics--I, Nuclear Physics--I 256040301	**CO1**	Analyze the kinematics of scattering processes, including differential and total cross sections for elastic and inelastic scattering, and apply wave mechanical concepts such as scattering amplitude and phase shifts.	✔	✔	✔
	CO2	Understand and apply the Born approximation and its validity in scattering theory, including the Born series and Eikonal approximation.	✔	✔	✔
	CO3	Evaluate nuclear properties such as nuclear spin, electric and magnetic moments, and the effects of external magnetic fields on hyperfine structures.	✔	✔	✔
	CO4	Analyze two-body nuclear forces and scattering phenomena, including the deuteron, neutron–proton scattering, effective range theory, and meson theory of nuclear forces.	✔	✔	✔
	CO5	Understand and apply principles of transducers and measurement systems, including signal conditioning, noise reduction, impedance matching, and the use of phase-sensitive detectors and lock-in amplifiers.	✔	✔	✔
Numerical Methods and Digital Eletcronics 256040302	**CO1**	Apply numerical methods to solve ordinary differential equations using techniques such as Euler's method, Runge–Kutta method, and Predictor–Corrector method.	✔	✔	

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	CO2	Analyze and solve partial differential equations, including elliptic, parabolic, and hyperbolic equations, using numerical methods for Laplace, Poisson, heat, and wave eqs.	✔	✔	✔
	CO3	Understand and implement digital electronic components such as parity generators, ROM, PAL, and utilize clocks and timers including TTL clock and 555 Timer.	✔	✔	
	CO4	Design and analyze shift registers and counters with practical applications in digital electronics.	✔	✔	
	CO5	Evaluate and implement D/A and A/D converters and analyze display technologies such as LED, LCD, and plasma.		✔	✔
Fiber Optics, Satellite Communication & Microprocessor–I 256040303	**CO1**	Understand and analyze radio wave propagation (free space, tropospheric, ionospheric) and basics of satellite communication (orbits, power systems, transponders).	✔	✔	
	CO2	Explain fiber optic communication principles: light propagation, modal concepts, dispersion, and components like sources, detectors, connectors.	✔	✔	✔
	CO3	Describe architecture and interfacing of microprocessor-based systems including microcontrollers, memory types, I/O devices, and related hardware/software.	✔	✔	
	CO4	Demonstrate 8085 Assembly language programming proficiency: instruction sets, data formats, execution, and arithmetic/data manipulation program development.	✔	✔	
	CO5	Analyze and implement microprocessor architectures, including memory and I/O interfacing, instruction decoding with 8085, for microcomputer system applications.	✔	✔	
Electronic Comminication-I 256040304	**CO1**	Understand and apply lumped element model for transmission lines; perform field analysis and use Smith chart for impedance matching and loss analysis.	✔	✔	
	CO2	Describe and analyze antenna parameters (radiation pattern, resistance, directivity, gain) and antenna types such as dipole, Yagi, and parabolic reflector.	✔	✔	✔

	CO3	Explain amplitude and angle modulation (AM, SSB, FM); analyze theory, spectrum, and modulator/detector circuits.	✔	✔	
	CO4	Analyze and design pulse modulation systems (PAM, PCM, PTM); understand digital carrier systems (ASK, FSK, CPFSK, MSK, PSK) and synchronization techniques.	✔	✔	
	CO5	Understand and apply digital communication techniques (bit error probability, matched filters, bit/carrier timing recovery); evaluate baseband and modulated system performance.	✔	✔	
Physics Practicals 256040305	**CO1**	Recall the pin configurations and functions of ICs (741, 555, 7400 series) used in the experiments.	✔	✔	
	CO2	Explain the working principles of circuits like multivibrators, oscillators, and counters based on theoretical concepts.	✔	✔	
	CO3	Construct and test circuits (e.g., Schmitt trigger, voltage regulator) using ICs and measure output parameters.	✔	✔	✔
	CO4	Interpret experimental data (e.g., frequency, waveforms) and compare results with theoretical expectations.	✔	✔	
	CO5	Validate circuit functionality by testing against specified performance criteria.	✔	✔	
Semester 4					
Advanced Quantum Mechanics--I, Nuclear Physics--I 256040301	**CO1**	Analyze the kinematics of scattering processes, including differential and total cross sections for elastic and inelastic scattering, and apply wave mechanical concepts such as scattering amplitude and phase shifts.	✔	✔	✔
	CO2	Understand and apply the Born approximation and its validity in scattering theory, including the Born series and Eikonal approximation.	✔	✔	✔
	CO3	Evaluate nuclear properties such as nuclear spin, electric and magnetic moments, and the effects of external magnetic fields on hyperfine structures.	✔	✔	✔
	CO4	Analyze two-body nuclear forces and scattering phenomena, including the deuteron, neutron–proton scattering, effective range theory, and meson theory of nuclear forces.	✔	✔	✔

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	CO5	Understand and apply principles of transducers and measurement systems, including signal conditioning, noise reduction, impedance matching, and the use of phase-sensitive detectors and lock-in amplifiers.	✔	✔	✔
Numerical Techniques & Sophisticated Experimental and Characterization Techniques 256040402	**CO1**	Describe and explain the fundamental numerical techniques used for solving complex scientific and engineering problems, including methods such as finite difference, finite element, and interpolation techniques.	✔	✔	✔
	CO2	Apply numerical algorithms and methods to solve real-world problems in areas such as data analysis, optimization, and simulation, using appropriate software tools and programming languages.	✔	✔	✔
	CO3	Analyze experimental data using sophisticated characterization techniques, such as spectroscopy, microscopy, and X-ray diffraction, to determine material properties and validate numerical models.	✔	✔	✔
	CO4	Evaluate the effectiveness and limitations of various experimental and characterization techniques in achieving accurate and reliable results, and make recommendations for improvements.	✔	✔	
	CO5	Design and conduct experiments using advanced techniques to characterize materials or phenomena, and integrate numerical methods to interpret experimental data and validate theoretical models.	✔	✔	✔
Microwaves and Microprocessor--II 256040403	**CO1**	Understand and apply 8085 microprocessor instructions for data handling and arithmetic operations.	✔	✔	✔
	CO2	Design and implement counters and time delays using the 8085 microprocessor.	✔	✔	
	CO3	Utilize stack operations and subroutines effectively in assembly programming.	✔	✔	✔
	CO4	Perform code conversions and arithmetic operations involving BCD and 16-bit data.	✔	✔	
	CO5	Describe the principles and applications of microwave devices and passive components.	✔	✔	✔
Remote Sensing & Electronic Communication--II 256040404	**CO1**	Apply transmission line theory to analyze and design electrical circuits involving lumped elements, field analysis, and impedance matching.	✔	✔	✔
	CO2	Design and evaluate various antenna systems based on their fundamental parameters and operational characteristics.	✔	✔	✔

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	CO3	Demonstrate knowledge of radio receiver architecture and performance, including AM and FM receivers, their components, and noise management.	✔	✔	
	CO4	Understand radar system principles and apply them to analyze radar performance, including pulsed radar, MTI, and Doppler systems.	✔	✔	✔
	CO5	Integrate and apply knowledge from transmission lines, antennas, receivers, and radar systems to solve complex problems in communication and radar technology.	✔	✔	✔
Physics Practicals-256040405	**CO1**	Identify the components, pin configurations, and specifications of ICs (741, 0800) and kits (8085, ExpEyes, optical fiber) used in the experiments.	✔	✔	✔
	CO2	Explain the working principles of circuits (filters, modulation, transmission lines) and systems (ADC, microprocessor programs) based on theoretical concepts.	✔	✔	✔
	CO3	Assemble and test circuits (low/high-pass filters, ADC) and operate kits (8085, ExpEyes, optical fiber) to obtain measurable outputs.	✔	✔	✔
	CO4	Interpret experimental results (e.g., cutoff frequencies, modulation indices, dielectric constants) and compare them with theoretical values.	✔	✔	✔
	CO5	Validate the performance of designed circuits (filters, ADC) and executed programs (8085) against predefined benchmarks.	✔	✔	✔
Count			74	100	77

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Course Outcomes of M.Sc. Environmental Sciences					
Academic Year 2022-23					
Course with Code	Name of CO	Description	Relevance to the		
			Local / Regional	National	Global
Semester I					
256060101- Environmental Science and Ecology	CO 1	Explain the fundamental concepts of ecology, including species interactions, natural selection, species richness, ecological succession, and ecosystem stability.	✔	✔	✔
	CO 2	Analyze the structure and functioning of ecosystems, focusing on energy flow, primary and secondary production, food chains, food webs, and decomposition processes.	✔	✔	✔
	CO 3	Compare and contrast the characteristics of various terrestrial biomes, including tundra, taiga, temperate forests, grasslands, deserts, and tropical rainforests, with a focus on forest resources and their sustainable management.	✔	✔	✔
	CO 4	Evaluate the impact of human activities, such as deforestation, forest degradation, and dam construction, on forest ecosystems and indigenous communities, with particular attention to India's forest resources.	✔	✔	
	CO 5	Assess the environmental implications of mineral resource exploration and usage, and the challenges associated with global food production, including the use of pesticides and the impact of modern agriculture on the environment.	✔	✔	✔
	CO 6	Propose sustainable solutions for conserving natural resources, emphasizing the role of individuals in promoting sustainable agriculture, pollution prevention, and equitable resource management.	✔	✔	✔
256060102- Environmental Issues and Impacts	CO 1	Explain the composition and temperature profile of the atmosphere, including the evolution of the primitive atmosphere and the sources and sinks of atmospheric components, with a focus on the causes, impacts, and mitigation of acid rain.	✔	✔	✔
	CO 2	Analyze the chemical processes affecting the stratospheric ozone layer, including the role of chlorofluorocarbons (CFCs) and nitrogen oxides in ozone depletion, and the Montreal Protocol.		✔	✔
	CO 3	Examine photochemical smog and the role of OH radicals and particles in climate, air quality, and health; include particle control strategies.	✔	✔	✔

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	CO 4	Discuss greenhouse effect, global warming, and climate change with focus on CO_2 impacts and international agreements like Kyoto Protocol.		✔	✔
	CO 5	Investigate ozone hole formation and CO_2-induced climate issues; assess ozone concentration trends and mitigation strategies.		✔	✔
	CO 6	Evaluate radiation hazards from anthropogenic sources, nuclear winter, and radioactive pollution, and propose preventive measures.	✔	✔	✔
256060103-Energy and Environment	**CO 1**	Understand the fundamental laws of energy flow, dynamic equilibrium, chemical kinetics, and basic chemistry of atoms, elements, and reactions.	✔	✔	✔
	CO 2	Analyze energy production/consumption, renewable and conventional fuels, and conservation strategies including solar input.	✔	✔	✔
	CO 3	Evaluate nuclear energy production and management, including uranium use and nuclear accident risks.		✔	✔
	CO 4	Explore non-conventional sources like photovoltaics, wind, tidal, and solar heating as sustainable solutions.	✔	✔	✔
	CO 5	Examine biomass and biofuel energy using natural vegetation, tree plantations, and energy crops.	✔	✔	✔
	CO 6	Assess environmental impacts of biomass and renewable energy programs.	✔	✔	✔
256060104-Environment and Soil	**CO 1**	Understand soil formation, weathering, degradation, horizons, and GIS/GPS applications in soil mapping and assessment.	✔	✔	✔
	CO 2	Analyze physical properties of soil (texture, porosity, etc.) and their impact on soil health and plant growth.	✔	✔	
	CO 3	Evaluate soil-water relationships, water flow, and uptake, and techniques to enhance water efficiency and reduce water loss.	✔	✔	✔
	CO 4	Investigate chemical properties of soil: clays, colloids, cation/anion exchange, acidity, and buffering.	✔	✔	
	CO 5	Examine lime's role in managing soil acidity and improving crop productivity.	✔	✔	
	CO 6	Assess ecological impacts of soil acidification and strategies for managing acidic soils sustainably.	✔	✔	✔
Semester II					

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256060201- Water Quality and Wastewater Treatment Techniques	**CO 1**	Understand the hydrological cycle, groundwater and surface water systems, pollutants, and factors influencing water quality.	✔	✔	✔
	CO 2	Analyze water resource management and wastewater origin/characteristics.	✔	✔	
	CO 3	Develop wastewater sampling and analysis skills, including physical, chemical, and bacteriological assessments.	✔	✔	✔
	CO 4	Examine wastewater treatment stages and recovery of valuable materials from effluents.	✔	✔	✔
	CO 5	Investigate industrial impacts on water quality (e.g., sugar, pharmaceuticals, tanneries).	✔	✔	
	CO 6	Assess water quality regulations, industry compliance, and sustainable management practices.	✔	✔	✔
256060202- Integrated Solid Waste Management	**CO 1**	Understand concepts of solid waste management, types, collection, volume reduction, and waste hierarchy.	✔	✔	
	CO 2	Analyze source reduction policies, government initiatives, and concentrating techniques (e.g., filtration, incineration).	✔	✔	
	CO 3	Evaluate recycling methods and technologies (e.g., baling, magnetic separation, material-specific recycling).	✔	✔	✔
	CO 4	Examine composting and landfilling systems, including leachate and landfill gas management.	✔	✔	✔
	CO 5	Understand hazardous waste management, including medical and nuclear waste treatment and disposal.	✔	✔	✔
	CO 6	Assess environmental impacts of waste practices and explore sustainable strategies for managing various wastes.	✔	✔	✔
256060203- Aquatic and Marine Environmental Chemistry	**CO 1**	Understand aquatic and marine chemistry fundamentals, including water properties, redox, metal complexes, and marine-derived pharmaceuticals.			✔
	CO 2	Analyze marine pollution sources (oil, metals), microbial degradation, estuarine pollution, and mitigation with focus on India.	✔	✔	✔
	CO 3	Examine oceans' role in climate regulation via seawater chemistry, oceanic gases, and carbon cycle.		✔	✔
	CO 4	Explore chemical-ocean-climate feedback mechanisms and future interactions.		✔	✔
	CO 5	Understand remote sensing principles and their environmental applications via GIS and GPS.	✔	✔	

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	CO 6	Apply remote sensing, GIS, and GPS to assess and manage marine and coastal pollution.	✔	✔	✔
256060204-Air Pollution: Quality and Control Methods	**CO 1**	Understand sources, types, effects of air pollutants, photochemical smog, health impacts, and the Air (Prevention and Control of Pollution) Act, 1981.	✔	✔	✔
	CO 2	Analyze air pollutant sampling methods (ambient, gaseous, particulate, stack sampling) and analytical principles.	✔	✔	
	CO 3	Examine air pollution control methods and devices for both particulates and gaseous pollutants.	✔	✔	✔
	CO 4	Evaluate efficiency of air pollution control technologies like filters, electrostatic precipitators, and wet collectors.	✔	✔	✔
	CO 5	Understand indoor air quality issues, pollutant sources, and health-related syndromes.	✔	✔	
	CO 6	Assess indoor air pollutant dynamics and propose mitigation strategies for improving indoor air quality.	✔	✔	
Semester III					
256060301-Environmental Biotechnology	**CO 1**	Evaluate impacts of nitrogen fertilizers, landfill liners, submicron toxins, and cleaner bioprocesses for sustainability.	✔	✔	✔
	CO 2	Analyze recycling/treatment of organic wastes (duckweed, vinasse, reed beds) for resource recovery and reuse.	✔	✔	✔
	CO 3	Investigate removal of recalcitrant compounds via immobilized organisms, bioremediation, and bioavailability enhancement.	✔	✔	✔
	CO 4	Examine bioremediation for contaminated sites and oil biocatalysis applications.	✔	✔	✔
	CO 5	Explore cleaner bioprocesses in industrial settings (e.g., pulp bleaching, microbial sustainability processes).	✔	✔	✔
	CO 6	Assess cleaner technologies in industries for sustainability and reduced environmental impact.	✔	✔	✔
256060302-Environmental Toxicology and Its Impact	**CO 1**	Understand fundamentals of toxicology including dose-response, xenobiotics, and toxic effects on systems like reproductive and immune.	✔	✔	✔
	CO 2	Analyze toxicology of elements, heavy metals, and hazardous compounds with emphasis on health and environmental effects.	✔	✔	✔
	CO 3	Examine presence, sources, and effects of heavy metals (e.g., As, Cd, Pb, Hg, Cr), and mitigation approaches.	✔	✔	✔

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	CO 4	Evaluate toxicological impact of halogens, organometallics, cyanide, CO on health and ecosystems.	✔	✔	✔
	CO 5	Assess pesticide use, persistence, classification, and bioaccumulation/biomagnification concerns.	✔	✔	✔
	CO 6	Apply toxicological knowledge to assess chemical health hazards and mitigation strategies.	✔	✔	✔
256060303-Environmental Rules and Regulations	**CO 1**	Understand the framework of environmental legislation in India, including key laws such as the Water Act, Air Act, Environment Protection Act, and Biological Diversity Act, as well as similar legislation in the USA and the Factories Act, 1948.	✔	✔	✔
	CO 2	Analyze the National Conservation Strategy and Policy Statement on Environment and Development, including environmental problems, legal actions, institutional frameworks, and strategies for pollution prevention, conservation, and sustainable development.	✔	✔	✔
	CO 3	Evaluate the Policy Statement for Abatement of Pollution, focusing on future directions, standards for critically polluted areas, clean technologies, fiscal measures, auditing, and partnerships.	✔	✔	✔
	CO 4	Examine the role and function of the National Environment Tribunal Bill, 1992, including compensation for environmental damage, establishment and jurisdiction of the tribunal, and dispute proceedings.	✔	✔	
	CO 5	Assess the impact of environmental policies on industrial development, energy, mining, tourism, transportation, and human settlements, and explore international cooperation and support systems.	✔	✔	✔
	CO 6	Apply knowledge of environmental laws and policies to address environmental challenges, including pollution control, conservation, and legal mechanisms for resolving disputes.	✔	✔	✔
256060304-Environmental Impact Assessment	**CO 1**	Understand the fundamental concepts and methodologies of Environmental Impact Assessment (EIA), including its role as a planning tool, criteria for selecting EIA methodologies, and the use of predictive models for impact assessment.	✔	✔	✔
	CO 2	Assess and predict the impacts of major projects on various environmental aspects, including noise, transport, landscape, air quality, soil, water, ecology, and socio-economic factors.	✔	✔	✔

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	CO 3	Analyze environmental risk assessment (ERA) concepts and methods, including key steps in performing an ERA, legislative and policy backgrounds, and the similarities and challenges between ERA and EIA.	✔	✔	✔
	CO 4	Evaluate the application of environmental remote sensing (RS) and geographical information systems (GIS) in EIA, including the use of RS data and software for impact prediction, mitigation, and monitoring.	✔	✔	✔
	CO 5	Develop skills in integrating GIS and remote sensing data into the EIA process, including their application in screening, scoping, baseline studies, impact prediction, and mitigation efforts.	✔	✔	✔
	CO 6	Apply knowledge of EIA methodologies, environmental risk assessment, and remote sensing technologies to real-world case studies, assessing their effectiveness in managing environmental impacts.	✔	✔	✔
Semester IV					
256060401- Remote Sensing and Geographical Information	**CO 1**	Understand the fundamentals of remote sensing, including definitions, scope, electromagnetic radiation, atmosphere windows, and the various platforms and sensors used in remote sensing systems, with a focus on LANDSAT, SPOT, and Indian remote sensing satellites.	✔	✔	✔
	CO 2	Analyze aerial photography techniques, including the use of vantage points, cameras, filters, and films, and comprehend the elements of visual image interpretation, as well as the principles of multispectral and microwave remote sensing and photogrammetry.	✔	✔	✔
	CO 3	Examine digital image processing techniques, including image restoration and enhancement, and apply image classification methods to various remote sensing applications in forestry, ecology, land use, agriculture, soils, geology, and disaster management.	✔	✔	✔
	CO 4	Explore the applications of remote sensing technologies in environmental science, including their use in monitoring and managing forestry, ecological systems, land use, and disaster response.	✔	✔	✔
	CO 5	Understand the principles and applications of Geographic Information Systems (GIS), including hardware and software requirements, and the conceptual models of spatial and non-spatial information.	✔	✔	✔

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	CO 6	Apply GIS technology and GPS for environmental science applications, integrating spatial and non-spatial data to support environmental analysis and decision-making.	✔	✔	✔
256060402-Environmental Modelling and Biostatistics	**CO 1**	Apply statistical measures of central tendency (mean, median, mode) and dispersion (standard deviation, skewness, kurtosis) to analyze data, and use correlation and linear regression techniques to model relationships between variables.	✔	✔	✔
	CO 2	Understand and utilize probability concepts, random variables, and density functions, including the application of binomial and normal distributions in statistical analysis and hypothesis testing.	✔	✔	✔
	CO 3	Explore the role of modeling in environmental sciences, including the classification of deterministic and stochastic models, steady-state and dynamic models, and the stages involved in building and formulating these models.	✔	✔	✔
	CO 4	Apply microbial growth kinetics models, such as the Monod equation, and methods for formulating dynamic balance equations, including mass balance procedures, to environmental and biological systems.	✔	✔	✔
	CO 5	Analyze and apply various environmental models, including the Lotka-Volterra model for population interactions, Leslie's matrix model, point source stream pollution models, box models, and Gaussian plume models, for understanding and predicting environmental phenomena.	✔	✔	✔
	CO 6	Develop and validate regression models (linear, simple, and multiple) for environmental data analysis and forecasting, and apply these models to practical environmental scenarios for accurate prediction and decision-making.	✔	✔	✔
256060402-Dissertation	**CO 1**	Formulate a scientifically relevant research problem in the field of environmental science and design an appropriate methodology to investigate it.	✔	✔	✔
	CO 2	Conduct independent research using appropriate experimental, analytical, or modeling tools, ensuring accuracy, reproducibility, and data integrity.	✔	✔	✔
	CO 3	Critically analyze research data, interpret findings in the context of existing scientific knowledge, and draw logical, evidence-based conclusions.	✔	✔	✔
	CO 4	Effectively communicate the research process and outcomes through a well-structured dissertation and oral presentation, adhering to academic and ethical standards.	✔	✔	✔
		Total	81	87	75

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