		NAAC -- Cycle-3
	Shri Manibhai Virani and Smt. Navalben Virani Science College	**Criterion- II**
	An Autonomous college affiliated to Saurashtra University, Rajkot	**Metric -2.6.1**

2.6.1	**Programme and course outcomes for all Programmes offered by the institution are stated and displayed on website and communicated to teachers and students.**

PO & CO OF ALL PROGRAMS

1.1 B.Sc. Biochemistry

PO 1	**Domain knowledge:** Demonstrate an understanding of fundamental biochemistry principles, including topics specific to chemistry and biochemistry.
PO 2	**Problem analysis:** Identify and critically analyse pertinent problems in the various domains of life sciences.
PO 3	**Design/development of solutions:** using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions pertaining to life sciences.
PO 4	**Conduct investigations of complex problems:** Cultivate the skills to Employ modern library search tools to locate and retrieve scientific information about a problem relating to biochemistry.
PO 5	**Modern tool usage:** Ability to handle/use appropriate chemical and biochemical experiments using tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO 6	**The Biochemist and society:** Demonstrate the ability to understand the role of scientific developments, particularly, biological sciences in a changing world from the disciplinary perspective as well as in relation to its professional and everyday use.
PO 7	**Environment and sustainability:** Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO 8	**Ethics:** Commitment to professional ethics and responsibilities.
PO 9	**Individual and team work:** Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO 11	**Project management and finance:** Demonstrate knowledge and scientific understanding to identify research problems, design experiments, generation of new scientific insights or to the innovation of new applications of Biochemistry research and provide solutions. Exhibit organizational skills and the ability to manage time and resources.
PO 12	**Life-long learning:** Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	21UBCCC101	Foundation of Biochemistry	1. Describe and review the concept of structure of atom, molecules and different bonds involved in the biological compounds 2. Identify and apply redox reactions and the principles of Thermodynamics in biochemical reactions 3. Define and calculate pH, buffers and explain buffer systems in the human body 4. Understand and apply the principles of physical chemistry that govern the inter and intra molecular interactions in the biological system 5. Apply the knowledge on the preparation and importance of the various solution used in Biochemistry	Core	4	30	70
I	21UBCCC102	Molecules of Life	1. Understand the foundations of biochemistry to identify the physical and chemical properties of water that sustains life 2. Classify, recognize and illustrate the structures of biomolecules 3. Examine and interpret the biochemical reactions of carbohydrates and lipids 4. Express importance of vitamins and porphyrins in biology 5. Understand the structure of nucleic acids, acknowledge the contribution of scientists and illustrate experiments demonstrating nucleic acid as genetic material	Core	4	30	70

I	21UBCCC103	Basic Biochemistry Practical	1. Acquaint with instruments used in biochemistry laboratory, basic laboratory practices and safety. 2. Solve numerical problems and prepare various laboratory reagents 3. Prepare the buffer solutions and know the acidic and basic nature of various chemicals and beverages 4. Undertake experiments for qualitative identification of biomolecules 5. Estimate concentration of unknown macro and micro molecules.	Core	3	40	60
II	21UBCCC201	Cell Biology	1. Explain and Compare the basic concept of structures, properties, functions, differences of a prokaryotic and eukaryotic cell. 2. Illustrate and relate the principle and functioning of different microscopic methods applied to study cell and cell structures. 3. Demonstrate the different models proposed on the structure of cell membrane and identify the structure & function of the different organelles of a cell. 4. Compare structural and functional aspects of cilia-flagella. Identify and Relate the role of cytoskeleton components in the cellular organization 5. Describe, Classify and Sketch the events in cell cycle and cell division	Core	4	30	70
II	21UBCCC202	Human Physiology-I	1. Identify the relationship between anatomy & physiology and the major levels of organization from molecules to organism. 2. Recognize and identify the principal tissue, major components, regulation and functions of physiological systems. 3. Explain and describe the composition, function of various body fluids like blood and lymph, their significance and related disorders. 4. Describe the mechanism of urine formation and excretion of urine renal system. 5. Enlist, Interpret and identify various disorders related tomajor systems of the body.	Core	4	30	70

II	21UBCCC203	Human Physiology –II & Endocrinology	1. Describe and illustrate organization of the nervous system and summarize the organization and structure of the endocrine system. 2. Identify, compare and relate functions of the brain, spinal cord, nerves and hormones in effective chemical control and coordination. 3. Classify and categorize hormones of different endocrine glands. Explain general principles of hormone synthesis, compare and relate mode of action of various hormones in the human body 4. Explain, summarize and appraise the significant role of organs of reproductive system and Interplay of different hormones in reproductive cycle. 5. Define, compare and correlate the knowledge of endocrinology for hormone associated problems.	Core	4	30	70
II	21UBCCC204	Cell biology and Physiology Practical	1. Identify and describe the salient features of the different stages of cell division and compare mitosis and meiosis 2. Recognize and identify different cell components. 3. Be able to perform, analyze and report on experiments and observations in basic hematological laboratory testing. 4. Perform urine analysis and evaluate normal and abnormal constituents. 5. Demonstrate understanding of the principles underlying tests of endocrine and reproductive function	Core	3	40	60

III	21UBCCC301	Protein Biochemistry	1. Classify, compare and evaluate the structural and functional differences of amino acids and various biologically important peptides 2. Describe, compare and predict structural forms of proteins and illustrate peptide bond formation 3. Identify and recognize the physiological roles of proteins. Understand, compare the roles of protease enzymes applied in protein sequencing 4. Describe, compare and apply the knowledge of various homogenization and chromatographic techniques used in protein purification. 5. Draw and evaluate electrophoretographs of proteins separated by different electrophoresis; explain and classify immunoglobulins.	Core	4	30	70
III	21UBCCC302	Enzymology	1. Explain relationship between the structure and function of enzymes 2. Interpret and explain significant mechanisms of regulation of enzymatic action 3. Apply appropriate methods for determination of catalytic parameters and activity of enzymes 4. Resolve problems considering kinetics and thermodynamics of enzymatic reactions 5. Analyze options for applying enzymes and their inhibitors in medicine and various industries	Core	4	30	70
III	21UBCCC303	Analytical Biochemistry	1. Apply the basic concepts of various analytical techniques to distinguish, characterize and analyze different biomolecules. 2. Relate working principle, instrumentation and applications of various bio-analytical instruments. 3. Illustrate and apply the principles and functioning of various analytical instruments to elucidate interpret and analyze properties of different Biomolecules (proteins and nucleic acids) such as their structures, molecular weight, solubility, etc. 4. Apply various analytical techniques in identification and characterization of wide range of known as well	Core	4	30	70

			as unknown chemical and biological substances and relate their functions with their properties. 5. Design methodologies and plan experiments to analyze, separate or purify wide range of molecules from biological samples on the basis of differences in their physicochemical properties.				
III	21UBCCC304	Enzymology and Bioanalytical Practicals	1. Describe, apply and execute the enzyme assay from homogenate 2. Compare and identify the differences in electrophoretic patterns of various proteins 3. Perform bioassay for protein estimations and calculate the concentration of unknown biological samples 4. Illustrate and draw the graphs to evaluate the effects of various factors like pH, temperature and substrate concentration on enzyme activity 5. Identify and characterize the amino acids from the mixture by applying TLC and paper chromatography technique	Core	3	40	60
IV	21UBCCC401	Intermediary Metabolism	1. Relate synthesis and degradation pathways for biomolecules 2. Identify the central metabolic pathways and their importance in cellular metabolism. 3. Illustrate how various molecules are utilized as fuels for oxidation and production of energy in living organisms. 4. Apply concepts of metabolism in understanding biochemical basis for various metabolic and lifestyle diseases, their diagnosis, treatment and management. 5. Combine and correlate interplay in pathways of carbohydrates, amino acids, lipids and nucleic acid metabolism.	Core	4	30	70

IV	21UBCCC402	Molecular Biology	1. Understand the basic concepts for DNA sequencing, replication and gene expression 2. Describe the general principles of gene organization and expression in both prokaryotic and eukaryotic organisms. 3. Demonstrate knowledge and understanding of the molecular machinery of replication, recombination and mutation in living cells. 4. Compare and contrast the mechanisms of bacterial and eukaryotic Transcription, and Translation 5. Understand the types of recombination and transposable elements and their applications.	Core	4	30	70
IV	21UBCCC403	Metabolism and Molecular Biology Practicals	1. Develop skills for blood collection by vein puncture, isolation of plasma and serum for biochemical analysis. 2. Compare pros and cons of chemical vs. enzymatic estimation methods for different analytes. Design and perform experiments to analyze various biochemical substances, metabolites from body fluids-plasma and serum. 3. Perform calculations and interpret the results of various biochemistry laboratory tests and derive conclusions and clinical correlations. 4. Estimate DNA and RNA from various samples and compare and correlate chemical v/s physical methods of their estimation. 5. Perform bacterial recombination experiment through conjugation and interpret the results.	Core	3	40	60
IV	21UBCDC401	Microbiology	1. Identify various microorganisms, classify and compare the function of flagella and pili. 2. Understand the nutritional requirements of microbes and relate them with growth rate. 3. Explain different microbial techniques and media to choose the correct practice of isolation of microbes. 4. Discern the replication strategies of representative viruses from the seven Baltimore classes; Comprehend the intricate interaction between viruses and host cells	Elective	4	30	70

			5. Identify and recognize microbial pathogens and understand the role of antimicrobial agents.				
IV	21UBCDC402	Membrane Biology and Bioenergetics	1. Describe the structure, organisation and biogenesis of biological membranes. Explain how physico-chemical properties of the lipids and proteins lead to the dynamic nature of biological membranes. 2. Demonstrate deep and rational understanding of how ions and solutes are transported across biological membranes, thus creating membrane gradients, demonstrate ability to solve practical problems related to membranes 3. Describe, Discuss and Classify different types of transport mechanism across membrane and list various transport proteins 4. Explain and interpret the organization of components of respiratory electron transport chain into complexes 5. Interpret and identify various types of phosphorylation and evaluate inhibitors of ETC and phosphorylation	Elective	4	30	70
IV	21UBCDC403	Microbiology Practical	1. Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively 2. Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures. 3. Know the various Physical and Chemical growth requirements of bacteria and get equipped with a method of bacterial growth measurement. 4. Gain experimental knowledge to isolate the specific organism 5. Check the effects of various antibiotics on growth of bacteria.	Elective	2	40	60
IV	21UBCDC404	Membrane Biology and Bioenergetics Practical	1. Isolate RBC from blood sample 2. Deduce and Illustrate effect of detergents on membranes 3. Prove that during photosynthesis oxygen is evolved 4. Isolate and estimate the photosynthetic pigments 5. Isolation of mitochondria from rat liver	Elective	2	40	60

V	21UBCCC501	Advanced Molecular Biology	1. Describe and differentiate how gene expression is regulated at the transcriptional and posttranscriptional level in prokaryotes and eukaryotes 2. Differentiate the various steps involved in the gene cloning and different enzymes involved in gene modification and their role in recombinant DNA technology. 3. Achieve broad thinking on different types of vectors and share insights of its applications in the field of biotechnology. 4. Gain insights on principle and applications of various techniques such as, nucleic acid hybridization, DNA sequencing, PCR, Microarray and blotting in the field life science. 5. Summarize various applications of genetic engineering in different fields.	Core	4	30	70
V	21UBCCC502	Genetics	1. Recall Mendelian laws and solve problems related to it. Infer gene interactions, and environmental effect on genes. 2. Identify, associate and analyze pedigree. Display effect of crossing over on next generation. 3. Develop an understanding of influence of gene flow on population trends and correlate it with evolutionary changes. 4. Identify chromosomal abnormalities, understand basics of prenatal diagnosis tests and match it up with the genetic disorders. 5. Relate mendelian genetics, linkage and population genetics to understand human genetics and heredity.	Core	4	30	70
V	21UBCCC503	Nutritional Biochemistry-Self Study	1. Summarize, critically evaluate and correlate the fundamental and applied aspects of nutrition. 2. Relate balance of energy intake through diet and expenditure via various physical activities in management of weight gain or weight loss and maintaining healthy body. 3. Illustrate functions of various nutrients and their deficiency diseases and prevention and treatment of	Core	4	30	70

			various nutritional deficiency disorders.				
			4. Identify the rich dietary sources for various macronutrients, vitamins, minerals as well as trace elements and design the balanced diet.				
			5. Apply the knowledge of nutritional biochemistry to make best food choices for promoting healthy lifestyle at individual, family and ultimately at society level.				
V	21UBCCC504	Molecular Biology and Genetics Practicals	1. Isolate and purify nucleic acids/plasmids for routine laboratory procedures. 2. Explain the underlying mechanisms of gene cloning. 3. Discuss the practical aspects of applying recombinant DNA technology. 4. Analyze inheritance pattern to create a pedigree chart. 5. Elucidate the concepts of linkage and crossing over to solve basic gene mapping problems.	Core	3	40	60
V	21UBCCE501	Clinical Biochemistry	1. Recognize importance and uses and of various lab instruments and describe requirements for setting up a clinical laboratory. Get organized with preparation and storage of reagents as well as samples. Point out importance of lab automation and quality control in laboratory procedures. Execute the precautionary and first-aid measures in clinical laboratories. 2. Identify and critically evaluate clinical problems associated with liver and kidney function. 3. Recognize biochemical basis and risk factors for cardiovascular diseases and apply various strategies for effectively in prevention and management of cardiovascular diseases for self, family and the society. 4. Distinguish inborn errors of metabolism and chromosomal diseases from other treatable diseases. Relate gene defects and its biochemical associations with symptoms and complications of genetically inherited diseases. Associate importance of prenatal diagnostic approaches in prevention of common and highly prevalent chromosomal diseases like Down's	Elective	4	30	70

			syndrome. 5. Explore modern diagnostic approaches in diagnosis, better management, and prevention of serious life-threatening complications of Diabetes mellitus - the most common metabolic disease in India and especially in Gujarat.				
V	21UBCCE502	Bioinformatics	1. Describe, examine the basic concepts of Bioinformatics and its significance in biological data analysis. 2. Classify and Test different types of Databases 3. Explain, Analyze and assess about the methods to characterize and manage the different types of biological data 4. Introduction to the basics of sequence alignment and analysis. 5. Overview about biological macromolecular structures and structure prediction methods.	Elective	4	30	70
V	21UBCCE503	Pharmaceutical Biochemistry	1. Define drug and illustrate on types of drugs including their use. Classify the various routes of administration with advantages and disadvantages. 2. Discuss, Interpret and Assess drug absorption and elimination from body 3. Discuss, Interpret and Assess drug action and metabolism 4. Explain, Analyse and assess adverse drug reactions and drug toxicity so that it can get minimize. 5. Identify, Devise and design process of new drug discovery and development of drug.	Elective	4	30	70

V	21UBCCE504	Clinical Biochemistry Practicals	1. Design and perform experiments to analyze various biochemical substances, metabolites from body fluids-plasma and serum using advanced kit based methods. 2. Compile and interpret the results of various biochemistry laboratory tests. 3. Master the skills of clinical biochemistry analysis and interpretations in evaluation of risk factors, diagnosis, prognosis and management of various diseases. 4. Have better insights on biochemistry and pathophysiology associated with renal, hepatic, cardiovascular and metabolic diseases with tests performed in a clinical biochemistry laboratory. 5. Critically evaluate various case studies and derive meaningful conclusions.	Elective	1	20	30
V	21UBCCE505	Bioinformatics Practicals	1. Predict functions of gene and genomes using online tools 2. Predict and evaluate the sequence and structure of proteins and peptides 3. Align protein and nucleotide sequence using various tools 4. Use tools and programmes used in Bioinformatics. 5. Perform insilico experiments and will predict structures of proteins.	Elective	1	20	30
V	21UBCCE506	Pharmaceutical Biochemistry Practicals	1. Enhance knowledge on drug labels. 2. Analyse various components of pharmaceuticals 3. Evaluate effect of drugs and drug metabolites 4. Analyse drug elimination and metabolism through kidney function test 5. Critically evaluate various case studies and derive meaningful conclusions.	Elective	1	20	30
VI	21UBCCC601	Advanced Cell Biology	1. Discuss, compare and distinguish different types of nuclear transport 2. Describe and assess different cell – cell interactions and its role in cell migration and adhesion. 3. Describe the mechanism and control of the cell cycle at the molecular level	Core	4	30	70

Sem	Code	Title	Course Outcomes	Type	Credit	Int	Ext
			4. Understand the molecular mechanisms that control apoptosis and how apoptosis is used in development 5. Explain, recognize and evaluate cancer development and progression. 6. Compare and choose different techniques for study of cell structure and function.				
VI	21UBCCC602	Immunology	1. Define and describe the cells and organs of immune system and summarize the role of antigen presenting cells, Analyze the different roles of lymphocytes, and identify the integration of Innate and adaptive immune response. 2. Classify and justify the role of MHC molecules based on the nature of Ag, Analyze and evaluate various immuno-diffusion techniques and compare different types and functions of immunoglobulins. 3. Analyze and evaluate the results of immuno techniques, understand the integrated role of complement system and describe molecular basis of antibody diversity 4. Compare, classify the cellular and molecular basis forAutoimmune disorders, analyze differences between various hypersensitive reactions and determine the differences between normal and cancer cells 5. Define, understand and apply the principles, applications and methods used in vaccine development, Compare and differentiate pathways of antigen processing and presentation.	Core	5	30	70

VI	21UBCCC603	Plant Biochemistry	1. Familiarize with the structure and function of Plant cell and its organelles. Learn the relationship between plant cell and electron transport components. 2. Analyze the Nitrogen cycle and Nitrogen fixation. Investigate the role and mode of action of plant regulators. 3. Review the components and reactions of photosynthesis (Light reactions, Dark reactions and CAM pathway) and photorespiration. 4. Perceive the role of secondary metabolites. 5. Demonstrate the physiological events. Illustrate the role of biochemical events with photo periodism and phytochrome.	Elective	5	30	70
VI	21UBCCC604	Applied Biochemistry Practical	1. Develop skills to perform, analyze and evaluate the results obtained from immunoelectrophoresis 2. Compare and evaluate immunodiffusion with immunoelectrophoresis and perform experiments to analyze the differences in the antigen structure. 3. Perform calculations and interpret the results of various immuno and serological test and derive conclusions and clinical correlations. 4. Perform DOT ELISA method, analyze and evaluate the importance of positive and negative control in the experiment. 5. Plan and Perform calculations to estimate plant pigments, metabolites required to compare and evaluate the results obtained from different plant sources	Core	4	40	60

1.2 B.Sc. Mathematics

PO 1	**Domain knowledge:** Demonstrate the knowledge of concepts, principles and applications of Mathematics in various fields.
PO 2	**Problem analysis:** Acquire critical thinking skills to understand and solve contemporary problems with knowledge and skills.
PO 3	**Design/development of solutions:** Make decisions to develop solutions to given situations/questions, formulate strategies to identify, define and solve problems including, as necessary, global perspectives.
PO 4	**Conduct investigations of complex problems:** Gain ability to design, conduct experiments, analyse and interpret data for investigating problems in Mathematics and allied sectors
PO 5	**Modern tool usage:** The ability to acquire, develop, employ and integrate a range of technical, practical and professional skills, in appropriate and ethical ways within a professional context, autonomously and collaboratively and across a range of disciplinary and professional areas.
PO 6	**The Mathematics Professional and society:** An awareness of the role of science within a global culture and willingness to contribute to the shaping of community views on complex issues where the methods and findings of science are relevant.
PO 7	**Environment and sustainability:** Understand complex environmental issues and their interrelationships and requirement of interdisciplinary domains for sustainable development
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and norms.
PO 9	**Individual and team work:** Able to function effectively as individual and as a member in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively using different modes (viz. written, verbal and digital) not only with scientific community but also with the society at large.
PO 11	**Project management and finance:** Understand the principles of management of finance and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning:** Able to recognize the need to undertake life-long learning and acquire the capacity to do so.

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	21UMTCC101	**Core 1:** Differential Calculus (F)	1. Recognize and interpret the deductions of various mean value theorems for differentiable functions. (K1, K2) 2. Describe the methods of finding Curvature, Asymptotes and Singular points. (K1, K2) 3. State and prove Leibnitz rule and implement the rule to compute the nth derivative of given functions. (K1, K4) 4. Verify the existence of limit and calculate the limit, if exists, of single variable function and utilize the concept of limit to verify the continuity of single variable function. (K3) 5. Apply the L Hospital's rule for limits to calculate the limit of function of single variable. (K3) 6. Derive the series expansion of a given function. (K3)	Core	3	30	70
I	21UMTCC102	**Core 2:** Matrix Algebra (F)	1. Define and utilize the concept of matrix. (K1) 2. Recognize the concept of Rank of a matrix and compute the rank of a given matrix. (K1, K2) 3. Recognize and utilize the elementary row operation to obtain echelon forms of given matrix and solve the systems of linear equations using concept of matrix (K1, K3) 4. Perform the process of the diagonalization and compute any power of a given matrix. (K2, K3) 5. Calculate Eigen values and obtain inverse using Cayley Hamilton theorem.(K3)	Core	3	30	70

| I | 21UMTCC103 | **Core Practical 1:** Practical on Differential Calculus and Matrix Algebra (Including mathematical software) | 1. Recognize the domain and range of given functions including polynomials, and hyperbolic functions and plot graph of the same through mathematical software.
 2. Utilize the mathematical software to visualize limits & continuity and L-Hospital Rule to calculate the limit of function of single variable.
 3. Recognize the importance of the Cayley-Hamilton theorem to find the inverse of the given matrix and utilize mathematical software to work-out the problems of Matrices.
 4. Obtain the expansions as well as interpret those expansions graphically with the help of different tools of mathematical software.
 5. Utilize direct methods including Gauss elimination method, Gauss Jordan method and Cramer's rule to solve the system of linear equations and find any power of a matrix by Diagonalization and Cayley Hamilton theorem. | Core | 6 | 40 | 60 |
| II | 21UMTCC201 | **Core 3:** Differential Equations (Ap) | 1. Classify differential equations by order, linearity, and homogeneity. Apply the proper method to find the general solution of a given differential equation.
 2. Use the suitable method to obtain the solution of a given first order and higher degree differential equation.
 3. Identify the suitable method to obtain the solution of a linear differential equation with constant coefficient
 4. Obtain the solution of a linear differential equation with variable coefficient.
 5. Define and derive the partial differential equation and find the order and degree of the given partial differential equation. | Core | 4 | 30 | 70 |

II	21UMTCC202	**Core 4:** Advanced Calculus (Ad)	1. Determine the existence of limits and calculate the limit of the function of several variable at a given point. (if exists) 2. Utilize the concept of limit to verify the continuity of function of several variables. 3. Verify the differentiability of function of several variables. 4. Illustrate the partial derivatives of given function of several variables. 5. Implement and verify the Euler's Theorem to solve the problems related to partial derivative. 6. Utilize the relation between Beta and Gamma function. 7. Apply Duplication formula and Reduction formulae to solve problems of integration.	Core	4	30	70
II	21UMTCC203	**Core Practical 2:** Practical on Differential Equations and Advanced Calculus (Including Mathematical Software.)	1. Explain the nature of solution curve using computer algebra system 2. Interpret the differentiability and visualize the concept of limit and continuity of function of several variables. 3. Utilize the different tools of mathematical software to understand the mathematical concepts with graphical interpretation. 4. Utilize the computer algebra system to solve the differential equations. 5. Calculate general solution of ordinary differential equation	Core	4	40	60
III	21UMTCC301	**Core 6:** Fundamentals of Mathematical Analysis (F)	1. Define, demonstrate and utilize the concept of convergence of sequence 2. Define, demonstrate and utilize the concept of convergence of series 3. Define, demonstrate and utilize the concept of Riemann integration 4. Explain the concept of fundamental and mean value theorem of integral calculus	Core	3/4	30	70

Sem	Course Code	Course Title	Course Outcomes	Type	Credit	Int	Ext
III	21UMTCC302	**Core 6:** Complex Variables (F)	1. Represent the complex numbers in algebraically, and plot geometrically in argand plane. 2. Demonstrate and express the arithmetic operations on complex numbers using either the rectangular form or the trigonometric form. 3. Compute and utilize the magnitude and the argument of a complex number to translate between the rectangular form and the trigonometric form of a complex number. 4. Compute the nth power or root of a complex number using De Moivre's theorem, and apply the results. 5. Verify the differentiability, continuity and limit of function of a complex variable.	Core	3	30	70
III	21UMTCC303	**Core 8:** Discrete Mathematics (Ad)	1. Understand and utilize the fundamental concepts of Discrete Mathematics and understand and verify the different types of relations. 2. Identify and apply basic concepts of set theory, arithmetic, logic, proof techniques, and binary relations. 3. Learn about partially ordered sets, lattices and their types. 4. Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems. 5. Understand and apply the concepts of Boolean Algebra and it forms.	Core	3/4	30	70

| | | | 5. Define and use of improper integration | | | | |

III	21UMTCC304	**Core Practical 3:** Computer Aided Mathematics	1. Explain the nature of solution curve using computer algebra system. 2. Utilize the software to compute derivative and integration. 3. Plot the 2D and 3D graphs of mathematical functions using mathematical software. 4. Analyze the mathematical functions using commands of mathematical software. 5. Utilize the different tools of mathematical software to understand the mathematical concepts	Core	4	40	60
IV	21UMTCC401	**Core 8:** Fundamentals of Linear Algebra (F)	1. Define and interpret the concept of a vector space and its properties. 2. Analyze and evaluate the concept of linear combination and span. Apply further to decide the set of vectors are linearly dependent or independent. 3. Explore the concept of subspace and solve the problems based on sum and direct sum of subspaces. 4. Identify and critically analyze basis and dimension of vector space. 5. Define the concept of Inner product space. Apply the properties of the inner product, the norm and the Cauchy Schwartz. Construct an orthonormal basis for an inner product space by using the Gram Schmidt process.	Core	3	30	70
IV	21UMTCC402	**Core 9:** Integral and Vector Calculus (Ad)	1. Evaluate the double integral in general and polar co-ordinates as well. Reverse the order of integration for a double integration. 2. Evaluate a triple integral to find volume in rectangular co-ordinates, cylindrical coordinates and spherical co-ordinates. 3. Evaluate the function using Laplace transform. 4. Explain the difference between vector point function and scalar point function.	Core	4/3	30	70

			5. Compute the derivatives and calculate the line integrals of vector functions and interpret their applications				
IV	21UMTCC404	**Core Practical 4:** Practical on Numerical Methods and Plotting including Mathematical Software	1. Find value of derivative of polynomial at a point by synthetic division method. 2. Identify the nature of roots of the equations after the transformations. 3. Find the numerical approximations to the roots of an equation by sketching the graph. 4. Apply bisection method, Newton-Raphson's method, False position method, Iteration method and Horner's method to obtain approximate solution. 5. Utilize the user interface of SCILAB including SCINOTES, file browser, variable browser, the command history and general commands including clc & clear Plot graphs of mathematical functions including Cartesian form, parametric form and polar forms of equations	Core	4	40	60
V	21UMTCC501	**Core 10:** Fundaments of Numerical Analysis (Ap).	1. Recall and describe the empirical laws used in curve fitting, including linear regression, polynomial regression, and exponential regression. 2. Interpret and explain the concepts of roots, zeros, and solutions of nonlinear equations and their applications. 3. Apply numerical methods, to find the roots of nonlinear equations. 4. Analyze the properties and solutions of linear algebraic equations and their applications in problems from different fields 5. Evaluate the efficiency and accuracy of numerical methods for solving linear algebraic equations, including direct and iterative methods. 6. Create and implement interpolation algorithms with equal intervals, such as Newton's divided	Core	4	30	70

			differences and Lagrange's formula, to estimate unknown values of a function at a given point.				
V	21UMTCC502	**Core 11:** Problem solving using programming (Ap)	1. Explain how mathematical problems can be solved using computational methods and C programming techniques. 2. Write program to solve given mathematical problem using the same 3. Find errors in the C program and correct it. 4. Apply C programming constructs to develop algorithms for solving mathematical problems in different fields, such as science, engineering, and finance. 5. Evaluate mathematical solutions, compare and contrast different approaches, and determine the most appropriate solution for a given problem. 6. Evaluate the suitability of different programming constructs and algorithms for solving mathematical problems based on their efficiency, accuracy, and applicability. 7. Create a C program that solves a specific mathematical problem by developing an algorithm, implementing the algorithm, and testing it for accuracy and efficiency. 8. Evaluate mathematical solutions, compare and contrast different approaches, and determine the most appropriate solution for a given problem.	Core	4	30	70
V	21UMTCC503	**Core 12:** Group Theory(F)	1. Recall and define the fundamental concepts of group theory, including groups, subgroups, normal subgroups, and isomorphisms. 2. Apply basic group theory techniques and algorithms to solve routine problems and exercises. 3. Classify and analyze different types of groups, such as permutation groups and cyclic groups, based on their structures and properties. 4. Compare and contrast different types of groups,	Core	4	30	70

			such as permutation groups and cyclic groups, to identify their distinct characteristics and properties. 5. Formulate and justify conjectures related to group theory concepts, and develop logical arguments to support or refute them. 6. Analyze the structure and properties of groups to classify them based on specific criteria. 7. Evaluate and apply group theory concepts to solve complex mathematical problems and proofs.				
V	21UMTCC505	**Core 14:** Set theory and Logic (Ap) (Self-Study Course) (Ap)	1. Define and explain the basic concepts of set theory, such as sets, subsets, unions, intersections, and complements. 2. Apply the rules of propositional and predicate logic to construct truth tables and evaluate the validity of logical statements. 3. Analyze and compare different types of sets, such as finite and infinite sets, countable and uncountable sets, and well-ordered sets. 4. Evaluate the logical equivalences and implications between propositions using laws and rules of propositional and predicate logic. 5. Design and construct formal proofs using set theory techniques, such as direct proofs, proof by contradiction, and proof by mathematical induction. 6. Evaluate and analyze the properties of functions and relations, including injectivity, surjectivity, and bijectivity, using set-theoretic concepts.	Core	4	30	70
V	21UMTCC506	**Core Elective 2:** Advanced Mathematical Analysis (Ad)/ Topology (Ad) / **Fuzzy Mathematics**(A	1. Define the concept of a fuzzy set and identify its key components. 2. Recognize and classify fuzzy relations based on their properties. 3. Apply basic operations on fuzzy sets, such as union, intersection, and complement. 4. Evaluate the degree of membership of an element	Core Elective	3/4	30	70

		d)	in a given fuzzy set using appropriate membership functions.				
			5. Analyze and interpret fuzzy relations using composition and aggregation operations.				
			6. Develop fuzzy rule-based systems to model complex real-world problems and make decisions under uncertainty.				
			7. Critically analyze and compare different defuzzification methods for obtaining crisp outputs from fuzzy sets.				
			8. Evaluate the applicability and limitations of fuzzy mathematics in various domains, such as control systems, pattern recognition, and decision analysis.				
V	21UMTCC507	**Core Practical 5:** Practical on Numerical Analysis and Problem solving using computer programming	1. Develop proficiency in implementing numerical algorithms to solve mathematical problems using computer programming.	Core	6	40	60
			2. Analyze and select appropriate numerical methods for solving mathematical problems				
			3. Evaluate the accuracy and efficiency of numerical methods for solving mathematical problems and identify their limitations.				
			4. Apply knowledge of numerical methods to solve practical mathematical problems.				
			5. Apply problem-solving strategies to analyze and solve mathematical problems using computer programming.				
			6. Create algorithms to solve mathematical problems using computer programming.				
			7. Evaluate and choose appropriate numerical methods to solve mathematical problems.				
			8. Analyze and optimize programs to solve mathematical problems efficiently.				
			9. Evaluate the accuracy of numerical methods and analyze the impact of errors on solutions.				

			10. Communicate mathematical ideas and solutions effectively using computer programming.					
VI	21UMTCC601	**Core 15:** Complex Analysis(Ap)	1. Recall and define the concepts of analytic functions, harmonic functions, entire functions, and their properties.	Core	4	30	70	
			2. Apply the Cauchy-Riemann conditions in Cartesian and polar forms to determine the differentiability of complex function.					
			3. Memorize and identify the fundamental theorems of algebra, including Cauchy's integral formula and the maximum modulus theorem.					
			4. Analyze and explain the significance of contour integration and its applications in complex analysis, including the evaluation of definite integrals.					
			5. Compare and contrast different types of mappings, such as Mobius mapping, linear functions, and bilinear mapping, and discuss their properties.					
			6. Evaluate and apply theorems and techniques, such as the residue theorem and expansion of complex functions in Taylor's and Laurent's series, to solve complex analysis problems.					
			7. Create and construct arguments to prove results, such as Cauchy's inequality, Liouville's theorem, and Morera's theorem, related to analytic functions and their properties					
			8. Synthesize and integrate knowledge from complex analysis to solve complex problems, including the evaluation of improper real integrals using the residue theorem.					

| VI | 21UMTCC602 | **Core 16:** Advanced Topic in Numerical Analysis (Ad) | 1. Demonstrate an understanding of interpolation formulae, including Gauss's forward and backward interpolation formulae, Sterling's formula, Bessel's formula, and Laplace-Everett's interpolation formula, and apply these formulae to interpolate data using central difference methods
2. Analyze and solve interpolation problems with unequal intervals using divided differences, properties of divided differences, Newton's divided difference formula, Lagrange's interpolation formula, and Lagrange's inverse interpolation formul
3. Apply numerical differentiation methods, including Gregory-Newton's forward and backward difference formulae, Sterling's formula, and central difference methods, to estimate derivatives of functions at given points.
4. Apply numerical integration techniques, including the trapezoidal rule and Simpson's rule, to estimate integrals of functions over given intervals.
5. Analyze and solve ordinary differential equations using Taylor's series method, Picard's method, Euler's method, Runge's method, and Runge-Kutta methods of various orders.
6. Evaluate the accuracy and efficiency of numerical methods for interpolation, differentiation, integration, and solving ordinary differential equations, and justify the appropriateness of the methods for specific problems. | Core | 4 | 30 | 70 |
| VI | 21UMTCC603 | **Core 17:** Optimization through Mathematical Programming | 1. Recall and explain the fundamental concepts of Operations Research.
2. Evaluate the feasibility and optimality of linear programming problems using graphical method and simplex method. | Core | 4 | 30 | 70 |

		(Ap)	3. Evaluate the optimal solution to transportation problems using various methods like Vogel's approximation method and MODI method.					
			4. Analyze the properties of the assignment problem and formulate it using the Hungarian method.					
			5. Analyze and solve sequencing problems using various methods like Johnson's rule and Branch and Bound method.					
			6. Synthesize and present the solutions to optimization problems using appropriate mathematical and computational tools.					
VI	21UMTCC604	**Core Practical 6:** Practical on Advanced Numerical Analysis and Optimization (Ap)	1. Apply central difference interpolation formulae to interpolate a given set of data and evaluate the accuracy of the interpolation.	Core	6	40	60	
			2. Analyze the effect of unequal intervals on the accuracy of interpolation using Lagrange's interpolation formula.					
			3. Derive and apply numerical differentiation methods such as forward difference, backward difference, and central difference to approximate the derivative of a given function.					
			4. Evaluate the accuracy and stability of numerical integration methods such as trapezoidal rule, Simpson's rule, and Gaussian quadrature.					
			5. Implement numerical methods such as Euler's method, improved Euler's method, and Runge-Kutta method to solve ordinary differential equations.					
			6. Analyze the convergence, consistency, and stability of numerical methods for solving ordinary differential equations					
			7. Recall and explain the fundamental concepts of Operations Research.					
			8. Evaluate the feasibility and optimality of linear programming problems using graphical method					

			9. Evaluate the optimal solution to transportation problems using various methods like Vogel's approximation method and MODI method. 10. Analyze the properties of the assignment problem and formulate it using the Hungarian method.				

1.3 B.Sc. Microbiology

PO 1	**Domain knowledge:** Demonstrate an understanding of fundamental principles of Microbiology, its applications and scope, along with an ability to identify beneficial and harmful role of microorganisms for the benefit of Science and Society
PO 2	**Problem analysis:** Accurately identify and critically analyse pertinent problems in the field of Applied Microbiology and various domains of biological sciences.
PO 3	**Design/development of solutions:** Search for and successfully arrive at viable conclusions/solutions pertaining to various aspects of life sciences using right approach and appropriate tools and techniques
PO 4	**Conduct investigations of complex problems:** Ability to investigate any complex problems related to Microbiology and other life science with the use of appropriate experimental tools/techniques/equipment.
PO 5	**Modern tool usage:** Understand standard operating procedures, safety measures and acquire in-depth technical competence to handle the basic laboratory instruments, and develop the skills to locate and retrieve scientific information with modern data search tools.
PO 6	**The Microbiologist and Society:** Demonstrate the ability to understand the role of scientific developments in a changing world from the disciplinary perspective as well as in relation to its professional and everyday use, with an insight into one's role in society and act in an honest and consistent manner based on a strong sense of self and personal values.
PO 7	**Environment and sustainability:** Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO 8	**Ethics:** Commitment to professional ethics and responsibilities.
PO 9	**Individual and team work:** Exhibit the potential to effectively accomplish tasks as a leader or a member of a team as well as independently in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively in spoken and written forms as well as through digital media with scientific community, society, and fellow mates.

PO 11	Project management and finance: Demonstrate knowledge and scientific understanding to design a research project and manage its execution to generate new scientific insights, innovations in Microbiology research and exhibit organizational skills for able management of time and resources.
PO 12	Life-long learning: Able to recognize the need to undertake life-long learning and acquire the capacity to build on critical thinking skills for periodic updating of scientific knowledge and its application.

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	21UMBCC101	**Core 1:** Fundamentals of Microbiology (F1)	1. Identify the pioneers of the subject and interpret their contributions that laid the groundwork for modern microbiology. 2. Demonstrate and relate the characteristic features of prokaryotic and eukaryotic cells and major groups of microorganisms and diversity of microbial world with the cultivation and preservation methods of microorganisms. 3. To relate and describe the flow of structural and functional differences among all the microbes and their nutritional requirements for the microbial growth. 4. Identify the influence of microbiology and 21st century challenges and opportunities that arise from our changing relationship with and understanding of microbes. 5. Relate the science of microbes and the social issues and concerns relevant to the field of microbiology.	Core	4	30	70
I	21UMBCC102	**Core2:** Microbial Growth and Control (F2)	1. Explain &analyze microbial growth, their types and requirement 2. Comprehend various phases of growth cycle 3. Analyze growth requirement and media selection for isolating specific microbes 4. Learn & Apply techniques of microbial isolation, purification and growth measurement 5. Learn & apply the methods of microbial control	Core	4	30	70

I	21UMBCC103	**Core Practical-1** Basic Microbial Techniques	1. Understand the operation of various basic instruments in a Microbiology Laboratory 2. Comprehend principle and procedure of various types of staining techniques 3. Analyse growth requirement and media selection for isolating specific microbes 4. Learn & Apply techniques of microbial isolation, purification and growth measurement 5. Learn & apply the methods of microbial control	Core	4	40	60
II	21UMBCC201	**Core3**: Microbial Taxonomy and diversity (F)	1. Identify the microorganism and their activities of the subject and interpret their benefits that laid the groundwork for modern microbiology. 2. Demonstrate and relate the characteristic features of prokaryotic and eukaryotic cells and major groups of microorganisms and diversity of microbial world with the identification and classification methods of microorganisms. 3. To relate and describe the flow of structural and functional differences among all the microbes and their nutritional requirements for the microbial growth. 4. Identify the influence of microbiology and 21st century challenges and opportunities that arise from our changing relationship with and understanding of microbes. 5. Relate the science of microbes and the social issues and concerns relevant to the field of microbiology.	Core	4	30	70
II	21UMBCC202	**Core 4:** Basic Biochemistry (F)	1. Understand the basics of structure of cellular matter, various types of reactions, 2. pH scale and the special properties of water 3. Understand and differentiate the structure and properties of fundamental monosaccharides. 4. To relate and describe the flow of structural and functional differences among all the amino acids and proteins, for the microbial growth. 5. Identify the structure and basic function of nucleotides. Understand structure of different classes of lipids and their roles in biological systems	Core	4	30	70

			6. Outline the chemical and physical properties of enzymes, mechanism of enzyme actions, factors affecting enzyme activity and enzyme synthesis.				
II	21UMBCC203	**Core 5:** Cell Structure and Organization (F)	1. Appreciate and understand the dynamic nature of the cell, including how it receives information and responds to its environment. 2. Comprehend various stages of cell cycle 3. Understand cellular transport mechanisms and how cellular organelles work and regulate biochemical synthesis in cell 4. Learn & Apply techniques of microscopic analysis of cell and cellular structures 5. Learn & apply the methods of qualitative and quantitative estimation of protein, carbohydrate and enzymes	Core	4	30	70
II	21UMBCC204	**Core Practical - 2** Microbial Diversity and Biochemistry	1. Understand the methods of isolation of different groups of microorganisms 2. Comprehend principle and procedure of identification of bacteria using various biochemical media 3. Analyse the qualitative and quantitative aspect of biomolecules using analytical techniques. 4. Learn & Apply techniques of microbial characterization using morphological features seen under microscope 5. Learn & apply the methods of microbial identification	Core	2	40	60
III	21UMBCC301	**Core6**: Applied and Environmental Microbiology	1. Understand and apply General principles of food Microbiology and role of microbes in various types of food production, food spoilage, food preservation and food commodities. 2. Understand and apply the principles of milk preservation, and processing in day to day life 3. Comprehend the principle of water purification and appreciate the use of latest technology in the field 4. Identify various stages of waste water treatment and solid waste management and its implication in the health and sanitation **5.** Relate the role of microbes in air and environmental	Core	4	30	70

			processes				
III	21UMBCC302	**Core7**: Agricultural Microbiology	1. Understand the formation process, profiling and microbial diversity of soil 2. Identify the group of Plant Growth Promoting Rhizobacteria 3. To learn and apply different organic farming strategies, biopesticides and biofertilizers for sustainable agriculture 4. Comprehend the diseases and prevention measures for farm animals 5. To Learn and apply isolation techniques to isolates different agriculturally important microbes	Core	4	30	70
III	21UMBCC303	**Core8**: Bioinstrumentation Techniques	1. To understand the principle of various bioanalytical techniques. 2. To comprehend the operational details of the instrumentation used in Microbiology. 3. To experiment with various techniques for varied analysis of varied biomolecules. 4. To analyse the limitations and creative use of techniques for solving of research problem. 5. To assess the applicability of the techniques to solve societal problems like detection of pollution, food adulteration, etc.	Core	4	30	70
III	21UMBCC304	**Core practical – 3:** Applied and Analytical Microbiology	1. Technical skill for enumeration of soil, food and milk microbes 2. Understanding about the role of microbes in agriculture and food 3. Knowledge about the properties of microbes which make them important in nature. 4. To develop skills, through lab experiments, in some of the specific methodologies used in the study of modern food and dairy microbiology 5. Statistical Skills and the basic experimental know how about biostatistics and bioinformatics	Core	4	40	60

IV	21UMBCC401	**Core 9: (Ad)** Bacterial Metabolism	1. Understand the central metabolic reactions in a cell and an organism 2. Understand the mechanism of energy generation and its utilization during cellular activities 3. Comprehend the fundamentals of catabolism of different biomolecules, its mechanism and its importance 4. Identify the metabolic differences among various categories of bacteria. 5. Understand the process and mechanism of transport of molecules across the membrane for metabolic reactions	Core	4	30	70
IV	19UMBCC402	**Core10: (Ap)** Industrial Microbiology	1. Understand the role of microorganisms in various product formation by microbial processes 2. Comprehend the mechanism of action of different groups of industrially important microorganisms in production of variety of products 3. Analyse the effect of different physical and chemical conditions on the microbial process for product formation. 4. Understand the process of product separation and purification using various techniques. 5. Apply the knowledge of strain improvement, parameter optimization and mechanism of microbial action to produce novel products with enhanced values.	Core	4	30	70
IV	21UMBCE401/ 21UMBCE402	**Core Elective:1** Quality Assurance and Quality Control / Mycology and Virology	1. To get a better perception in industrial microbiology standards 2. To understand industrial requirement of microbial technology 3. To get better opportunities in pharmaceutical industry/laboratories/ Research institutes 4. To be equipped with standard operating procedures as per regulatory authorities 5. To make the learner able to apply the norms of the quality regulation in the industry and various laws governing the same.	Core Elective	4	30	70

IV	21UMBCE401/ 21UMBCE402	**Core Elective:1** Quality Assurance and Quality Control / **Mycology and Virology**	1. To get a better perception on General features and characteristics of fungi 2. To understand the general features and properties of different classes of fungi 3. To understand the basic difference in the mode of nutrition, reproduction and propagation in different classes of fungi 4. To comprehend the basics of general features, characteristics, and classification of viruses 5. To learn and apply Cultivation and enumeration techniques for viruses	Core Elective	4	30	70
IV	21UMBCC403	**Core Practical – 4 –** Fermentation Microbiology	1. Fermentative production of selected microbial products in the laboratory 2. Methods for product isolation, purification and estimation 3. Enzyme kinetic study	Core	3	40	60
IV	21UMBCE403/ 21UMBCE404	**Core Elective Practical:** Quality Assurance and Quality control / Mycology and Virology	1. Acquire skills Quality management system 2. Understand the role of quality in human life and its role in betterment of society 3. Identify different domains of industry in quality systems like food, pharma etc.	Core Elective	2	40	60
IV	21UMBCE403/ 21UMBCE404	**Core Elective Practical:** Quality Assurance and Quality control / Mycology and Virology	1. Identify various fungi on the basis of morphological characters 2. Distinguish different parts of fungal thallus 3. Cultivation techniques of fungi from various samples 4. Cultivation techniques for Coliphage	Core Elective	2	40	60
IV	21UMBDE405	**DE** Pharmaceutical Microbiology	1. To get a better perception about the importance of pharmaceutical microbiology standards 2. To have a basic understanding about the role of microbial technology in industries 3. To acquire skills necessary in pharmaceutical industry/laboratories/ Research institutes		3		

			4. To learn and apply the standard operating procedures as per Pharmaceutical regulatory authorities				
IV	21UMBDE406	**DE Practical:** Pharmaceutical Microbiology	1. Acquire skills to examine microbial load of pharmaceutical products 2. Understand the role of microbes in drugs 3. Identify different microbes associated with products, enumerate them and understand their role 4. Evaluate different parameters affecting pharmaceutical product quality.		2		
IV	21UMBTD401	**TDE - 1:** Microbes in Human welfare	1. To get a better perception on General features and characteristics of fungi 2. To understand the general features and properties of different classes of fungi 3. To understand the basic difference in the mode of nutrition, reproduction and propagation in different classes of fungi 4. To comprehend the basics of general features, characteristics, and classification of viruses 5. To learn and apply Cultivation and enumeration techniques for viruses		4		
V	21UMBCC501	**Core11: (Adv.)** Immunology	1. Demonstrate a comprehensive and practical understanding of basic immunological principles involved in protection mechanism. 2. Differentiate between innate and adaptive immunity, primary and secondary responses and identify the role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses. 3. Differentiate between humoral and cell mediated immunity. 4. Discuss Dysfunctional immunity and its consequences, Process of infection and vaccination 5. Application of Principle of various immune reactions in research and diagnosis	Core	4	30	70

V	21UMBCC502	Core12: (Adv/App) Molecular Biology and Genetic Engineering	1. Understanding of the basics of human genetics and hereditary 2. Comprehension of the mechanism of replication and recombination 3. Description of the process of transcription and translation in Prokaryotes 4. Development of knowledge of the biochemical basis of Mutation, Mutagenesis and repair 5. Understanding and analysing the basic concept and scope of recombinant DNA technology, recognize its various tools, it applications, and ethical aspects of using RDT in developing products.	Core	4	30	70
V	21UMBCC503	Core 13: (Self-study) – (F/Ap)– Phycology	1. Understand the general features of algae and their distribution 2. Acquire a consolidated overview on different major groups of algae and algal classification 3. Evaluate the importance and functions of various organelles in the ultra-structure of algal cell 4. Comprehend the major differences among varied range of thallus organization and pigment systems 5. Recognize and appreciate the economic importance of different groups of algae	Core	4	30	70
V	21UMBCE501	Core Elective 2: Fundamentals of Research Methodology	1. Understand the concept of research and importance of studying research methodology 2. Gain knowledge regarding various components of research 3. Distinguish between various scientific documents 4. classes of fungi 5. Understand the concept of thesis writing 6. Gain elementary knowledge regarding application of statistics in research	Core Elective	4	30	70
V	21UMBCE502	Core Elective 2: Microbiology & Health care	1. Understand the historical development of microbiology and the establishment of role of microbes in human health 2. Appreciate the beneficial role of microorganisms in Gut health and the importance of Probiotics 3. Recognize the role of microorganisms in and as food	Core Elective	4	30	70

			as well as in food spoilage 4. Evaluate the role of microorganisms in plant health 5. Understand the types and benefits of vaccines.					
V	21UMBCE503	**Core Elective 2:** Pharmaceutical Microbiology	1. To get a better perception about the importance of pharmaceutical microbiology standards 2. To have a basic understanding about the role of microbial technology in industries 3. To acquire skills necessary in pharmaceutical industry/laboratories/ Research institutes 4. To learn and apply the standard operating procedures as per Pharmaceutical regulatory authorities	Core Elective	4	30	70	
V	21UMBCC505	**Core Practical – 5:** Clinical and Molecular Microbiology	1. Collect blood samples and other clinical samples and perform various serological and 2. hematological diagnostic tests 3. Understand the significance of blood count, various blood components and their analysis 4. Isolate genetic material from different types of cells 5. Quantify the nucleic acid material 6. Perform gene transfer in bacteria using various techniques 7. Perform mutation in bacteria	Core	3			
V	21UMBCE504	**Core Elective Practical – 5:** Fundamentals of Research Methodology	1. Acquire skills related to the Research problem formation and research designing 2. Understand the importance of scientific writing 3. Identify the statistical methods most suitable for data analysis	Core Elective	2			
V	21UMBCE 505	**Core Elective Practical – 5:** Microbiology & Health care	1. Isolate microorganisms from different material and can study them 2. Can predict on the quality of the material	Core Elective	2			

| V | 21UMBCE 506 | **Core Elective Practical – 5:** Pharmaceutical Microbiology | 1. Acquire skills to examine microbial load of pharmaceutical products
2. Understand the role of microbes in drugs
3. Identify different microbes associated with products, enumerate them and understand their role
4. Evaluate different parameters affecting pharmaceutical product quality. | Core Elective | 2 | | |

1.4 B.Sc. Chemistry

PO 1	**Domain knowledge:** Demonstrate an understanding of concepts, principles and applications of chemistry in various fields. Conduct experiments and analyse data, while maintaining responsible and ethical scientific conduct.
PO 2	**Problem analysis:** Employ critical thinking and efficient problem-solving skills in the basic areas of chemistry.
PO 3	**Design/development of solutions:** Using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions pertaining to Chemical Science.
PO 4	**Conduct investigations of complex problems:** Cultivate the skills to Employ modern library search tools to locate and retrieve scientific information about a problem relating to Chemistry.
PO 5	**Modern tool usage:** Ability to handle/Use appropriate chemistry experiments using tools/techniques/ basic laboratory equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO 6	**The Mathematics Professional and society:** Understand own's role in scientific developments for society and act in an honest and consistent manner based on a strong sense of self and personal values
PO 7	**Environment and sustainability:** Understand complex environmental issues and their interrelationships and requirement of interdisciplinary domains for sustainable development
PO 8	**Ethics:** Commitment to professional ethics and responsibilities.
PO 9	**Individual and team work:** Able to function effectively as individual and as a member or leader in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively using different modes (viz. written, verbal and digital) not only with scientific community but also with the society at large.
PO 11	**Project management and finance:** Understand the principles of management of finance and apply these to one's own work, as a

		member and leader in a team, to manage projects and in multidisciplinary environments.					
PO 12		**Life-long learning:** Able to recognize the need to undertake life-long learning and acquire the capacity to do so.					

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	21UCHCC101	**Core 1:** Introductory Inorganic and Analytical Chemistry (F)	1. Remember basic idea of structure of atom and its mechanics. 2. Understand the periodic properties, shape, geometry of various elements and their compound. 3. Apply basic knowledge and predict the properties of the main block element. 4. Correlate and compare various methods for preparations of different concentrated solutions. 5. Understand and apply knowledge of acid base, redox and non-aqueous titration.	Core	4	30	70
I	21UCHCC102	**Core 2:** Introductory Organic and Physical Chemistry (F)	1. Recognize the basic concept of organic chemistry for a chemical reaction. 2. Distinguish between different kinds of isomers and Able to Predict the stereochemistry of organic compound. 3. Remember nomenclature and understand the properties of organic compound. 4. Understand the principles of kinetics and mechanisms of surface reactions. 5. Memorize gaseous laws and exploring the way solid, liquid and gases change under different situation.	Core	4	30	70
I	21UCHCC103	**Core Practical 1:** Combined Practical	1. Identify one cation and anion in a given unknown inorganic salt and record observation and write laboratory reports according to disciplinary standards. 2. Built ability for summarization and determination of basic physical properties. 3. Illustrate scientific skills in understanding, planning and preparing various organic reagents and solutions. 4. Understanding the scientific methods for calibration	Core	4	40	60

			of the glassware's and instruments. 5. Understanding, planning and performing experiments for preparation and standardization of analytical solutions.				
II	21UCHCC201	**Core 3:** Conceptual Inorganic and Analytical Chemistry (F)	1. Recognize basic properties of transition and inner-transition elements. 2. Remember and understand molecular orbital theory of various element. 3. Define and compare the various solid& liquid crystalline compounds. 4. Identify& estimate the errors and statistics, calibration of instruments and organic qualitative analysis. 5. Determine& compare the various titrimetric analyses of water treatment.	Core	4	30	70
II	21UCHCC202	**Core 4:** Conceptual Organic and Physical Chemistry (F)	1. Understand physical & chemical properties and plan the preparation of Alkenes, Alkynes, Dienes, Alcohols, Phenols, Ethers and Epoxide, Alkyl halide and Aryl halide. 2. Use concepts of chemical kinetics for making predictions and explanations of type, rate and order of reactions. 3. Understanding aromatic behavior of organic compounds and their typical chemical properties. 4. Recall the concept of Chemical equilibrium and chemical kinetics. 5. Understand and apply properties, application and various methods for preparation of colloidal solution. 6. Understand and apply properties, application and various methods for preparation of colloidal solution.	Core	4	30	70
II	21UCHCC203	**Core Practical 2:** Combined Practical	1. Apply chemical tests on organic & inorganic small molecules for their qualitative analysis and identification. 2. Select & perform titrimetric analysis of metal ions and organic compounds. 3. Identify adulteration in food stuff and evaluate water quality as per international standards. 4. Comprehend the rate and order of elementary chemical	Core	4	40	60

			reactions.				
			5. Perform scientific experiments and accurately record observation to infer results of the experiments.				
III	21UCHCC301	**Core 5:** Inorganic Chemistry (Ad)	1. Understand the principle, theory and instrumentation of quantum chemistry. 2. Calculate microstate and ground state spectral term of multi electron system. 3. Remember basic idea of magneto chemistry and understand the properties of organometallic compound. 4. Identify, interpret and evaluate the concepts of crystal field theory 5. Classify and apply knowledge of crystal field theory.	Core	4	30	70
III	21UCHCC302	**Core 6:** Analytical Chemistry (Ad)	1. Learn separation by solvent extraction & fuel analysis techniques 2. Able to differentiate volumetric analysis with known electrochemical cells 3. Understand the electro analytical methods 4. Summarize the knowledge about various Opto-analytical. 5. Understand and compare theory with practical the knowledge of polarimeter in polarography	Core	4	30	70
III	21UCHCC303	1. **Core 7:** Petrochemicals and Polymers (Ad)	2. Learn separation by solvent extraction & fuel analysis techniques 3. Understand and explain fundamental concept of Petroleum and describe basic terminologies of crude oil and petroleum refineries. 4. Understand fundamental technology behind the refinery of petroleum and Interpret the various Processing methods of Petroleum products 5. Summarize, Correlate and synthesizes various of aromatic compounds. 6. Recognize fundamental theory and significance of some industrial polymer and different kind of polymers and their properties 7. Illustrate properties of polymer compound through various methods of their analysis	Core	4	30	70

IV	21UCHCC401	**Core 8:** Organic Chemistry (Ad)	1. Recognize the basic concept of carbonyl compounds and active methylene group for a chemical reaction. 2. Prediction and synthesis of carboxylic acid and derivatives with different reagents. 3. Understanding of classification, properties and synthesis of nitrogen containing compounds 4. Identification Classification, properties and prediction of the products of alcohol and phenol with various synthetic path. 5. Differentiate mechanisms of nucleophilic substitution and Elimination and the factors affecting it.	Core	4	30	70
IV	21UCHCC402	**Core 9:** Physical Chemistry (Ad)	1. Recall law of thermodynamics (Zero and First) 2. Understand properties & behavior of chemical potential 3. Distinguish Free energy change and its applications in chemical reactions. 4. Classify the types, of concentration cell and application of EMF. 5. Derive and state photo Chemistry law and its application.	Core	4	30	70
	21BCHCL401	**Core Elective 1:** Green Methods in Chemistry/Soil Analysis (Ad)	1. Retrieve and understand basic principles of Green Chemistry. 2. Understand the principle and instrumentation of microwave reactor and microwave assisted organic synthesis. 3. Application of ionic liquids and green solvents in chemical industries. 4. Correlate use of eco-friendly green catalysts in synthesizing chemicals. 5. Building the chemical future in green synthesis.	Core Elective	4	30	70
	21BCHCL402	**Core Elective Practical 1:**	1. Gain knowledge on rocks and minerals, their composition and the types of soils formed from different parent materials 2. Understand various soil physical, chemical and biological properties and their impact on plant growth 3. Imparts knowledge on essential nutrients, soil fertility, nutrient transformations in soil.	Core Elective	1	20	30

			4. Describe the Organic Forms of Nitrogen, Mineralizable Nitrogen 5. Analyze Soil Health by applications of different Chemical Test				
V	21UCHCC501	**Core 10:** Spectral and Separation Techniques (Ap)	1. Understand the principle, fundamental theory of molecular spectroscopy and Ultraviolet spectroscopy. 2. Understand and identify structural symmetry of various molecules. 3. Calculate Rf values, apply theoretical knowledge to design and develop suitable operating conditions for separation and identification of organic/natural compounds from multi-component mixtures. 4. Understand the principle, fundamental theory and instrumentation of column chromatographic techniques& ion exchange chromatographic techniques. 5. Understand and differentiate the importance and perfection of HPLC and GC techniques and various applications of separation techniques to medicinal and pharmaceutical field.	Core	4	30	70
V	21UCHCC502	**Core 11:** Synthetic Molecules (Ap)	1. Classification, synthesis and application of dyes. 2. Understand the different explosives, perfumes, and sweetening agents with their synthesis and application. 3. Well acquainted with the synthesis of some important class of drugs. 4. Employ the core subject knowledge of antibiotic, antiviral, antimalarial drugs. 5. To understand various industrially important reactions and rearrangements with mechanism and application.	Core	4	30	70
V	21UCHCC503	**Core 12:** **(Self-Study)** Industrial Formulations (Ad)	6. Understand and apply the concepts of soaps and detergents. 7. Interpret chemistry of binders to develop green coatings and its manufacturing. 8. Define and Compare applications, manufacturing and properties of refractories and ceramics. 9. Identify and recognize various types of cement and its properties.	Core	4	30	70

			10. Understand the types, manufacturing, properties and raw materials of glass.				
V	21UCHCL501	**Core Elective 2:** Unit Operation & Processes / Surface Coating Techniques/Industrial Utility	1. Remember basic of equipment design and important parameters of equipment design for Filtration and Centrifuge. 2. Get adequate knowledge about the drying, mass transfer, distillation and extraction process. 3. Apply basic knowledge and predict the reaction mechanism of sulphonation and hydrogenation. 4. Correlate and Compare various methods for oxidation and hydrolysis for different subtract. 5. Understand manufacturing of various organic molecules by alkylation and Esterification.	Core Elective	4	30	70
V	21UCHCL501	**Core Elective 2:** Unit Operation & Processes / Surface Coating Techniques/Industrial Utility	1. Decide the surface preparation methods suitable for different substrate materials. 2. Summarize the basic concept of electroplating & interpret testing & evaluation. Explain importance of electroplating & its applications. 3. Student should able to discover formulations of Electrolyte based on different processes. 4. Student should able to understand the fundamental principles of Paint and Coating Formulation via classification and film formation mechanisms. 5. Basic understanding of designing Solvent, Brightener and Emulsifiers for formulation of various electrolytes	Core Elective	4	30	70

1.5 M.Sc. Chemistry

PO₁	Depth and breadth of knowledge: To prepare efficient chemistry graduates with strong fundamental knowledge to cater the needs of industries/laboratories/Academics related to chemistry.
PO₂	Practice, Operation and usage of modern tools and technology: To inculcate technical skills in the chemistry graduates towards the use of modern & sophisticated instruments, equipments & cheminformatic tools to analyze and obtain molecular information of the material.
PO₃	Research, numeracy and scholarship: To develop ability among graduates to work for the effective & practical solutions for issues related to chemical science while complying with economical, environmental, ethical, and safety aspects.
PO₄	Professional capacity and passion of learning: To provide graduates who can skillfully utilize the chemical literature to assess & identify problems significant to industries & society.
PO₅	Global, moral And Aesthetic Sustainability: To enrich Gradates With contemporary training in professional responsibilities including ethics the global and societal impact.

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	19PCECC101	**Core 1:** Organic Chemistry	1. Understand concept and types of reaction Mechanism, draw arrow notation, categorize bond cleavages, and generation of reactive intermediates. 2. Understand the concept of various electronic effect and its applications. 3. Predict the stability of reactive intermediates by applying electronic effect. 4. Calculate aromaticity and differentiate between aromatic, anti-aromatic and non-aromatic compounds 5. Illustrate preparation of organic reagents and recognize appropriate reagent for particular reaction.	Core	4	40	60
I	19PCECC102	**Core 2:** Analytical Chemistry	1. Differentiate basic analytical techniques and apply for various chemical analysis. 2. Calculate modes of concentration for chemical analysis. 3. Apply concept of non-aqueous titration for chemical analysis. 4. Understand the different terms and criteria of Intellectual Property right	Core	43	40	60

I	**19PCECC103**	**Core 3:** Inorganic Chemistry	1. Predict bond order & shapes of covalent compounds using MO VB theories. 2. Classify coordination compounds & predict isomerism, coordination number, shapes and spectral term symbol for coordination compounds. 3. Understand and apply CFT for splitting of d-orbitals in octahedral, tetrahedral and square planner complexes. 4. Determine symmetry elements and their point groups of molecules by point group theory 5. Recognize bonding, synthesis and application of organometallic complexes.	Core	34	40	60
I	**19PCECC104**	**Core 4:** Physical Chemistry	1. Recall types & order of chemical reaction 2. Understand properties & behavior of ideal, non-ideal and dilute solutions 3. Distinguish Free energy change and its applications in chemical reactions 4. Classify the types, characteristics and mechanism of homogeneous & heterogeneous catalysis. 5. Derive synthesis of polymers and its identification by different techniques.	Core	3	40	60
I	**19PCECC105**	**Practical Core 1 & 2:** Organic & Analytical Chemistry	1. Perform Qualitative Analysis of a ternary organic mixture 2. Prepare and standardize the solutions. 3. Demonstrate Calibration of glassware and apparatus. 4. Measure the Assay and % Purity of fine chemicals. 5. Employ appropriate extraction methods for the chemical separation	Core	3	40	60
I	**19PCECC106**	**Practical Core 3 & 4:** Inorganic & Physical Chemistry	1. Perform Qualitative Analysis of an inorganic mixture containing six radicals. 2. Utilize Conductivity meter, pH & Potentiometer, Refractometer, and Ultrasonic instrument for physicochemical analysis. 3. Demonstrate experiments on Partition Co-efficient, First and second order reactions-order determination, energy of activation, Heat of vaporization, Partial molar volume.	Core	3	40	60

5. Employ appropriate extraction methods for the chemical separation.

II	19PCECC201	Core 5: Separation Techniques	1. Understand the principle, fundamental theory and instrumentation of various planar and column chromatographic techniques. 2. Identify the significance, quality, and limitations of the results produced by the various separation techniques. 3. Apply theoretical knowledge to design and develop suitable operating conditions for separation and identification of organic/natural compounds from multi-component mixtures 4. Calculate Rf values and Interpret HPLC and GC chromatograms to perform qualitative analysis of unknown 5. Differentiate various applications of separation techniques to medicinal and pharmaceutical field.	Core	4	40	60
II	19PCECC202	Core 6: Organic Reactions & Rearrangements	1. Understand concept and types of reaction mechanism draw arrow notation, categorize bond cleavages. 2. Extend concept of molecular rearrangement and describe plausible reaction mechanism mentioning its applications in organic synthesis. 3. Describe Principle, plausible reaction mechanism and applications of various organic reactions. 4. Identify suitable starting material, reagent and reaction condition or product for given organic transformations. 5. Apply concept of various reaction and rearrangements to predict plausible product(s).	Core	3	40	60
II	19PCECC203	Core 7: Stereochemistry	1. Understand the fundamentals of stereochemistry and able to draw stereoisomers of organic compounds, and recognize diastereomers, enantiomers, meso compounds and centers of symmetry. 2. Able to discuss the relative stability of conformational isomers of cyclohexanes and related compounds. 3. Recognize and discuss the stereoisomers of chiral compounds that do not contain a stereogenic carbon center and assign the configuration of the stereoisomer. 4. Understand and identify the Substitution Nucleophilic (SN1, SN2, SNi & Mixed SN1 & SN2) and Elimination reaction (E1, E2 and E1cB) mechanism and stereochemistry and Addition Reactions to Carbon-Hetero multiple bonds. 5. Apply the stereochemistry concept to identify configuration,	Core	3	40	60

			conformation, stereochemical notations, Nucleophilic substitution, elimination, reduction and addition reactions to Carbon-Hetero multiple bond.			
II	19PCECC204	**Core 8:** Modern Analytical Techniques	1. Understand Principle and theory of various spectroscopy. i.e. UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry. 2. Discuss Instrumentation of UV-Vis, FT-IR, NMR Spectroscopy and Mass Spectrometry. Demonstrate competence in collecting and interpreting data in the laboratory. 3. Solve problems related to the saturation, functional group, molecular weight and structure of molecules 4. Analyze and interpret spectroscopic data for structure elucidation.	Core	3	40	60
II	19PCECC205	**Practical Core 5 & 6:** Separation Techniques & Organic Synthesis	1. Design and develop solvent system for separation and identification of organic/natural compounds from multi-component mixtures. 2. Construct manual thin layer chromatography and Column chromatography and Demonstration of HPLC and GC-Mass spectrometer. 3. Demonstrate laboratory setup for various reactions conditions. 4. Apply understanding of reaction mechanism and reagents to perform organic preparation. 5. Analyze product formation by using physical measurement, separation and purification techniques.	Core	2	40	60
II	19PCECC206	**Practical Core 7 & 8:** Stereochemistry & Modern Analytical Techniques	1. Apply the stereochemistry concept to identify optical activity of pure stereoisomers and racemic mixture 2. Calculate enantiomeric excess of racemic mixture. 3. Apply UV Viz. phenomena to find out wavelength, concentration and chemical shifts of organic molecules. 4. Interpret IR spectrum for identification of various functional group in organic molecules. 5. Operate polarimeter, UV Visible and IR spectrophotometer.	Core	2	40	60

III	19PCEOCC301	**Core 9:** Interpretative Molecular Spectroscopy (Self-study)	1. Calculate wavelength of organic molecules by UV-Vis Spectroscopy 2. Differentiate functional groups based on their frequencies by using IR spectroscopy 3. Analyse molecular structure and its molecular weight by their fragmentation pattern in mass spectroscopy 4. Deduce the chemical structure from ¬¬1H NMR, 13C NMR and 2D-NMR spectral data. 5. Analyse data obtained from sophisticated instruments (like UV-Vis, FTIR, NMR, and Mass) for the structure determination and chemical analysis.	Core	3	50	50
III	19PCEOCC302	**Core 10:** Heterocyclic Chemistry	1. Generate IUPAC nomenclature for heterocyclic systems and vice versa. 2. Predict and describe chemical reactivity of various heterocyclic compounds. 3. Illustrate & Plan synthetic methodology for various heterocycles. 4. Identify suitable starting material, reagent and reaction condition or product for given reaction of heterocyclic compounds. 5. Apply concept of various reaction and rearrangements to predict plausible product(s), and characterize using spectroscopic techniques.	Core	4	40	60
III	19PCEOCC303	**Core 11:** Organic Synthesis: A Disconnection Approach	1. Understand concept of disconnection, synthon and synthetic equivalents and its application in disconnection analysis. 2. Understand concept of functional group interconversion strategy and its application for the aromatic compounds. 3. Recognize disconnection pattern for dicarbonyl compounds including 1-2, 1-3, 1-4, 1-5 and 1-6 dicarbonyl framework and plan synthesis thereof. 4. Apply the stepwise disconnection approach for a range of compounds having different patterns of functionalization to support selected strategic and tactical principles in retrosynthetic analysis of targeted molecules. 5. Analyze published synthetic routes in terms of retrosynthetic strategy, recognize the importance of reagent selection for common transformations and suggest reagents for such transformations in the context of such synthetic	Core	4	40	60

			routes.				
III	19PCEODC301	DSE –Core-1 Medicinal Chemistry	1. To understand the chemistry of drugs with respect to their pharmacological activity. 2. Demonstrate an understanding of the steps involved in the drug discovery and design process 3. Understand the background of combinatorial chemistry and role of combinatorial chemistry in drug discovery. 4. Critically analyse biological pathways for their potential as drug targets for a given disease. 5. Describe the role of pharmacodynamic and pharmacokinetic factors as determinants of drug response.	Elective	4	40	60
III	19PCEODC302	DSE –Core-1 Pharmaceutical Technology	1. Discuss the fundamental principles for dosage form design, drug release and drug delivery. 2. Classify different dosage forms and apply principles of pharmaceutical science in formulation and dispensing the various dosage forms 3. Apply the engineering principles for formulation of solutions, suspensions and emulsions, granules and tablets 4. Formulate the dosage forms for a given API based on its properties 5. Develop a formulation process for a given API	Elective	4	40	60
III	19PCEOCC304	**Practical Core 10 & 11:** Heterocyclic Chemistry & Organic Synthesis	1. Demonstrate laboratory setup for various reactions conditions. 2. Apply understanding of reaction mechanism and reagents to perform heterocyclic preparation. 3. Analyze product formation by using physical measurement, separation and purification techniques. 4. Design and develop solvent system for separation and identification of organic/natural compounds from single/multi-step reactions. 5. Construct manual Thin layer chromatography and Column chromatography whenever applicable.	Core	4	60	40
III	19PCEODC303	**Practical DSE –Core 1** Medicinal Chemistry	1. Demonstrate laboratory setup for various reactions conditions. 2. Apply understanding of reaction mechanism and reagents to perform drug synthesis/ Important intermediates/ privilege scaffolds.	Prac. Elective	2	20	80

			3. Analyze product formation by using physical measurement, separation and purification techniques. 4. Design and develop solvent system for separation and identification of drug/intermediate compounds from single/multi-step reactions. 5. Construct manual Thin layer chromatography and Column chromatography whenever applicable.				
III	19PCEODC304	**Practical DSE –Core-1** Pharmaceutical Technology	1. Demonstrate laboratory setup for various reactions conditions. 2. Apply the principles of equipments and instruments with their working and uses in formulation of dosage forms. 3. Formulate and evaluate of solid dosage form such as tablets, tablet coating and capsules. 4. Formulate and evaluate of syrup, emulsion and dry suspension. 5. Formulate and evaluate of injections and eye drops.	Prac. Elective	2	20	80
IV	19PCEOCC401	**Core 12:** Project/Internship/Skill Training/Advance Practical	1. Apply critical and analytical skills in a scientific and professional manner. 2. Critically apprising and interpretative published literature 3. Synthesize knowledge and skills previously gained and applied to an in-depth study. 4. Select from different research methodologies, methods and forms of analysis to produce a suitable research method. 5. Present the finding of their project in a written report.	Core	12	80	20
IV	19PCEOCC402	**Core 13:** Chemistry of Natural Products	1. Understand the concept of identification and isolation of primary and secondary metabolites. 2. Prepare systematic extraction method for the active ingredient. 3. Explain structural significance of the active molecules from the natural resources. 4. To identify active molecules from medicinal plants. 5. Illustrate total synthesis of the selected natural products.	Core	5	50	50
IV	19PCEOCC403	**Core 14:** Chemistry of Synthetic Drugs	1. Classify type of disease and drugs 2. Employ the core subject knowledge of anticancer and anti-infectious, Cardiovascular and the drugs affecting on metabolic disease. 3. Well acquainted with the synthesis of some important class	Core	5	50	50

				Core	3	50	50
			of drugs. 4. Knowledge about the mechanism pathways of disease and curing by medicinal compounds. 5. Critically evaluate modern methods of functional group transformations and the application of protecting groups in Drug synthesis.				
III	19PCEACC301	**Core 9:** Interpretative Molecular Spectroscopy (Self-study)	1. Calculate wavelength of organic molecules by UV-Vis Spectroscopy 2. Differentiate functional groups based on their frequencies by using IR spectroscopy 3. Analyse molecular structure and its molecular weight by their fragmentation pattern in mass spectroscopy 4. Deduce the chemical structure from ¬¬1H NMR, 13C NMR and 2D spectral data. 5. Analyse data obtained from sophisticated instruments (like UV-Vis, FTIR, NMR, and Mass) for the structure determination and chemical analysis.	Core	3	50	50
III	19PCEACC302	**Core 10:** Analytical Method Development & Validation	1. Understand the latest internationally recognized standards and developments in analytical assurance and their acceptance criteria 2. Gain an understanding of method validation requirements as per ICH guideline and Pharmacopoeia. 3. Identify and classify suitable analytical methods on the basis of various characteristic i.e., accuracy, precision, specificity, etc. 4. Evaluate statistical data Elements for Assay Validation 5. Prepare method validation protocol	Core	4	40	60
III	19PCEACC303	**Core 11:** Industrial Formulation Development	1. Define the components and their functions of product design and development processes 2. Identify and analyze the product design and development processes in manufacturing industry. 3. Gained an understanding of modern formulation technology 4. Design an experimental protocol to investigate selected factors' effects 5. Develop and improve commercial products	Core	4	40	60

III	19PCEADC301	DSE –Core-1: Chemistry of Food Analysis	1. Identify & classify carbohydrates, enzymes, lipids, proteins and vitamins. 2. Appreciate methods of analysis of food carbohydrates and activation & inactivation of enzymes. 3. Choose physical and chemical tests for analysis of oils and fats. 4. Categorize & classify proteins and vitamins with their source & structure. 5. Employ detection methods for food additives and adulterants.	Elective	4	40	60
III	19PCEADC302	DSE – Core 1: Instrumental Methods of Analysis	1. Understand the theory and practice of instrumental methods for the emission and absorption spectroscopy, ICP-OES, Thermal techniques etc. 2. Distinguish between qualitative and quantitative measurements and be able to effectively compare and critically select methods for elemental and molecular analyses 3. Demonstrate sampling and sample treatment prior to analysis 4. Assess concepts of availability and evaluation of analytical standards and formulate standard methodology for analysis. 5. Apply the basic phenomena of instrumental techniques to operate instruments and evaluate the experimental data.	Elective	4	40	60
III	19PCEACC304	Core 10 & 11 Practical: Analytical Method Development &Validation & Industrial Formulations	1. Understand the latest internationally recognized standards and developments in analytical assurance and their acceptance criteria. 2. Identify and classify suitable analytical methods on the basis of various characteristic i.e.accuracy, precision, specificity, etc. 3. Evaluate statistical data Elements for Validation 4. Define the components and their functions of product design and development processes 5. Develop and improve commercial products	Core	4	60	40

III	19PCEADC303	**DSE – Core 1 Practical:** Practical Chemistry of Food Analysis	1. Choose physical and chemical tests for analysis of oils and fats. 2. Quantify different parameter of Food and Adulterant. 3. Employ different detection methods for food additives and adulterants.	core	2	20	80
III	19PCEADC304	**DSE – Core 1** Practical Instrumental Methods of Analysis	1. Understand the practice of instrumental methods for absorption spectroscopy. 2. Distinguish between qualitative and quantitative measurements and be able to effectively compare and critically select methods for elemental and molecular analyses 3. Demonstrate sampling and sample treatment prior to analysis 4. Apply the basic phenomena of instrumental techniques to operate instruments and evaluate the experimental data.	Pra. Elective	2	20	80
IV	19PCEACC401	**Core 12:** Project/Internship/Skill Training/Advance Practical	1. Apply critical and analytical skills in a scientific and professional manner. 2. Critically apprising and interpretative published literature 3. Synthesise knowledge and skills previously gained and applied to an in-depth study. 4. Select from different research methodologies, methods and forms of analysis to produce a suitable research method. 5. Present the finding of their project in a written report.	Core	12 12	80	20
IV	19PCEACC402	**Core 13:** Chemistry of Natural Products	1. Understand the concept of identification and isolation of primary and secondary metabolites. 2. Prepare systematic extraction method for the active ingredient. 3. Explain structural significance of the active molecules from the natural resources. 4. To identify active molecules from medicinal plants. 5. Illustrate synthesis of the selected natural products.	Core	5	50	50
IV	19PCEACC403	**Core 14:** Regulatory Affairs	1. Understanding of important regulatory concepts 2. To provide global knowledge of Regulatory Affairs and create Regulatory Strategy 3. Write Regulatory Documents 4. Take independent responsibility for own professional development	Core	5	50	50

		5. Evaluate scientific data and conclusions intended for regulatory review				

1.6 M.Sc. Microbiology

PO$_1$	In depth understanding of basic and applied aspects of microbiology
PO$_2$	Develop inclination towards own professional goals over a wide range of career options expanding from R&D, Industrial or Govt. sector or as an Entrepreneur
PO$_3$	Ability to retrieve biological information through data mining and data handling.
PO$_4$	Familiarized with latest and advanced tools and techniques of biological sciences.
PO$_5$	Capacity to develop, employ and integrate technical and professional skills as a member of team withholding the essence of collaboration, cooperation and integrity.
PO$_6$	Analysis of scientific issues across the spectrum of related disciplines
PO$_7$	Make oneself aware of core and allied research areas along with flexibility in finding void areas of research objectives and accordingly come with novel solution.
PO$_8$	Acquire skills specific to microbiology and allied fields for converting information to knowledge through hypothesis, design, execution and analysis
PO$_9$	Capability to contribute acquired knowledge leading to find a suitable solution for an existing problem
PO$_{10}$	Uphold the responsibility as a global citizen maintaining professional and ethical values
PO$_{11}$	Understand microbiology as a social endeavor in context to bringing about harmony with nature

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	19PMBCC101	**Core 1** Biomolecules	1. Comprehend and analyze concept of biomolecules and biochemical processes. 2. Relate chemical interactions between molecules in biological systems. 3. Evaluate structure and role of various biological molecules. 4. Interpret various phenomenon associated with biomolecules. 5. Predict and determine the physiological problems related to biomolecules.	Core	4	40	60
I	19PMBCC102	**Core 2:** Microbial Cell Biology and Physiology	1. Demonstrate the structures and functions of cell and sub-cellular organelles 2. Inspect energy generating mechanisms in bacteria 3. Elucidating the transport system of bacteria 4. Illustrate the adaptation process of microorganisms during different environmental conditions 5. Summarize the aspects of microbial interactions	Core	4	40	60
I	19PMBCC103	**Core 3:** Microbial Diversity and Evolution	1. Elucidating the concepts of evolution 2. Elucidating the diversity of different groups of microbes 3. Interpreting different microbial classification systems 4. Analyze and compare diverse adaptive parameters of extremophiles 5. Employ the tools for studying the diversity of bacteria	core	4	40	60
I	19PMBCC104	**Core Combined Practical-1:** Microbial and Biochemical Techniques	1. Define the principle, remember the protocol and demonstrate the result of a set of experiments 2. Apply the basic concepts of microbiology in designing experiment and analyzing the obtained data. 3. Perform experiment and analyze the data to evaluate certain parameters and explain its significance. 4. Construct an experiment based on requirements and analyze the result obtained in testing hypothesis or prediction for a well-defined purpose	Core Practical	6	100	100

II	19PMBCC201	**Core 5:** Microbial Genetics	1. Recall and understand Mendalian and non Mendalian concepts, mechanism of linkage and population genetics 2. Explain and apply various gene transfer methods and mutation techniques 3. Explain and analyze mechanism behind DNA replication and repair systems 4. Explain and compare mechanisms associated with various transcriptional and post transcriptional system with a brief understanding of various types of RNA 5. Discuss and analyze mechanisms behind translation and gene regulation systems	Core	4	50	50
II	19PMBCC202	**Core 6:** Analytical Techniques	1. Recall basic principles of instrumentation 2. Classify and demonstrate various analytical techniques for biological applications 3. Select and utilize appropriate instrumentation method for sample identification, analysis and problem solving 4. Explain and interpret data according to application 5. Compare and choose between various analytical methods for sample analysis	Core	4	50	50
II	19PMBCC203	**Core 7:** Immunology and Medical Microbiology	1. Define and describe the cells and organs of immune 2. system and distinguish between innate and adaptive immune response 3. Understand the structure and function of antigens and antibodies, basis of their interaction and carry out diagnostic tests based on these interactions 4. Comprehend the molecular basis of transplantation immunology and predict its success in different scenarios 5. List out medically important microbes, understand mechanism of their pathogenesis Choose prevention and control strategies for pathogens	Core	4	40	60
II	19PMBCC205	**Core 8:** Microbial Metabolism	1. Relate different metabolic processes 2. Understand regulation of metabolic processes 3. Analyze and Interpret the basics of metabolism 4. Experiment with various physicochemical parameters to determine their role in biochemical reactions 5. Classify the enzymes	Core	4	40	60

II	**19PMBCC205**	**Core 9:** Molecular Techniques	1. Isolate and purify DNA, RNA, protein 2. Select different analytical tools to demonstrate various techniques 3. Perform experiment, analyze the data and explain its significance. 4. Understandthe different metabolic and immunological interactions	Core Practical	4	100	100
III	**19PMBCC301**	**Core 10:** Bioinformatics	1. Browse, search, and retrieve biological data from public repositories 2. Upload new sequences onto GenBank, perform text and sequence-based searches, and analyze the results 3. Edit raw Sanger sequence data for phylogenetic analysis (edit chromatograms, identify Contamination, align sequences, remove ambiguously aligned sites) 4. Reconstruct phylogenetic analysis using various tools, interpret the result and produce publication ready trees 5. Use programs for visualizing and analyzing protein structures.	Core	4+1	90	10
III	**19PMBCC302**	**Core 11:** Industrial Microbiology	1. Apply the basics of fermentations; analyze the process of control systems; scale up operations; different upstream and downstream processes 2. Relate the constructional features of different types of fermentors; modes of sterilization; batch, continuous and fed batch fermentations 3. Apply the knowledge to choose important process parameters at its basic and statistical level with real time operation in any fermentation process 4. Analyze and compare the different types of fermentors; sterilization operations; fermentation modes; upstream and downstream processes on bioproducts 5. Apply the practical skill & hypothesize the outcome for microbial fermentation	Core	4+1	90	10
III	**19PMBCC303**	**Core 12:** Gene Manipulation Techniques	1. Describe and enlist the tools associated with gene cloning techniques; & application of genetic engineering in human welfare 2. Illustrate the stages of cloning techniques 3. Differentiate gene insertion techniques by using DNA	Core	4+1	90	10

			marker techniques 4. Design gene cloning techniques 5. Interpret the results , apply the experiments and develop skills for handling tools in genetic engineering				
III	19PMBCC304	Core 13: Microbial Ecology (self-study)	1. Differentiate various microbial interactions 2. Express relationship of microorganisms with biotic and abiotic factors 3. Subdivide microorganisms as per ecological, morphological and reproductive characteristics 4. Choose the microbes in controlling of different environmental pollutions 5. List the name of microbes present in various biogeochemical interactions	Core	3		
III	19PMBDC301	**Discipline Specific Elective-** Environmental Microbiology & Biotechnology	1. Infer the global issues of environment and their impact on society 2. Comply waste management system and apply the same in field 3. Summarize the process of biodegradation and remediation 4. Interpret existing and emerging technologies that are important in the area of environmental biotechnology 5. Design and explain practical approaches of environmental biotechnology	Elective	4+1	50	50
III	19PMBDC302	**Discipline Specific Elective** Food and Dairy Microbiology	1. Explain the interactions between microorganisms and the food and milk environment, and factors influencing their growth and survival 2. Interpret the significance and beneficial activities of microorganisms in food and milk 3. Distinguish the characteristic identifiable features of food borne diseases and spoilage microorganisms 4. Choose an appropriate method for food and milk preservation 5. Evaluate, explain & compare the different technical skills used for food and dairy related microbe cultivation, identification, and assaying of products	Elective	4+1	50	50

IV	19PMBCC401	**Core 13:** Agricultural Microbiology	1. Show soil and its characteristics 2. Choose microorganisms in soil as per their role in agriculture 3. Produce biofertilizer and biopesticides 4. Differentiate Plant Microbe interaction 5. Summarize harmful interaction between plant and microbes	Core	4+1	90	10
IV	19PMBDC401	**Discipline Specific Elective-** Pharmaceutical Microbiology	1. Explain and differentiate role of different authorities in pharma industries 2. Play a role in different sectors of pharma industries 3. Choose differentiate drug delivery systems 4. Use different parameters for quality analysis 5. Apply and analyze standard operating procedures for different pharmaceutical products	Elective	4+1	50	50
IV	19PMBDC402	**Discipline Specific Elective-:** Advanced Molecular Techniques	1. Investigate DNA and Protein characteristics 2. Compare and select various techniques used in isolation and purification 3. Plan sequential steps in genome analysis 4. Evaluate various protein engineering steps 5. Produce gene copies using PCR and analyze biomolecule by blotting studies	Elective	4+1	50	50

1.7 M.Sc. Industrial Chemistry

PO$_1$	Depth and breadth of knowledge: To develop strong fundamental knowledge of chemical engineering and chemistry as per current needs.
PO$_2$	Practice, Operation and usage of modern tools and technology: To enhance usage, practice and operation of modern tools and technology.
PO$_3$	Research, numeracy and scholarship: To categorize literature review and apply knowledge to plan new research methodologies in the field of chemistry and chemical engineering.
PO$_4$	Professional capacity and passion of learning: To augment professional capacity and love of learning skills.
PO$_5$	Global, moral and aesthetic sustainability: To imbibe moral and aesthetic values for global sustainability.

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	19PICCC101	Core 1: Industrial Stoichiometry & Momentum Transfer Operations	1. Understand the elementary concepts material and energy balance with and without chemical reactions. 2. Understand and use process calculations for batch and continuous processes. 3. Know the Design of fluid systems, flow meters, pressure vessels and vacuum producing devices. 4. Understand the basic phenomena for calculations of Rayleigh's and Buckingham π methods for momentum transfer operations. 5. Understand the advanced consideration for designing fluidized bed columns and apply concepts of mass, momentum and energy conservation to flows.	Core	4		
I	19PICCC102	Core 2: Industrial Unit Operations	1. Learn fundamentals of mass transfer operations. 2. Apply principles of mass transfer to equipments used in gas absorption, distillation column, extraction, drying, and filtration operation. 3. Understand fundamentals of heat transfer operations. 4. Apply empirical equations to solve heat transfer problems in conduction, convection and radiation	Core	4		

			modes. 5. Design and analyze the performance of heat exchangers.				
I	19PICCC103	**Core 3:** Organic & Retro Synthesis	1. Understand the formation and reactivity and stability of nucleophiles, electrophiles, carbene, nitrene, ylides and alkynes. 2. Design syntheses of organic molecules and prediction of mechanism for organic reactions. 3. Learn Principles, mechanism and applications of various name reactions. 4. Learn principles and mechanism of rearrangements and their applications 5. Design the disconnection and synthesis of various organic aromatic molecules.	Core	4		
I	19PICCC104	**Core Practical 1:** HTO, MTO	1. Plan experiments and present the experimental data meaningfully. 2. Apply theoretical concepts for data analysis and interpretation. 3. Visualize and understand chemical engineering unit operations related to heat transfer operation, and mass transfer operation. 4. To critically evaluate data collected. 5. Employ safe laboratory practices handling laboratory glassware, equipment, and chemical reagents to perform common laboratory techniques.	Core Practical	3		
I	19PICCC105	**Core Practical 2:** OS, FM	1. Plan experiments and present the experimental data meaningfully. 2. Apply theoretical concepts for data analysis and interpretation. 3. Visualize and understand chemical engineering unit operations related to fluid and particle mechanics, and mass transfer operations such as extraction. 4. To critically evaluate data collected to determine the identity, purity, and yield of products. 5. Employ safe laboratory practices handling laboratory glassware, equipment, and chemical reagents to perform common laboratory techniques, including	Core Practical	3		

			recrystallization, vacuum filtration, aqueous extraction, thin layer chromatography, column chromatography.				
II	19PICCC201	**Core 4:** Heterocyclic Chemistry	1. Understand basic concept of heterocyclic chemistry and nomenclature of heterocyclic compounds using systematic IUPAC nomenclature including Five-member, Six member, Benzofused five membered and six membered heterocycles. 2. Describing the classification of heterocyclic compounds according to their different types. 3. Practice to draw the heterocyclic compound's structure from name and identify the name from structure using IUPAC system. 4. Showing the multiple methods of preparation of heterocyclic compounds. 5. Identify and recognize the chemical properties and reactivity of heterocyclic compounds using heterocyclic concept. Analyse the disconnection of heteroaromatic compounds.	Core	4	40	60
II	19PICCC202	**Core 5:** Mechanical Operations	1. To build basic knowledge of various mechanical operations. 2. To review the practical importance and relevance of unit operations used for crushing, grinding and size separation in chemical industry. 3. To separate the particles based on its size in equipments. 4. To study a detailed overview of equipment used to perform various mechanical operations and problems associated during the implementation and applications. 5. To build a bridge between theoretical and practical concept used in industry	Core	3		
II	19PICCC203	**Core 6:** Technologies in Chemical Industries	1. Apply resources and need for membrane technology in water treatment in other process industrial plants. 2. Understand the principles of nanotechnology; characterization of nano structured materials; and tools and equipment for producing and assembling at	Core	3	50	50

			the nano scale. 3. To cultivate interest in the research and development of nanotechnology for future advancement of the career. 4. Understand the formulation technology used in Agrochemical industries 5. To promote interests of the fermentators, types of reactors in fermentation industries.				
II	19PICCC204	**Core-7:** Unit Processes & Reagents	1. Remember the advanced concepts of unit processes like Halogenation, Alkylation & Acylation 2. Understand the advanced concepts of unit processes like Oxidation, Hydrogenation & Reduction 3. Apply the advanced concepts of unit processes like Nitration, Sulphonation & Esterification 4. Apply the advanced concepts of organic reagents-I 5. Apply the advanced concepts of organic reagents-II	Core	3	50	50
II	19PICCC205	**Core-Practical-3** MO & TCI	1. Remember the advanced concepts of Mechanical crushers. Understand the advanced concepts of Mechanical shakers. 2. Apply the advanced concepts of Mechanical separator. 3. Apply the advanced concepts of preparation of Metallic oxides NPs. 4. Apply the advanced concepts of characterization of NPs.	Core-Practical	3	40	60
II	19PICCC206	**Core Practical-4** MS, PC	1. Remember the advanced concepts of Name reactions & rearrangements. 2. Understand the advanced concepts of multistage synthesis. 3. Apply the advanced concepts of physico-chemical excersice. 4. Apply the advanced concepts of Potentiometry, conductometry and refractometry. 5. Apply the advanced concepts of polarimeter.	Core-Practical	3	40	60

III	19PICCC301	Core 8: Polymer Chemistry & Technology	1. Understand step-growth and chain polymerization, with respect to mechanism and kinetics. 2. Understand polymer manufacturing processes 3. Produce synthetic polymers 4. Understand extrusion process of polymer 5. Create biodegradable and non-biodegradable polymers	Core	3	50	50
III	19PICCC302	Core 9: Chemical Reaction Engineering	1. Apply concepts in reaction kinetics and classify reactions according to different properties. 2. Calculate the reaction rate constant and reaction activation energy using given temperature-based data. 3. Designing experiments involving chemical reactors, and analyzing and interpreting data. 4. Determine conversion and yield for chemical reactions. 5. Apply kinetic concepts in heterogeneous reactions.	Core	3	50	50
III	19PICCC303	Core 10: Instrumental Techniques of Analysis	1. Understand to identify the basic components of spectroscopic instrumentations. 2. Demonstrate a working knowledge of spectrometry techniques. 3. Understand a working knowledge of chromatography techniques. 4. Understand the processes responsible for NMR chemical shifts and splitting patterns 5. Understand the basic concepts of GC and HPLC techniques and its applications.	Core	4	50	50
III	19PICCC304	Core 11: Industrial Safety & Management (Self-study)	1. Understand Intrinsic & Extrinsic Safety, Hazards, Risk assessment methods and MSDS. 2. Understand the various process safety devices and process safety analysis method. 3. Understand the importance of GLP & GMP in industries 4. Apply the knowledge when necessity of shut down the plant 5. Understand the disaster management	Core	3	50	50

III	19PICDC301	**DSE-Core-1** Chemical Technology-I	1. Analyze the advanced concepts of drugs and pharmaceuticals-I 2. Analyze the advanced concepts of drugs and pharmaceuticals-II 3. Analyze the advanced concepts of essential oil and isolation of natural products 4. Evaluate the advanced concepts of dyes and intermediates 5. Evaluate the advanced concepts of heat treatments & non-destructive testing technology	Elective	4	40	60
III	19PICDC302	**DSE–Core 1:** Pharmaceutical Technology	1. Discuss the fundamental principles for dosage form design, drug release and drug delivery. 2. Classify different dosage forms and apply principles of pharmaceutical science in formulation and dispensing the various dosage forms 3. Apply the engineering principles for formulation of solutions, suspensions and emulsions, granules and tablets 4. Formulate the dosage forms for a given API based on its properties 5. Develop a formulation process for a given API	Elective	4	40	60
III	19PICCC305	**Core Practical 5:** CT, PC & RE	1. Create the advanced concepts of synthesis of various dyes. 2. Apply the advanced concepts of dyeing processes of synthesized dye. 3. Analyze the advanced concepts of polymer preparation by suspension and emulsion techniques. 4. Evaluate the advanced concepts of polymer preparation by Emulsion and bulk techniques. 5. Creat the advanced concepts of Reaction Engineering.	Core	3		
III	19PICCC306	**Core Practical 6:** ITA	1. Create the advanced processes for separation of amino acids by of ascending chromatography. 2. Evaluate the advanced concepts of analytical separation. 3. Apply advanced knowledge of separation of mixture of amino acids. 4. Create the advanced processes for separation of	Core Practical	1		

			amino acids by of Radial chromatography. 5. Apply advanced concepts of measurement of the Rf value.				
IV	**19PICCC402**	**Core 13:** Process Dynamics & Control	1. To demonstrate fundamental understanding of process control. 2. Know the concept related process, steady state, unsteady state, feed-back control. 3. Use Laplace Transform and other properties of it. 4. Obtain transfer functions related to the first order system. 5. Analyze a chemical reactor system controlled with the advanced control strategies.	Core	4	50	50
IV	**19PICCC403**	**Core 14:** Advance Organic Chemistry	1. Understand the advanced concepts of stereoisomerism. 2. Analyze the basic technology of cyclostereoisomerism. 3. Apply the fundamental technology of green chemistry. 4. Evaluate and create the concepts of methods in organic synthesis. 5. Evaluate and create the basic concepts of oxidizing & reducing reagents.	Core	4	50	50
IV	**19PICDC401**	**DSE-Core-2** Chemical Technology-II	1. Understand the advanced concepts of ceramic & refractories industries. 2. Analyze the basic technology of soap & detergents industries. 3. Apply the fundamental technology of paint industries. 4. Evaluate and create the concepts of pigment industries. 5. Evaluate and create the basic concepts and technology of sugar industries.	Elective	4	40 40	60

IV	19PICDC402	DSE Core 2: Chemistry of synthetic drugs	1. Classify type of disease and drugs 2. Employ the core subject knowledge of anticancer and anti-infectious, Cardiovascular and the drugs affecting on metabolic disease. 3. Well acquainted with the synthesis of some important class of drugs. 4. Knowledge about the mechanism pathways of disease and curing by medicinal compounds. 5. Critically evaluate modern methods of functional group transformations and the application of protecting groups in Drug synthesis.	Elective	4	40	60

1.8   M.Sc. Mathematics

PO$_1$	Depth and breadth of knowledge: To prepare efficient mathematics graduates with strong fundamental knowledge and advanced mathematical skills to cater the needs of academics and industries related to mathematics.
PO$_2$	Practice, Operation and usage of modern tools and technology: To provide graduates who can skillfully utilize the mathematical tools including mathematical software to assess, identify and solve problems significant to industries & society.
PO$_3$	Research, numeracy and scholarship: To develop ability among graduates to apply advanced knowledge of mathematics to demonstrate the active participation in mathematical research work to provide solutions of mathematical problems.
PO$_4$	Professional capacity and passion of learning: To train mathematics graduates with skills to enhance professional capacity and exhibit life-long learning skills through constant knowledge up- gradation.
PO$_5$	Global, moral and aesthetic sustainability: To enrich the mathematics graduates with moral and aesthetic values for global sustainability.

Semester	Course code	Course Title	Course Outcomes	Type Core/ Elective	Credit	CIA	SEE
I	19PMTCC101	**Core 1:** Group and Ring Theory	1. Understand basic principles of algebraic structure of group, abelian group, cyclic group. 2. Focus and analyse the homomorphic image of group. 3. Extend the concepts of automorphism and product of sets to the structure of group. 4. Understand the special classes of groups: Finite Abelian Groups and the converse of well-known Lagrange's theorem 5. More conceptual learning of the structure of ring, Recognize and understand the concept of Ideals.	Core	4	40	60
I	19PMTCC102	**Core 2:** Topology	1. Recognize and interpret the topological structures and their characterizations. 2. Identify and understand the subspace topology and product topology. 3. Identify and classify the types of topologies including quotient topology and metric topology. 4. Understand differentiate and apply the hierarchy of the topological spaces and their characterizations.	Core	4	40	60

I	**19PMTCC103**	**Core 3:** Functions of Several Variables	1. Identify and define functions of the form $T:R^n \rightarrow R^m$ 2. Understand the concepts including limit, continuity for the functions of several variables. 3. Understand the concepts of partial derivative of first and higher order for functions of several variables. 4. Recognize and understand the concepts of tensor algebra on finite dimensional vector spaces, 5. Understand and apply alternating and symmetric tensors, wedge products, vector fields and forms as well as their basic properties.	Core	4	40	60
I	**19PMTCC104**	**Core 4:** Theory of Differential Equations	1. Understand the meaning of Ordinary Differential Equations. 2. Understand and solve Partial differential equation. 3. Identify and solve Gauss hyper geometric equation. 4. Understand, identify and solve Cauchy Problem including Charpit's and Jacobi's method.	Core	4	40	100
I	**19PMTID101**	**DISCIPLINE SPECIFIC ELECTIVE - ID - I:** Fundamentals of Classical Mechanics	1. Understand and describe elementary principles of motion. 2. Understand and criticize equations of motion and classify the dynamical systems. 3. Derive and utilize Lagrange's equation of motions. 4. Identify, understatnd and solve two body central force problem. 5. Identify, understatnd and solve problems related to Equations of Motion and Rigid bodies.	Elective	4	50	50

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5. Understand and apply the continuity of functions

I	19PMTC105	**Practical**: Numerical Methods using Scilab	1. Understand the concept of open source mathematical software including SCILAB. 2. Understand and utilize the user interface of SCILAB including console, file browser, variable browser, the command history and general commands including clc & clear 3. Utilize pre-defined mathematical constants, variables and operators of Scilab, Input and utilize inbuilt matrix commands and library functions to write programs. 4. Solve numerical problems using Scilab programs. 5. Interpolate the value using tabulated data and numerical methods combined with customized Scilab program.	Practical	2	40	60
II	19PMTCC201	**Core 5:** Advanced Ring Theory and Extension Fields	1. Understand advanced (extended) algebraic structures like polynomial 2. ring, division ring, field and extension fields. 3. Recognize and understand different types and principles of the 4. structures. 5. Identify the standard results regarding concepts of extension fields and 6. Galois field. 7. Explore the applications of the extension fields to geometry and other fields of mathematics. 8. Analyze and extend the concept of modules and types of modules.	Core	4	40	60
II	19PMTCC202	**Core 6:** Real Analysis and Measure Theory	1. Understand basic principles set theory, Borel set, - Algebra,outer measurable sets and Lebesgue measurable sets. 2. Analyse the Lebesgue measurable function. 3. Understand the concept of Lebesgue Integral and Riemann 4. InExtend the concepts of Lebesgue integration to differentiation of integration 5. More conceptual learning of the structure of L Spaces and completeness of the space.tegration.	Core	4	40	60

II	19PMTCC203	**Core 7:** Theory of Partial Differential Equations	1. Identify and understand the higher order partial differential equations. 2. Classify the higher order partial differential equations. 3. Distinguish between linear and nonlinear the higher order partial differential equations 4. Identify and understand the higher order partial differential equations with variable coefficients 5. Understand and solve the given Boundary value problems and Equipotential surfaces	Core	4	40	60
II	19PMTCC204	**Core 8:** Advanced Classical Mechanics	1. Understand, define and verify Rigid Body Equations of Motion. 2. Understand and compare theory of relativity in classical mechanics. 3. Formulate covariant four dimensional equations 4. Derive the Hamilton's equation of motion. 5. Understand and utilize the Canonical transformations and Generating functions.	Core	4	40	60
II	19PMTCC205	**Core Practical 2:** Introduction to Latex	1. Understand the purpose and nature of LaTeX. 2. Understand how LaTeX differs from a word processor. 3. Install and utilize LaTeX and its related components successfully on personal computer. 4. Create document using LaTeX including the features like line break, fonts size, page breaks. 5. Utilize LaTeX and its templates to compose Mathematical documents, presentations, and reports. 6. Identify, remember and effectively utilize symbols useful for mathematical type setting. 7. Create complete document including title page, index, chapters, tables graphics and bibliography	Core Practical	2	60	40
III	19PMTCC301	**Core 9:** Complex Analysis	1. Understand the concept of complex plane and generalize the concept of coordinate plane. 2. Determine continuity/differentiability/analyticity of a complex function and find the derivative of a function. 3. Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula. 4. Compute the residue of a function and use the residue	Core	4	40	60

			theory to evaluate a contour integral or an integral over the real line. 5. Analyze and classify the singularities of complex function in given region.				
III	19PMTCC302	**Core 10:** Discrete Mathematics	1. Write an argument using logical notation and determine if the argument is or is not valid. 2. Demonstrate the ability to write and evaluate a proof or outline the basic structure of and give examples of each proof technique described. 3. Understand the basic principles of sets and operations in sets. 4. Demonstrate an understanding of relations and functions and be able to determine their properties. 5. Demonstrate different traversal methods for trees and graphs	Core	4	40	60
III	19PMTCC303	**Core 11:** Advanced Topics in Linear Algebra	1. Remember the basic principles of linear transformation describe characteristic roots and understand representation of linear transformation by matrix. 2. Analyze the Canonical forms 3. Identify rational canonical forms and Demonstrate Jordan forms 4. Develop matrices in F_n and explain Eigen value, determinate and trace 5. Recognize and understand the concept of important transformation and real quadratic forms.	Core	4	40	60
II	19PMTCC304	**Core 12: Self-Study Course:** Optimization Techniques.	1. Understand basic principles of Operation Research Techniques of strategic decision planning. 2. Focus and analyze the optimum utilization of constraint resources in various span of human life. 3. Extend the concepts of Minimax & Maximin principles. 4. Understand the project management by critical path method & project evaluation and review techniques. 5. Understand the theory of queue.	Core	4	40	60
III	19PMTDC301	**DSE-Core-** Financial Mathematics	1. List the financial markets, distinguish between various options. 2. Differentiate between options and contracts; define the terms like portfolio, sensitivity to volatility, risk –free	Elective	4	50	50

			investment and solution of problems on option pricing. 3. Introduce simple model for asset prices, proof of Ito's lemma and its extension. 4. Black - Scholes Differential equation and its solution. 5. Define discrete dividend structure one jump conditions for the same				
III	19PMTDC302	DSE-Core- I Quantitative Foundations of Bioinformatics	1. Understand analyze and apply the concept of calculus 2. Identify the proper numerical methods and techniques 3. Understand, analyze and apply the concept of Correlation and regression. 4. Understand Probability Theory 5. Understand types of probability distribution.	Elective	4	5	50
IV	19PMTCC401	Core 13: Advanced Topics in Number Theory	1. Explain the principles of Number systems, divisibility and primes 2. Explain about Congruences and Chinese remainder theorem and compute congruence related problems and their solution 3. Understand Diophantine equation and apply methods to solve Diophantine equation and convert real world problem in find their solution 4. Recall rational and irrational and explain Farey fraction and continued fraction 5. Explain meaning of approximation to irrational and classify continued fraction.	Core	4	40	60
IV	19PMTCC402	Core 14: Functional Analysis	1. Understand the concept of Normed Linear Spaces and Banach Spaces. 2. Classify the weak and strong convergence of sequences. 3. Apply uniform boundedness theorem. 4. Understand the structures of Inner Product Spaces and Hilbert Spaces. 5. Apply the Hahn-Banach Theorem.	Core	4	40	60
IV	19PMTCC403	Core 15: Advanced Topics in Graph Theory	1. Understand and apply the fundamental concepts in graph theory 2. Characterize the Euler and Hamiltonian Graphs 3. Analyze the principles and concepts of graph theory in practical situations 4. Validate and critically assess a mathematical proof;	Core	4	40	60

			5. Describe and apply some basic algorithms for graphs				
IV	19PMTCC404	**Core 16:** Differential Geometry	1. Define functions of class K, regular curve, Unit speed curve, re- parameter ization of curves, Curvature of a curve. 2. Conpute arc length and re- parameterization of a curve by its are length. 3. Define Frenet - Serret apparatus, prove Frenet - Serret theorem, conpute the Frenet - Serret apparatus for the given curve. 4. Difine simple surface and study of various surfaces. 5. Define first and second fundamental forms as well as Christoffel symbols compute first - second fundamental forms and Christoffel symbols for the given surface.	Core	4	40	60
IV	19PMTDC401	**DSE Core I1:** Mathematical Statistics	1. Provide a concise and clear description of a statistical problem 2. Provide a description of the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. 3. Provide a discussion of the results and of the statistical analysis. 4. Provide a conclusion to the study including a discussion of limitations of the analysis. 5. Provide a derivation for mathematical statistics problems.	Elective	4	60	40