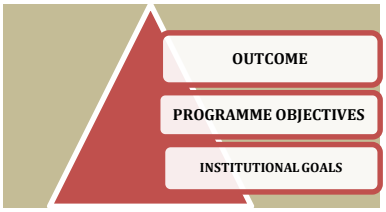
LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK

FOR UNDERGRADUATE EDUCATION



INTERNAL QUALITY ASSURANCE CELL

GOVT. MADHAV SCIENCE P.G.COLLEGE UJJAIN

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK

FOR UNDERGRADUATE EDUCATION

SECTION A

1.1 Introduction

Fostering quality Higher Education across campus is a high priority task for any HEI. Further improvement of quality of higher education is considered critical for enabling effective participation of young people in knowledge production and participation in the knowledge economy, improving national competitiveness in a globalized world and for equipping young people with skills relevant for global and national standards and enhancing the opportunities or social mobility. Sustained initiatives are required for institutionalizing an outcome-oriented higher education system and enhancing employability of graduates through curriculum reform, based on a learning outcomes-based curriculum framework, improving/upgrading academic resources and learning environment, raising the quality of teaching and research across all higher education institutions; technology use and integration to improve teaching-learning processes and reach a larger body of students through alternative learning modes such as open and distance learning modes and use of MOOCs.

Other priority areas of action for fostering quality higher education include translation of academic research into innovations for practical use in society and economy, promoting efficient and transparent governance and management of higher education system, enhancing the capacity of the higher education system to govern itself through coordinated regulatory reform and increasing both public and private sector investment in higher education, with special emphasis on targeted and effective equity-related initiatives.

1.2 Learning outcomes-based approach to curriculum Enrichment and Execution

College being an Affiliated college focuses on Curriculum Enrichment and Execution rather than Curriculum planning and Development.

The fundamental premise underlying the learning outcomes-based approach to curriculum Enrichment and Execution is that higher education qualifications such as a Bachelor's Degree programmes and PG Programmes are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge,

understanding, skills, attitudes and values measurable through Internal Examination CCE modes and experiential activity modules) and academic standards expected of graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study.

It may be noted that the learning outcomes-based curriculum framework in this college not only intend to promote designing of a syllabus for a programme of study or learning contents of courses within each programme of study or to prescribe a set of approaches to teaching-learning process and assessment of student learning levels. Instead, they are intended to allow for flexibility and innovation in (i) programme design and syllabi development by higher education institution for self-finance subjects (ii) Enrichment of Execution process of Syllabi (ii) teaching-learning process, (iii) assessment of student learning levels, and (iv) periodic programme review within a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes.

The overall objectives of the learning outcomes-based curriculum framework are to:

- Help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;
- Enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values or attributes), a graduate of a programme should be capable of demonstrating on successful completion of the programme of study;
- Maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility; and
- Provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

1.3 Key outcomes underpinning curriculum enrichment and execution

The learning outcomes-based curriculum framework for undergraduate education is a framework based on the expected learning outcomes and academic standards that are expected to be attained by graduates of a programme of study and holder of a qualification. The key outcomes that underpin curriculum enrichment and execution

at the undergraduate level include Graduate Attributes, Qualification Descriptors, Programme Learning Outcomes, and Course Learning Outcomes:

1.3.1 Graduate attributes

The graduate attributes reflect the particular quality and feature or characteristics of an individual, including the knowledge, skills, attitudes and values that are expected to be acquired by a graduate through studies at the institution.
The graduate attributes include capabilities that help strengthen one's abilities for widening current knowledge base and skills, gaining new knowledge and skills, undertaking future studies, performing well in a chosen career and playing a constructive role as a responsible citizen in the society. The graduate attributes define the characteristics of a student's university degree programme and describe a set of characteristics/competencies that are transferable beyond study of a particular subject area and programme contexts in which they have been developed. Graduate attributes are fostered through meaningful learning experiences made available through the curriculum, the total college experiences achievable through Flagship programmes and a process of critical and reflective thinking developed therein

The learning outcomes-based curriculum framework is based on the inherent principle that every student and graduate is unique. Each student or graduate has his/her own characteristics in terms of previous learning levels and experiences, life experiences, learning styles and approaches to future career-related actions. The quality, depth and breadth of the learning experiences made available to the students while at institution help develop their characteristic attributes. The graduate attributes reflect both disciplinary knowledge and understanding, generic skills, including global competencies that all students in different academic fields of study should acquire/attain and demonstrate. Some of the characteristic attributes that a graduate should demonstrate are as follows:

- ***Disciplinary knowledge:*** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study.
- ***Communication Skills:*** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one‟s views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
- ***Critical thinking:*** Capability to apply analytic thought to a body of knowledge;

- analyse and evaluate evidence, arguments, claims, beliefson the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theoriesby following scientific approach to knowledge development.
- ***Problem solving:*** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one‟s learning to real life situations.
- ***Analytical reasoning****:* Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesize data from a variety of sources; drawvalid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
- ***Research-related skills:*** A sense of inquiry and capability for asking relevant/appropriate questions, problematizing, synthesizing and articulating; Ability to recognize cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyze, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.
- ***Cooperation/Team work****:* Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group,and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
- ***Scientific reasoning:*** Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
- ***Reflective thinking:*** Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.
- ***Information/digital literacy:*** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
- ***Self-directed learning:*** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
- ***Multicultural competence:*** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.
- ***Moral and ethical awareness/reasoning:*** Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work,

- avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.
- ***Leadership readiness/qualities:*** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
- ***Lifelong learning:*** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

1.3.2 Qualification descriptors

A qualification descriptor indicates the generic outcomes and attributes expected for the award of a particular type of qualification (for eg. a bachelor's degree or a Postgraduate degree). The qualification descriptors also describe the academic standard for a specific qualification in terms of the levels of knowledge and understanding, skills and competencies and attitudes and values that the holders of the qualification are expected to attain and demonstrate. These descriptors also indicate the common academic standards for the qualification and help the degree-awarding bodies in designing, approving, assessing and reviewing academic programmes. The learning experiences and assessment procedures are expected to be designed to provide every student with the opportunity to achieve the intended programme learning outcomes. The qualification descriptors reflect both disciplinary knowledge and understanding as well asgeneric skills, including global competencies that all students in different academic fields of study should acquire/attain and demonstrate.

Qualification descriptors for a Bachelor's Degree programme : The students who complete three years of full-time study of an undergraduate programme of study will be awarded a Bachelor's Degree. Some of the expected learning outcomes that a student should be able to demonstrate on completion of a degree-level programme may include the following:

- Demonstrate (i) a fundamental/systematic or coherent understanding of an academic field of study, its different learning areas and applications, and its linkages with related disciplinary areas/subjects; (ii) procedural knowledge that creates different types of professionals related to the disciplinary/subject areaof study, including research and development, teaching and government and public service; (iii) skills in areas related to one's specialization and current developments in the academic field of study.
- Use knowledge, understanding and skills required for identifying problems and issues, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources, and their application, analysis and evaluation using methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments;
- Communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s);
- Meet one's own learning needs, drawing on a range of current research and development work and professional materials;
- Apply one's disciplinary knowledge and transferable skills to new/unfamiliar contexts, rather than replicate curriculum content knowledge, to identify and analyse problems and issues and solve complex problems with well-defined solutions.
- Demonstrate subject-related and transferable skills that are relevant to some of the job trades and employment opportunities.

1.3.3 Programme learning outcomes

The outcomes and attributes described in qualification descriptors are attained by students through learning acquired on completion of a programme of study. The term 'programme' refers to the entire scheme of study followed by learners leading to a qualification. Individual programmes of study will have defined learning outcomes which must be attaind for the award of a specific certificate/diploma/degree. The programme learning outcomes are aligned with the relevant qualification descriptors.

Programme learning outcomes will include subject-specific skills and generic skills, including transferable global skills and competencies, the achievement of which the students of a specific programme of study should be able to demonstrate for the award of the certificate/Diploma/Degree qualification. The programme learning outcomes would also focus on knowledge and skills that prepare students for further study, employment, and citizenship. They help ensure comparability of

learning levels and academic standards across colleges/universities and provide a broad picture of the level of competence of graduates of a given programme of study.

1.3.4 Course learning outcomes

The programme learning outcomes are attained by learners through the essential learnings acquired on completion of selected courses of study within a programme. The term 'course' is used to mean the individual courses of study that make up the scheme of study for a programme. Course learning outcomes are specific to the learning for a given course of study related to a disciplinary or interdisciplinary/multi-disciplinary area. Some programmes of study are highly structured, with a closely laid down progression of compulsory/core courses to be taken at particular phases/stages of learning. Some programmes allow learners much more freedom to take a combination of courses of study according to the preferences of individual student that may be very different from the courses of study pursued by another student of the same programme.

Course-level learning outcomes will be aligned to programme learning outcomes. Course- level learning outcomes are specific to a course of study within a given programme of study. The achievement by students of course-level learning outcomes lead to the attainment of the programme learning outcomes. At the course level, each course may well have links to some but not all graduate attributes as these are developed through the totality of student learning experiences across the years of their study. Teaching - learning process

The *Learning Outcomes-Based Approach* to curriculum planning, Enrichment, and transaction requires that the teaching-learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. The outcome- based approach, particularly in the context of undergraduate studies, requires a significant shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies. Planning for teaching therein becomes critical. Every programme of study lends itself to well-structured and sequenced acquisition of knowledge and skills. Practical skills, including an appreciation of the link between theory and experiment, will constitute an important aspect of the teaching-learning process. Teaching methods, guided by such a framework, may include: lectures supported by group tutorial work; practicum and field-based learning; the use of prescribed textbooks and e-learning resources and other self-study materials; open-ended project work, some of which may be team-based; activities designed to promote the development of generic/transferable and subject-specific skills; and internship and visits to field sites, and industrial or other research facilities etc.

1.4 Assessment methods

A variety of assessment methods that are appropriate to a given disciplinary/subject area and a programme of study are used to assess progress towards the course/programme learning outcomes. Priority will be accorded to formative assessment. Progress towards achievement of learning outcomes is assessed using the following: time-constrained examinations; closed-book and open-book tests; problem based assignments; practical assignment laboratory reports; observation of practical skills; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva voce interviews; computerised adaptive testing; peer and self- assessment etc. and any other pedagogic approaches as per the context .

Course wise Learning Outcomes

Course/Learning outcomes

B. Sc. Chemistry

Class: B.Sc. First Year

Paper: Physical Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course, the students will be able to-
Unit I (A)	Mathematical concept:	• Use the knowledge of logarithm, differentiation and integration for understanding derivations in different chapters.
Unit I (B)	Gaseous State and Molecular Velocities:	• Understand relationship between kinetic energy and temperature of a gas. • Calculate the partial pressure, and use of kinetic theory of gases to understand the nature of gases.
Unit II (A and B)	A) Liquid State B) Solid State:	• Differentiate among solid, liquid and gases through different models and objects. • Students will also be able to learn the nature of intermolecular forces and dependent properties like viscosity, surface tension and capillary action and their practical applications. • This study will help the students during post graduation and also for industrial application.
Unit III	Chemical Kinetics	• Understand that how to determine reaction rate and factors affecting the rate of reaction. • Calculate rate constant and order of reaction for different kind of reactions. • The students will be able to apply the concepts to solve the numerical problems during post graduation and competitive examinations.
Unit IV	Radioactivity and Nuclear Chemistry	• Learn the different kinds of nuclear reactions and their mechanism. • Learn the mechanism of radioactivity and its measurement.

		• Basic understanding of chemical consequences of interaction of radiation with nucleus. • Learn the applications of nuclear chemistry in theoretical and nuclear power plant. • Apply the concepts encountered in the text or unit in post graduation level.
Unit V	A) Chemical Equilibrium: B) Colloidal Solutions:	• Understand different properties of colloids, different examples of colloidal dispersion and uses. • Utilize this knowledge for further study or for the research purpose especially in the field of nanotechnology.

Class: B.Sc. First Year

Paper: Inorganic Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course the students will be able to-
Unit I	A) Atomic Structure B) Periodic Properties:	• Understand the meaning of four quantum numbers and different atomic theories, concept of nuclear charge, ionization energy, electron affinity and different parameters. • They will be able to apply the quantum mechanics for the energy calculation of different energy states of an atom in post graduation studies and other competitive examination
Unit II	Chemical Bonding- Part I:	• Understand the structure of a chemical substance in terms of bonds. • Apply VSEPR theory to determine the geometry of a molecule. • Imagine the molecule in three dimension structure and will be able to utilize this knowledge at their post graduation level and also for competitive examination.
Unit III	Chemical Bonding- Part II:	• Differentiate bonding amongst ionic and covalent compounds. • Understand that how lattice energy is correlated with physical properties of ionic compounds like solubility. The students will be able to utilize the knowledge of semiconductors at industrial level.
Unit IV	A) s-Block Elements B) p-Block Elements Part-1	• Understand the general trends of s block and p block elements in periodic table and study different compounds of s block and p block elements. • Know the significance of alkali and alkaline earth metals in biological system. • Utilize the knowledge of compounds of metals, nonmetals like boron, carbon, aluminum and different alloys at industrial level.
Unit V	p-Block Elements Part-2	• Understand the structure and synthesis of boranes and silicates and their application at industrial and research level.

Class: B.Sc. First Year

Paper: Organic Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course the students will be able to-
Unit I	Structure and Bonding:	• Recognize the difference between aliphatic and aromatic compounds. • Correlate the stability of organic molecules with aromaticity. • Gain the knowledge of different kinds of reaction mechanism. On the basis of knowledge of intermediate formation and mechanism of reaction students will be able to predict the final product during post graduation and higher studies.
Unit II	Alkanes and Cycloalkanes:	• Different reactions of alkanes and cycloalkanes. • Different kinds of strain through conformational studies of cycloalkane and stability of different conformers. • This study will help the students during post graduation and competitive examinations.
Unit III	Alkenes Cycloalkenes Dienes	• Understand the different kinds of reactions of alkenes and cycloalkenes. • Apply these methods in multistep synthesis of useful compounds at industrial and research level.
Unit IV	Alkynes and Alkyl Halides	• Learn the skill of writing mechanism of reaction through different reactions of alkyl halides. • Able to understand different synthetic methods and reaction and will be able to apply these methods in multistep synthesis of useful compounds at research and industrial level.
Unit V	Stereochemistry of Organic	• Predict whether an organic compound is chiral or achiral. • Recognize different elements of symmetry in chiral

	Compounds	compound. • Recognizing and assigning stereochemical designations of organic compounds, which will help in next level of graduation (stereochemistry of amines, stereochemistry of carbohydrates) and also during post graduation.

Class: B.Sc. Second Year

Paper: Physical Chemistry

Units	**Course content**	**Course/Learning Outcomes:** After completion of course the students will be able to-
Unit I	A) Thermodynamics B) Thermochemistry	• Understand the different thermodynamic properties. • Apply the law of thermodynamics to the real systems. • Understand different thermodynamic cycles.
Unit II	A) Phase Equilibrium B) Solid Solution C) Liquid-Liquid Mixture D) Partial Miscible Liquids	• Understand different terminologies of phase equilibrium. • Apply the concepts of text lecture in practical and post graduation level
Unit III	Electrochemistry- I	• Understand different types of conductance. • Construct an electrochemical cell. • Calculate EMF of a cell through standard reduction potential data. • Understand different electrode reactions. • Apply these concepts to study the next unit.
Unit IV	Electrochemistry-II	• Understand the redox reaction occurring at electrode. • Know the different kinds of electrodes and use of electrodes in different electrochemical equipments. • Understand the mechanism of buffer action.
Unit V	A) Surface Chemistry B) Catalysis	• Differentiate the mechanism of adsorption and absorption. • Understand different methods of determination of surface area and able to utilize it during research. • Learn phenomenon of catalysis and application.

Class: B.Sc. Second Year

Paper: Inorganic Chemistry

Units	**Course content**	**Course/Learning Outcomes:** After completion of course, the students will be able to-
Unit I	Chemistry of Elements of First Transition Series:	• Different periodic properties of d-block elements of first transition series. • Learn the chemistry of binary compounds. • Understand the chemistry of these metal ions for the syntheses of different metal complexes in next units.
Unit II	Chemistry of Elements of Second and Third Transition Series	• Compare the trends between 3d, 4d and 5d series like stability of complexes in high and low oxidation states, magnetic, spectral and other properties. • Understand the role of transition metals in electronic, biomedical, analytical, and catalytic and various applications. • They will able to utilize this knowledge in research as well as industrial area.
Unit III	A) Coordination Compounds B) Oxidation and Reduction	• Understand the basic concepts of coordination chemistry and role of d-electrons and d- orbitals in bonding. • Differentiate among different theories of bonding. • Apply the concepts encountered in this unit to the next level of graduation (Metal-ligand bonding). • They will learn different techniques of extraction which will be useful for mining processes.
Unit IV	General Chemistry of f-Block Elements	• Understand the spectral magnetic and general properties as well as the role of actinides as nuclear fuel, in laser techniques, in batteries and for other purposes. • Utilize this knowledge during post-graduation level and also for research and industrial area.
Unit V	A) Acids and bases B) Nonaqueous Solvent	• Understand the different theories of acids and bases. • Learn about different non aqueous solvents and able to use their knowledge in analytical chemistry.

Class: B.Sc. Second Year

Paper: Organic Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course the students will be able to-
Unit I	Electromagnetic Spectrum: Absorption Spectrum	• Compare all the electromagnetic radiations in terms of energy and wavelength. • Understand the handling of UV and IR instruments. • Understand that, why some compounds are colored and some are colorless. • Interpret UV and IR spectra. • Develop problem solving skills and able to use it at next level of spectroscopy.
Unit II	A) Alcohols B) Phenols	• Know the different methods for the syntheses of alcohols and phenols which they can use in multistep synthesis at industrial level. • Learn the orientation effect on phenol. This study will help the students during post graduation and competitive examinations. • Use different reactions for further research.
Unit III	Aldehydes and Ketones	• Learn the IUPAC naming of aldehydes and ketones. • Compare the reactivity of different aliphatic and aromatic aldehydes and ketones. • Write the mechanism of different condensation reactions. • Develop the skills of synthesizing new condensation compounds for research purpose as well as for other applications at industrial level.
Unit IV	A) Carboxylic Acids B) Ether	• Compare the reactivity of different aliphatic and aromatic carboxylic acids. • Learn the handling of carboxylic acids in practical laboratory by knowing their physical and chemical properties

		• Learn different reactions for synthesis of acid and acid derivatives. • Utilize this knowledge during further higher studies and also during research.
Unit V	Organic Compounds of Nitrogen	• Compare the basicity of different types of amines. • Stereochemistry of amines and their stereo chemical designation. • Different kinds of reactions and their mechanism. • Know the practical applicability of different nitro and amine compounds at industrial as well as research laboratory.

Class: B.Sc. Third Year

Paper: Physical Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course the students will be able to-
Unit I	A) Elementary Quantum Mechanics B) Molecular Orbital Theory	• Solve Schrodinger equation to obtain wave functions. • Understand the application of Schrödinger equation to find out the allowed energy level of atoms. • Calculate the energy levels from wave functions. • This learning will help the students to solve the problems during higher studies.
Unit II	Spectroscopy: A) Introduction B) Rotational Spectrum C) Vibrational Spectrum	• Understand the role of microwave spectroscopy for determination of molecular structure, dipole moment and bond length. • Understand the role of Vibrational spectroscopy in functional group identification. • Students will utilize the knowledge for structural analysis of given unknown molecule.
Unit III	A) Raman Spectrum B) Electronic Spectrum C) UV spectroscopy	• Understand the role of spectroscopic techniques for the characterization of materials which will help them in research level.
Unit IV	Photochemistry	• Understand different photochemical process through Jablonski diagram. • Learn the different photochemical reactions of simple organic compounds. • Utilize this knowledge during post graduation and higher studies.
Unit V	Physical Properties and Molecular Structure:	• .understand different magnetic behavior of molecules. • Learn the different techniques of measurement of dipole moment

Class: B.Sc. Third Year

Paper: Inorganic Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course the students will be able to-
Unit I	A) Hard and Soft Acids and Bases B) Silicones and Phosphazenes	• Understand the trends of acidity and basicity in periodic table. • Learn the stability of salts through HSAB theories. • Learn the syntheses and reactions of silicones and Phosphazenes. • Understand the applicability of these silicones and Phosphazenes at industrial level.
Unit II	A) Metal Ligand Bonding B) Thermodynamics and kinetics	• Understand the bonding in metal complexes. • Understand the difference between VBT and CFT. • Learn that how geometries affect splitting and stability of d-orbital's. • Understand the structure, color, magnetism and different behavior of complexes through CFT model. • Understand the stability of complexes on the ground of thermodynamic and kinetic aspects. • Know the role of complexes in biomedicine, environmental cleaning and drug delivery system.
Unit III	Magnetic properties of Transition Metal Complexes	• Understand the relation between the electronic arrangement and magnetic behavior of complexes. • Learn about the magnetic moment and their determination through different methods. • Calculate the ground state term symbol for different d electronic systems.
Unit IV	Electronic Spectra of Transition metal complexes	• Understand the spectroscopic notations. • Able to relate the electronic configuration of metal ion with spectral properties of complex.

		• Understand the role of ligands in appearance of color of complex. • Predict simple electronic spectrum of metal complex through Orgel diagram. • Develop the skills for synthesis and characterize a coordination complex during research for desired application.
Unit V	Bioinorganic Chemistry	• Understand the role of elements in biological system. • Learn the mechanism of functioning of these metal coordinated biomolecules. • Know the application of these metal coordinated biomolecules in electron transfer mechanism, toxicology, as diagnostic agent and many more.

Class: B.Sc. Third Year

Paper: Organic Chemistry

Units	**Course content**	**Course/ Learning Outcomes:** After completion of course the students will be able to-
Unit I	Nuclear Magnetic Resonance Spectroscopy	• Understand the basic principle of NMR spectroscopy. • Able to interpret the simple NMR spectrum of organic compounds. • Able to use the concepts of shielding, deshielding and coupling constant to elucidate the structure of given organic compound. • Apply the knowledge of spectroscopy during post graduation and higher studies.
Unit II	A) Organo metallic Compounds B) Organo sulphur Compounds	• Know the different methods for the syntheses of Grignard reagent, organo lithium, organo sulphur and organo zinc compounds. • Know the uses and applications of these compounds in various chemical reactions at industrial as well as research level. • Learn the different kinds of polymers, their synthesis and uses at industrial level for various applications.
Unit III	Carbohydrates	• Able to classify different carbohydrates. • Understand the role of carbohydrates for maintaining human health. • Learn the structure, functions, different reactions and stereochemistry of carbohydrates • Understand the mechanism of cleansing action of soap and detergents and able to apply the knowledge of this mechanism at industrial level.
Unit IV	Amino Acids, Peptides, Protein	• Understand the essential and non essential amino acids. • Understand the stereochemistry of amino acids.

	and Nucleic Acids	• Learn the types and structure of proteins. • Learn that how structure of proteins affect functioning. • Understand the composition of nucleic acids and able to distinguish the structural features of RNA and DNA. • Able to apply the knowledge in genetic studies during post graduation and research area.
Unit V	A) Synthetic Dyes B) Pericyclic Reactions	• Learn the different methods and reactions of different dyes. • Know the usefulness of different dyes at industrial level as coloring agent. • Synthesize the different dyes at industrial level. • Know the different pericyclic reactions and the rules governing these reactions.

Course- B. Sc. Mathematics

B. Sc. I Year

Paper-I **ALGEBRA AND TRIGNOMENTARY**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Rank of Matrix, Normal & Echelon form of a matrix. Characteristic equation of a matrix, Eigen values. Eigen vectors. Linear Independence of row and column matrix.	Student must be able to: • Write the matrix representation of a set of linear equations and to analyse the solution of the system of equations • How to find the Eigen values and Eigen vectors which are used in various branches of engineering. •How to apply linear independence of row and column matrix.
UNIT-II	Cayley Hamilton theorem and its use in finding inverse of a matrix. to solve a system of linear (homogeneous and non homogeneous) equations. Theorems on consistency and inconsistent of a system of linear equations. Solving linear equations upto three unknowns.	• Students able to test the consistency and inconsistency of system of equations. • Students can solve a system of linear equations in three variables .Systems of linear equations can be used to solve resource allocation problems in business and economics.
UNIT-III	Relation between the root and coefficients of general polynomial equation in one variable. Transformation of equations. Reciprocal equations. Descarte's rule of signs.	The course will enable the students to: •Understand relation between root and coefficients of Polynomial. •How to Transforms an equation. • How to apply Descarte's rule of signs.
UNIT-IV	Logic- logical connectives. Truth table, Tautology, Contradiction, Logical equivalence. Algebra of proposition. Boolean Algebra- definition and properties. Switching circuits and its applications. Logic gates and circuits.	•Students learnt about statements, logical connectives, Logical equivalence. Algebra of proposition. •Using truth table to prove statement is Tautology or Contradiction. •How to check the statements are logical equivalence. •Boolean algebra is used to analyse and simplify the digital (logic) circuits.
UNIT-V	De- Movier's theorem and its applications, direct and inverse circular and hyperbolic functions. Expansion of trigonometric functions. Logarithm of complex quantities. Gregory's series. Summation of trignometrical series.	• De- Movier's theorem used in obtaining relationships between trigonometric functions of multiple angles (like sin 3x, cos 7x) and powers of trigonometric functions (like $\sin^2 x$, $\cos^4 x$). •Another important use of De Moivre's theorem is in obtaining complex roots of polynomial equations. • Understands the Logarithm of complex quantities. •How to use Gregory's series summation of trignometrical series.

B. Sc. I Year

Paper-II **CALCULUS AND DIFFERENTIAL EQUATIONS**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Successive differentiation, Leibnitz's theorem Maclaurin's and Taylor's series expansions, Asymptotes.	Student must be able to: • The notion of successive differentiation. • Find the Maclaurin's and Taylor series expansions of given functions • Taylor's series can be used to solve ordinary differential equations, to find the sum of series, evaluation of limits. Most important application of Taylor's series is to use partial sums to approximate functions. • Leibnitz's theorem is used to find the value of nth derivative at zero of function which can be express as a product of two functions. •How to compute Asymptotes.
UNIT-II	Curvature, tests for concavity and convexity, points of inflection, multiple points, tracing of curves in Cartesian and polar coordinates.	In this section student will learn the following : • Draw the graph of some curves using curve tracing. •Understand the concept of curvature & calculate curvature of curve in Cartesian or polar form. • Curvature is used in differential geometry & in a three part equation for bending of beams. It is also applied to measurements of the stress in the semiconductor structures.
UNIT-III	Integrations of transcendental functions. Definite integrals, Reduction formulae, Quadrature Rectification.	The course will enable the students to: •Know about transcendental functions & how to integrate them. •Integration by reduction formula always helps to solve complex integration problems.
UNIT-IV	Linear differential equations and equations reducible to the linear form. Exact differential equations. First order and higher degree equations solvable for x, y and p. Claraiut's equation and singular solutions. Geometrical meaning of a differential equation. Orthogonal trajectories.	Student must be able to • How to solve linear differential equations and reducible to equations in the linear form. •Learn various techniques of getting exact solutions of first order linear differential equations and linear differential equations of higher degree. •Applications in fluid dynamics- Design of containers and funnels. •Applications in heat conduction analysis - Design of heat spreaders in microelectronics.
UNIT-V	Linear differential equation with constant coefficients. Homogeneous linear ordinary differential equations. Linear differential equations of second order. Transformation of equations by changing the dependent variable independent variable, method of variation of parameters.	The course will enable the students to: •Solve linear differential equation with constant coefficients and homo differential equation. •Students able to transform equation by changing the dependent variable independent variable. •Student must be able to find solution by the method of variation of parameters. •Second-order differential equations play a central role in the physical sciences. They are found, for example, in laws describing mechanical systems, wave motion, electric currents and quantum phenomena.

B. Sc. I Year

Paper-III **VECTOR ANALYSIS AND GEOMETRY**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Scalar and vector product of three vectors, products of four vectors. Reciprocal vectors, vector differentiation, Gradient, Divergence and Curl.	After learning the contents of this unit the student must be able to • Calculate the scalar & vector product of three and four vectors. •Find the gradient (Normal to the surface) of scalar function. It is used to compute directional derivative. • Find divergence and curl of vector field and prove identities involving them.
UNIT-II	Vector Integration. Theorems of Gauss, Green, stoke's(without proof) and problem based on them.	Students will able to •Interpret line, surface and volume integrals. Using line integral we will compute work done by a particle in moving along curve. • Evaluate integrals by using Green's Theorem, Stokes theorem, Gauss's Theorem. Gauss theorem is applying to calculate volume. •These theorems relate vector fields and integrals - Green's theorem for vectors in two dimensions, and the other theorems for vector fields in three dimensions.
UNIT-III	General equation of second degree, tracing of conics, system of conics, polar equation of conic.	Student must be able to •How to trace conics. •Graph the polar equations of conics. •Define conics in terms of a focus and a directrix.
UNIT-IV	Equation of cone with given base, generators of cone, condition for three mutually perpendiculars generators, right circular cone, equation of cylinder and its properties.	The course will enable the students to: • How to find equation of cone with given base •Understands Condition for three mutually perpendiculars generators. • Students able to find the equation of Right circular cone. •Students know about Cylinder and its properties.
UNIT-V	Central coincoids, Paraboloids, plane sections of concoids, generating lines.	Student must be able to •Get an idea of central conicoids, parabola, and plane section of coincoids. • Understands the concept of generating lines.

B. Sc. II Year

Paper-I **ABSTRACT ALGEBRA**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Definition and basic properties of groups, subgroup, subgroup generated by subset, Cyclic groups and simple properties.	The course will enable the students to: • Group & its properties. • Subgroups, Cyclic groups and simple properties.
UNIT-II	Coset decomposition, Lagrange's theorem and its corollaries including Fermat's theorem, Normal subgroups, and Quotient groups.	• Use Lagrange's theorem to determine information about the order of a subgroup of a group and powers of elements of a group. •Understands Fermat's theorem •Explain the significance of the notions of cossets, normal subgroups, and Quotient groups. • Recall and use of definition & properties of cosets and subgroups.
UNIT-III	Homomorphism and Isomorphism of groups, fundamental theorem of homomorphism. Transformation and permutation group Sn (various subgroups of Sn, n<5 to be studied), Cayley's theorem.	• Understands the concepts of Homomorphism and isomorphism of groups. •definition of Permutation group and its subgroups. • Understands Cayley's theorem and its applications.
UNIT-IV	Group Automorphism, inner Automorphism, group of Automorphisms, Conjugacy relation and centraliser. Normaliser, Counting Principle, class equation of a finite group, Cauchy's theorem for finite abelian groups and non abelian groups.	• Understand definition of group Automorphism, inner Automorphism • How to define Conjugacy relation and centraliser. •Define Normaliser, Counting Principle • Understands Cauchy's theorem for finite abelian & non abelian groups.
UNIT-V	Definition and basic properties of Rings. Ring homomorphism, subrings, Ideals and Quotient rings, Polynomial rings & its properties, Integral domain and field.	The course will enable the students to: • Definition of Ring, subring & Ring homomorphism • Understands Ideals and Quotient rings. • Understands Integral domain and field.

B. Sc. II Year

Paper-II **ADVANCED CALCULUS**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Definition of a sequence, Theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, series of non negative terms, comparison test , Cauchy's Integral test, Cauchy's Root test, ratio tests, Raabe's tests, logarithmic tests, Alternating series, Leibnitz's test, Absolute and conditional convergence	• Understands the notions of limit of a sequence, bounded and monotonic sequences, Cauchy's convergence criterion. • Understands the convergence of a series of real numbers by comparison test , Cauchy's Integral test, Cauchy's Root test, ratio tests, Raabe's tests, logarithmic tests. •How to applied Leibnitz's test for alternating series. •To acquaint the student with mathematical tools available in Statistics needed in various field of science and engineering.
UNIT-II	Continuity of functions of single variable, sequential continuity. Properties of continuous functions. Uniform continuity, chain rule of differentiability, Mean value theorems and their geometrical Darboux's intermediate theorem for derivatives	The course will enable the students to: • Define continuity of functions of single variable and properties of continuous functions. • Understands sequential continuity , uniform continuity. • Applying Chain rule of differentiability. •Understand the consequences of various mean value theorems for differentiable functions.
UNIT-III	Limit and continuity of functions of two variables, Partial differentiation, Change of variable, Euler's theorem on homogeneous functions, Taylor's theorem for function of two variables, Jacobians.	• How to calculate the limit and examine the continuity of a function at a point. • Euler's theorem is very useful to proving complicated problem based on partial differentiation in simpler manner. • How to apply Taylor's theorem •Definition of Jacobians and it can be used to check variable are independent or dependent.
UNIT-IV	Envelopes, Evolutes, maxima and minima of functions of two variables, Lagrange's multiplier method, Beta and Gamma functions	• What is maxima and minima of function? How to find maxima and minima of functions of two variables. Finding maxima or minima also has important applications in linear algebra and game theory. •Derive relation between Beta and Gamma functions. • Evaluate integrals by using Beta and Gamma functions.
UNIT-V	Double and triple Integrals, volumes and surfaces of solid of revolution, Dirichlet's integrals, change of order of integration in double integrals	•Evaluation of Line, Double integral, Triple integrals and Change of variables in integral. • Apply double and triple integral to find Area, Volume, Total mass, Centre of gravity and Moment of inertia. • Understand to the Change the order of integration in double integral. It s very useful to compute the value of some difficult integral in easier manner.

B. Sc. II Year

Paper-II **DIFFERENTIAL EQUATIONS**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Series solution of differential equations, Power series method, Bessel and Legendre equations, Bessel and Legendre functions and their properties recurrence and generating function, Orthogonality of functions.	The course will enable the students to: •Find the series solution of differential equations for ordinary and regular singular points. • Bessel's and Legendre' functions generating function. • Orthogonality of functions.
UNIT-II	Laplace transformation, Linearity of Laplace transformation, Existence theorem for Laplace transform, Laplace transforms of derivatives and integrals, shifting theorems, differentiation and integration of transforms.	•Students enable to compute Laplace transforms using various properties. • Understands Existence theorem for Laplace transforms. • Differentiation and integration of transforms. • How to solve differential equations by using Laplace Transform. How to find transfer function of mechanical system, How to use Laplace Transform in nuclear physics as well as Automation engineering, Control engineering and Signal processing.
UNIT-III	Inverse Laplace transforms, convolution theorem, Application of Laplace transformation for solving initial value problems of second order linear differential equations with constant coefficients.	•How to apply inverse Laplace transform to solve differential equations. •Students can find inverse Laplace transform using convolution theorem of function which can be expressed as a product of two functions. •Inverse Laplace transformation and Fourier Transform which are used in various branches of engineering.
UNIT-IV	Partial differential equations of the first order, Lagrange's solution, some special types of equations which can be solved easily by methods other than the general method, Charpit's general method.	•How to form partial differential equations by eliminating arbitrary constant or functions. • Find the solution of First order linear partial differential equations (Lagrange's PDE). • Find the solution of First order non linear partial differential equations (Standard forms & Charpit's methods).
UNIT-V	Partial differential equation of second and higher orders, Classification of partial differential equations of second order, Homogeneous and non-homogeneous equations with constant coefficients, equation of vibrating string, heat equation Laplace's equation and their solutions.	The course will enable the students to: • Classify the PDE. •Solve Homogeneous and non-homogeneous equations with constant coefficients. • Learn the use of the separation of variable technique to solve partial differential equations relating to heat conduction in solids and vibration of solids in multidimensional systems.

B. Sc. III Year

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

Paper-I LINEAR ALGEBRA AND NUMERICAL ANALYSIS

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Definition and examples of Vector spaces, subspaces, sum and direct sum of subspaces, Linear span, Linear dependence, independence and their basic properties, Basis, Existence theorem for basis, Dimension, Finite dimensional vector spaces, existence of complementary subspaces of a subspaces of a finite dimensional vector space, Dimension of sum of subspaces, Quotient space and its dimension.	Student must be able to • know about vector spaces, subspaces, sum & direct space of subspaces. • How to check vectors are L.D. Or L.I. •know about Basis, Existence theorem. • Define FDVS, Quotient space and its dimension. • Linear and abstract algebra is one of the cornerstones of mathematics and it is at the heart of many applications of mathematics and statistics in the sciences and engineering.
UNIT-II	Linear transformations and their representation as matrices, Algebra of linear transformations, Rank-Nullity theorem, change of basis, dual space, bi-dual space and natural isomorphism, adjoint of a linear transformation, Diagonalisation, Bilinear, Quadratic and hermitian forms.	•Students understand linear transformations and their representation as matrices. • Applying Rank-Nullity theorem. • How to use Diagonalisation. •Bilinear, Quadratic and hermitian forms.
UNIT-III	Inner Product Space- Cauchy- Schwartz inequality, orthogonal vectors, orthogonal complements, orthogonal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process.	•Understands the definitions of inner product space • How to use Cauchy- Schwartz inequality • Recall Orthogonal vectors, orthogonal complements, orthogonal sets and bases. •Gram-Schmidt orthogonalization process.
UNIT-IV	Solution of Equations: Bisection, Secant, Regula-Falsi, Newton's Methods. Roots of second degree polynomial equations. Interpolation: Lagrange interpolation, Divided differences, Interpolation formula using Differences. Numerical Quadrature. Newton's-Cote's formulae, Gauss Quadrature formulae.	The course will enable the students to: •How to solve algebraic & transcendental equation numerical methods. • Understand the concepts of interpolation & how to use for equal & unequal intervals. • How to apply Newton's-Cote's, Gauss Quadrature formulae.
UNIT-V	Linear equations direct methods for solving systems of linear equations (Gauss elimination, LU decomposition, Cholesky decomposition), Iterative methods(Jacobi, Gauss Seidal reduction methods.). Ordinary differential equations: Euler's method, single step method, Runge-Kutt's method, Multistep methods, Milne Simpson method. Methods based on Numerical integration, Methods based on numerical diff.	•Understands various methods to solve systems of linear equations. •Iterative methods to solve systems of linear equations. •how to apply Numerical Method to solve ODE •Understands Numerical Integration •Understand Numerical Differentiation Understands the applications of numerical integration in various fields of science & engineering.

B. Sc. III Year

Paper-II **REAL AND COMPLEX ANALYSIS**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Riemann integral, Integrability of continuous and monotonic functions. The fundamental theorem of integral calculus. Mean value theorems of integral calculus, Partial derivatives and differentiability of real-valued functions of two variables. Schwarz's and Young's theorem. Implicit function theorem.	Student must be able to •Understands the Riemann integral. • The fundamental theorem of integral calculus. •Mean value theorems of integral calculus. • Understands Schwarz's and Young's theorem. Implicit function theorem.
UNIT-II	Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests. Frullani's integral as a function of a parameter. Continuity, derivability and Integrability of an integral of a function of a parameter. Fourier series of half and full intervals.	• Test the convergence of Improper integrals using Comparison tests, Abel's and Dirichlet's tests. • Continuity, derivability and Integrability of an integral of a function of a parameter. • Fourier series of half and full intervals.
UNIT-III	Definition and examples of metric spaces. Neighbourhoods. Limit points. Interior points. Open and closed sets. Closure and interior Boundary points. Subspace of metric space, Cauchy sequences, Completeness, Cantor's intersection theorem. Contraction principle, Real number as a complete ordered field. Dense subsets. Baire Category theorem. Separable, second countable and first countable spaces Continuous functions, Uniform continuity, Properties of continuous functions on Compact sets.	•Definition of metric space and subspace of metric space. • Known about Limit points. Interior points. Open and closed sets. • Define Cauchy's sequence and completeness. • Cantor's intersection theorem and Baire Category theorem. • understands Second countable and first countable spaces. • Definition of Continuous functions, Uniform continuity. •Properties of continuous functions on Compact sets.
UNIT-IV	Continuity and differentiability of complex functions. Analytic functions, Cauchy- Riemann equations, harmonic functions, Cauchy's Theorem, Cauchy's Integral formula.	• Understands concepts of continuity and differentiability of complex functions. • How to check function is analytic or not? •Evaluation of integrals using Cauchy's theorem & Cauchy's Integral formula.
UNIT-V	Power series representation of an analytical function, Taylor's series Laurent's series, Singularities, Cauchy's Residue Theorem, contours Integration.	• How to represents analytic functions as power series • Know about Taylor's, Laurent's series. • How to find singular point & Compute residue at which. •Evaluation of contours Integration using Cauchy's Residue Theorem.

B. Sc. III Year

Paper-III STATISTICAL METHODS

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	COURSE CONTENTS	COURSE LEARNING OUTCOMES
UNIT-I	Frequency distribution-Measures of central tendency, Mean, Median, Mode, G.M., H.M., Partition values, Measures of dispersion-Range, Interquartile range, Mean deviation, Standard deviation, Moments, Skewness and Kurtosis.	•How to compute & uses Measures of central tendency & Measures of dispersion •M.D. & S.D. •how to find Moments about mean & about origin. • Understands Skewness and Kurtosis.
UNIT-II	Probability- Event, Sample space, Probability of an event, Addition and multiplication theorems, Baye's theorem, Continuous Probability-Probability density function and its application for finding mean, mode, median and standard deviation of various continuous Probability distributions. Mathematical expectation, Expectation of sum and product of random variables, Moment generating function.	Students will be able to: • To understands the concepts of Probability. •Compute a conditional probability for an event. • Use Baye's theorem to compute a conditional probability. •Calculate the expected value of an event. • Apply the knowledge gained in Probability theory in Medical Sciences, Life Sciences and Engineering fields.
UNIT-III	Theoretical distribution- Bionomial, Poisson, rectangular and exponential distributions, their properties and uses.	•Understand theoretical distribution, their properties and uses. • Find the probability using Bionomial, Poisson distributions.
UNIT-IV	Methods of least squares, Curve fitting, co-relation and regression, partial and multiple correlations (upto three variables only),	Students will able to • Fit a straight line. •Calculate the correlation coefficient for the given data. • Compute regression lines for the given data.
UNIT-V	Sampling- Sampling of large samples, Null and alternative hypothesis, Errors of first and second kinds, Level of significance, Critical region, Tests of significance based on chi-square, t, F and Z-statistics.	•Understands Null and alternative hypothesis. •Errors of fist and second kinds. • level of significance, critical region •Tests of significance based on chi-square, t, F and Z-statistics. •The researcher apply Z-test, which is appropriate to test the existence of population mean difference in the case of large sample size and the t-test is for small sample size. Moreover, F-test is used for test of several mean and variance, while Chi-square test is for testing single variance, goodness of fit and independence.

Program Learning outcomes

M. Sc.

M.Sc. First Semester

Paper: Inorganic Chemistry I (MCH-401)

Unit	Course Content	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Stereochemistry and Bonding in Main Groups Compounds:	• Predict the geometries of anions, cations and neutral inorganic molecules through VSEPR. • Learn the methods to predict the geometries of polyatomic molecules. • Calculate binding energy through Walsh diagram. • This learning will help them to prepare for competitive examinations like CSIR-NET and SET also
Unit- II	Metal-Ligand Equilibrium in Solution	• Understand the formation and stability of complex in solution and factors affecting it. • Understand the chelate effect and its effect on stability. • Understand the role of potentiometry and spectrophotometry for the determination of formation constant.
Unit-III	Reaction Mechanism of Transition Metal Complexes	• Learn the mechanism of different kinds of reactions of metal complexes. • Understand the thermodynamic and kinetic lability and inertness. • Develop their critical thinking through the discussions of possible reaction mechanisms.
Unit- IV	Metal Ligand Bonding	• Apply the quantum mechanical approach to derive molecular orbitals from atomic orbitals. • Compare the MO diagrams for octahedral, tetrahedral and square planar complexes.
Unit-V	HSAB Theory	• Learn the different concepts of acids and bases and the basis of Hard and Soft Acid and Base theory. • Learn the stability of salts through HSAB theories.

Paper: Organic Chemistry I (MCH-402)

Unit	Course Content	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Nature of Bonding in Organic Molecules	• Learn about bonding in organic molecules. • Compare the stability among different systems. • Calculate resonance energy of different systems through HMO diagram. • Able to correlate the shielding and deshielding phenomena of NMR spectroscopy with aromaticity.
Unit- II	Stereochemistry	• Understand the enantiotopic and diastereotopic atoms, groups and faces. • Distinguish stereoselective and stereospecific synthesis. • Understand the role of stereoselective synthesis in drugs designing. • Determine optical activity in biphenyls, allenes and spiranes.
Unit-III	Conformational analysis and linear free energy relationship	• Know the conformational study of cycloalkanes and decalins. • Understand the effect of conformation on reactivity of a given group. • Learn the generation and stability of different intermediates.
Unit- IV	Reaction Mechanism: Structure and Reactivity	• Understand different types of reactions and mechanism. • Learn the methods of determining mechanism of reactions. • Utilize the knowledge of reaction mechanism to synthesize compounds at research or industrial level.
Unit-V	Aliphatic Nucleophilic Substitution	• Learn the mechanism and stereochemistry of different types of nucleophilic substitution reactions. • Predict the mechanism of unknown reaction and main product on the basis of knowledge of stability of intermediate formation • Understand the effect of solvent and nucleophile on the rate of substitution and neighboring group participation, which help them to synthesize the organic compounds at industrial level.

Paper: Physical Chemistry I (MCH-403)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Introduction to exact Quantum Mechanical results	• Explain the structure of molecules and spectroscopic behavior of atoms and molecules through quantum mechanical results
Unit- II	Approximate methods	• These methods are used when exact solutions of Schrödinger equations cannot be found.
Unit-III	Angular Momentum	• This learning will help the students to understand and measure the momentum of rigid bodies in rotation
Unit- IV	Classical Thermodynamics	• Understand the efficiency of engine, laws of thermodynamics in refrigeration and air conditioning, thermal power plants, nuclear power plants, solar wind geothermal.
Unit-V	Statistical Thermodynamics	• Use this knowledge in interpreting partition functions and in application of entropy relationships.

Paper: Group Theory & Spectroscopy I (MCH-404)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Symmetry and Group Theory in Chemistry	Various physical systems such as crystals and hydrogen atom can be modeled by symmetry groups.
Unit- II	Microwave Spectroscopy	Used in determining molecular structure, dipole moment, bond angle, bond length.
Unit-III	Infrared Spectroscopy	Apart from functional groups of the molecule this technique is used in quality control and dynamic measurements and in forensic analysis as well.
Unit- IV	Raman Spectroscopy	Rapid characterization and chemical composition and structure of given sample may be solid liquid gas or powder.
Unit-V	Molecular Spectroscopy Photoelectron Spectroscopy	Used in determining relative energies of atoms and molecules, elemental composition of materials and in characterization of bonding.

Paper: Mathematics for Chemists (MCH-405 (a))

(For students without mathematics in B.Sc.)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Vectors, Matrix Algebra	Use of vector will simplify higher mathematical equations. This learning will help in understanding the position, velocity and momentum of a particle.
Unit- II	Differential Calculus	Many chemical process and phenomena can be described by first order differential equation. Knowledge of different equation will help to understand various natural laws.
Unit-III	Integral Calculus	Scattering in quantum mechanics conformal mapping leads to creation of integral equation.
Unit- IV	Elementary Differential Equations	Knowledge of different equation will help to understand various natural laws.
Unit-V	Permutation and Probability	Permutation and combination helps in organic synthesis and in arrangement of objects in a definite order.

Paper: Biology for Chemists (MCH-405(b))

(For students without biology in B.Sc.)

Unit	**Course Content**	**Course/Learning outcomes**
Unit-I	Cell structure and functions	Cells provide structure for a body intake of nutrients for food and carry out important functions
Unit- II	Carbohydrates	Carbohydrates provide fuel for central nervous system and energy for muscles. Information about fat metabolism
Unit-III	Lipid	Lipids have major cellular function as structural components. Shock absorber to protect vital organs.
Unit- IV	Amino-acids, Peptides and Proteins	The important nutrition, fertilizers and food technology, used in drugs biodegradable plastics.
Unit-V	Nucleic Acids	Therapeutic use in making insulin in making cancer drugs and in forensic to identify DNA.

M.Sc. Second Semester

Paper: Inorganic Chemistry II (MCH-406)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Electronic Spectral Studies of Transition Metal Clusters	• Predict the electronic transitions occurring in the molecule through Orgel and Tanabe Sugano diagram. • Analyze the complexes showing d-d transitions and charge transfer spectra. • Discuss the electronic spectrum of given transition metal complex during research.
Unit- II	Magnetic Properties of Transition Metal Complexes	• Understand magnetic behavior of complexes. • Explain what anomalous magnetic moment is and what factors responsible for it. • Calculate spin only magnetic moment for various transition metal complexes.
Unit-III	Metal π-complexes	• Correlate the reactivity and properties of transition metal complex with their structure and bonding. • Elucidate the structural features through spectroscopic techniques. • Learn the industrial applications of organometallic compounds. • Utilize the knowledge of this organometallic chemistry at research level also.
Unit- IV	Metal Clusters	• Understand metal metal bonding. • Learn preparative methods of different metal clusters. • Learn various kinds of metal cluster reactions and stability of clusters on the basis of 18 electron rule. • Utilize knowledge of these methods at research and industrial level.
Unit-V	Optical Rotatory Dispersion and Circular Dichroism	• Learn about optical rotatory dispersion and circular dichroism curve. • Discuss cotton effect. • Assign absolute configuration of chiral

		coordination complexes.

Paper: Organic Chemistry II (MCH-407)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Aromatic Electrophilic Substitutions	• Understand that why aromatic compounds give electrophilic substitution reactions. • Write the mechanism of electrophilic substitution. • Learn about the different name reactions and application at research and industrial level.
Unit- II	Free Radical Reactions	• Predict the main products of free radical mechanism on the basis of reactivity and selectivity. • Learn about the different examples of neighbouring group assistance and bridgehead systems. • Discuss the stereochemistry of free radical reactions.
Unit-III	Addition Reactions	• Write the mechanism of *syn* and *anti* addition. • Understand the difference between regioselectivity and chemoselectivity. • Learn the mechanism of addition reaction on cyclic system and aromatic ring.
Unit- IV	Addition to Carbon- Hetero Multiple bonds	• Learn the applications of Grignard and other organometallic reagents in reaction mechanism. • Write the mechanisms of condensation reactions. • Know the application of condensation products at industrial level. • Identify that given reaction is substitution or elimination depending on substrate, reagents and conditions.
Unit-V	Pericyclic Reactions	• Differentiate among different kinds of pericyclic reactions and rules governing them. • Understand the orbital interaction and orbital symmetry of various kinds of pericyclic reactions. • Develop skills to solve the problems based on FMO approach.

Paper: Physical Chemistry II (MCH-408)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Chemical Dynamics	Understand chemical reaction kinetics in the form of mathematical models, in understanding ozone depletion food decomposition.
Unit- II	Surface Chemistry	In enzymatic reactions, in electronics, microchips used in computers, surface film coating.
Unit-III	Macromolecules	Learn the applications of plastics, fibers and elastomers
Unit- IV	Non-Equilibrium Thermodynamics	In biological system, protein folding unfolding and transport through membrane
Unit-V	Electrochemistry	Electrical batteries galvanic cell fuel cell lithium ion battery.

Paper: Spectroscopy II and Diffraction Methods (MCH-409)

Unit	**Course Content**	**Course/Learning outcomes:** After completion of course the students will be able to-
Unit-I	Nuclear Magnetic Resonance Spectroscopy	• Develop skills to correlate different NMR parameters such as chemical shift, coupling constant, splitting pattern with the molecular structure. • Interpret Simple NMR spectra of organic compounds. • This learning will enable the students to work on NMR spectrometer.
Unit- II	Nuclear Quadrupole Resonance Spectroscopy	• Understand the basic principle of NQR spectroscopy. • Learn the application for molecular structure determination as well as in drug development.
Unit-III	Electron Spin Resonance Spectroscopy	• Learn the hyperfine splitting and application of ESR spectroscopy in free radicals, inorganic and organic compounds having one electron and inorganic transition metal ions. • Apply the knowledge of this technique for those sample analysis where conventional magnetic technique fails. (in the field of medicines and research field)
Unit- IV	X-ray Diffraction	• Learn the application of crystallography in crystal structure analysis. • Utilize the knowledge in determination of particle size and structure of unknown compounds in research field and in validation of drugs in pharma industry.
Unit-V	Electron Diffraction	• Basic principle of electron diffraction techniques. • Learn the applications of electron diffraction method like TEM and SEM in surface structure determination. • Apply these techniques in solid state chemistry and research field especially in field of nanotechnology.

Paper: Computers for Chemist (MCH-410)

Unit	**Course Content**	**Course/Learning outcomes :** After completion of course the students will be able to-
Unit-I	Introduction to computers and computing	• To gain the basic knowledge of computers and functioning. • Understand the role of output, input devices and CPU. • Develop computational skills.
Unit- II	Computer Programming in FORTRAN/C/BASIC	• Learn programming languages like FORTRAN/C/BASIC • Role of FORTRAN and other programming in scientific computing.
Unit-III	Programming in Chemistry	• Different programming can be used for electronic structure calculation, to draw the structure, kinetics study and many more.
Unit- IV	Use of Computer Programs	• They will be able to write independent programs and correctly compile them. • To gain knowledge about different softwares related to chemistry, which help them in research studies.
Unit-V	Internet	• Work on different search engines for searching different programs on chemistry. • Hands on practice on MS office and other programs.

M. Sc. III Semester

Paper I: Application of Spectroscopy-I (MCH-501)

Unit	Topic	Outcome
Unit - 1	Electronic Spectroscopy	After studying this unit students will: • Understand the basics of electronic spectroscopy. • Understand the spectral properties of various electronic configurations of d-block transition metals. • Understand the applications of electronic spectroscopy for octahedral, tetrahedral etc. structures of complexes and molecules. • Use knowledge of electronic spectroscopy in further study and research work.
Unit - 2	Vibrational Spectroscopy	After studying this unit students will: • Learn basics of vibrational spectroscopy. • Understand symmetry and shapes of various molecules by using this technique. • Learn the mode of bonding in the complexes of various multidentate ligands. • Learn the applications of Raman spectroscopy. • The knowledge of vibrational spectroscopy and Raman spectroscopy is beneficial in further advanced study and research.
Unit - 3	Nuclear Magnetic Resonance Spectroscopy-I	After studying this unit students will: • Understand the basic concept of NMR. • Learn shielding and deshielding mechanism. • Understand the correlation of chemical shift with various functional groups and other nuclei. Study NMR spectroscopy will facilitate the students in advanced study and research work.
Unit - 4	Nuclear Magnetic Resonance Spectroscopy-II	After studying this unit students will: • Understand the chemical exchange and effect of deuteration. • Understand complex spin-spin interaction between more than one nuclei. • Learn coupling constant and its use in NMR interpretation. • Understand NMR shift reagents, solvent effects and NOE. • Unitize this knowledge in advanced study and research work.

Unit - 5	Mössbauer Spectroscopy	After studying this unit students will: • Understand basic principle and structural parameters of Mössbauer spectroscopy. • Learn the application of this technique in understanding bonding and structure of iron complexes. • Use this technique in understanding metal ligand bonding and coordination no. in tin complexes. • This unit will enhance the knowledge of students for the further advanced study and research.

Paper II: Photochemistry (MCH-502)

Unit	Topic	Outcome
Unit - 1	Photochemical Reactions	After studying this unit students will: • Understand the basics of photochemical reactions. • Enhance the knowledge of students for studying the photochemical reactions of various molecules. • Understand, why a photochemical reaction occurs and how the changes occur in the molecule in presence of light. • Use knowledge of photochemical reactions in further advanced studies and in research work.
Unit - 2	Determination of Reaction Mechanism	After studying this unit students will: • Learn to understand the basics of reaction mechanism of photochemical reactions. • Understand how to determine the rate constant for the photochemical reaction. • Able to learn the types of photochemical reactions. • Understand reactions and mechanism and apply them in the study of the photochemical reaction of alkenes, carbonyls, aromatic compounds etc. • The knowledge of reaction mechanismis beneficial in further advanced study and research.
Unit - 3	Photochemistry of Alkenes Photochemistry of Aromatic Compounds	After studying this unit students will: • Understand the reactions and mechanisms of alkenes in presence of light. • Learn photochemical rearrangements in this unit. • Also understand the isomerism in the aromatic compounds in presence of light. • Learn photochemical addition and substitution reactions of aromatic compounds.

Unit - 4	Photochemistry of Carbonyl Compounds	After studying this unit students will: • Understand the intermolecular and intramolecular reactions of carbonyl compounds in presence of light. • Learn photochemical rearrangements, cyclization and dimerization reaction. • Learn photochemical reactions of saturated and unsaturated compounds and their mechanisms. • Study of photochemistry of carbonyl compounds will facilitate the students in advanced study and research work.
Unit - 5	Miscellaneous Photochemical Reactions	After studying this unit students will: • Understand the mechanism of important photochemical reactions. • These reactions are important for advanced study as well as research work. • Pharmaceutical, chemical, pesticide etc. industries use photochemical reactions for the formation of their products. • This unit will enhance the knowledge of students for the further advanced, research and in industries.

Paper-III: Environmental Chemistry (MCH-503)

Unit	Topic	Outcome
Unit - 1	Atmosphere Atmospheric Chemistry Tropospheric Photochemistry	After studying this unit students will: • Understand earth's atmosphere, its layers, temperature, pressure, biogenomical cycle of carbon etc. and it will develop their thoughts and ideas about the environment. • Have better knowledge of atmospheric chemistry and will learn to connect chemistry with the environment. • Learn the chemistry happening in various layers of atmosphere. • Use this knowledge of atmospheric chemistry in further advanced study and research work.
Unit - 2	Air Pollution Acid Rain Stratospheric Ozone Depletion Greenhouse Effect Urban Air Pollution	After studying this unit students will: • Understand the causes of air pollution and it will develop their thoughts and awareness about it. • Learn the chemistry behind the acid rain its adverse effects on the environment. • Learn the chemistry of ozone depletion and understand its mechanism. • Understand that how to control ozone depletion and also learn about the greenhouse effect. • This unit will make students aware about air pollution and cultivate the idea of controlling it. • The knowledge of air pollution and its chemistry will also help in advanced studies and environmental research.
Unit - 3	Aquatic Chemistry and Water Pollution	After studying this unit students will: • Understand Biological oxygen demand and chemical oxygen demand. • Learn the chemistry behind the water pollution and its treatment. • Become aware of water pollution and give their efforts to minimize it. • Learn the techniques of treatment and purification of waste or polluted water. • Study of this unit will encourage students to develop new cost-effective techniques for the purification and treatment of polluted water.

		• Become interested in the advanced study and research in the field of environment chemistry.
Unit - 4	Environmental Toxicology Toxic Heavy Metals Toxic Organic Compounds Polychlorinated biphenyls Polynuclear Aromatic Hydrocarbons	After studying this unit students will: • Understand the toxic effects of heavy metals and toxic organic compounds. • Learn how these toxic metals and compounds are polluting water and soil. • Learn biochemical and damaging effects of various heavy metals. • Learn the sources and structures of various organic pollutants. • It will enhance the knowledge of students for the advanced study and environmental research work.
Unit - 5	Soil and Environmental Disasters	After studying this unit students will: • Understand the chemical composition of soil and micronutrients present in it. • Learn how the plastic, metal and fertilizers are polluting the soil and understand re-mediation of soil. • Understand world's biggest disasters caused by various chemicals and their effect on environment and living species. • It will enhance the knowledge of students for the further advanced study and research in soil science and environment.

Paper IV: Organotransition Metal Chemistry (MCH-504)

Unit	Topic	Outcome
Unit - 1	Alkyls and Aryls of Transition Metals Compounds of Transition Metal-Carbon Multiple Bonds	After studying this unit students will: • Learn the synthesis and chemistry of various organocopper compounds. • Understand the reactions and mechanism of low valent carbenes and carbynes of alkylidenes and alkylidynes. • Learn the use of low valent carbenes and carbynes in organic synthesis. • Use this knowledge of synthetic chemistry in advances study, pharmaceutical & chemical industries and in research.
Unit - 2	Transition Metal π-Complexes	After studying this unit students will: • Learn the synthesis of π-complexes of unsaturated organic molecules. • Understand the bonding and nature of transition metal π-complexes. • Learn the reactions and mechanisms of π-complexes. • The knowledge of transition metal π-complexes will be utilized in advances study, pharmaceutical & chemical industries and in research.
Unit - 3	Transition Organometallic Compounds	After studying this unit students will: • Understand the bonding and structural properties of transition metal boron compounds. • Learn the bonding and structural properties of transition metal silicon compounds. • Learn the chemistry and structural properties of hydrogen with bonds to transition metal. • Use this knowledge of synthetic chemistry in advances study, pharmaceutical & chemical industries and in research.
Unit - 4	Homogeneous Catalysis	After studying this unit students will: • Learn homogeneous catalytic reactions and polymerization reactions. • Learn the use of carbon monoxide as a homogeneous catalyst. • Learn hydrocarbonylation reactions and activation of C-H bonds. • Utilize this knowledge of synthetic chemistry in advanced study,

		pharmaceutical & chemical industries and in research.
Unit - 5	Fluxional Organometallic Compounds	After studying this unit students will: • Understand the fluxionality of various organometallic compounds. • Learn dynamic equilibrium in the organometallic compounds. • It will enhance the knowledge of students for further advanced study and research.

Paper V: Polymer (MCH-505)

Unit	Topic	Outcome
Unit - 1	Basics	After studying this unit students will: • Understand the basics concepts and importance of polymers. • Become familiar with the various type of polymers and their structures. • Understand the reaction and mechanism of polymerization. • It will enhance the knowledge of students for further advanced study.
Unit - 2	Polymer Characterization	After studying this unit students will: • Understand the concept of average molecular weight and viscosity average molecular weight. • Learn the practical significance of molecular weight. • Learnto measure molecular weight of a polymer by using various methods. • Utilize this knowledge of polymer characterization in in advanced study and polymer research.
Unit - 3	Analysis and Testing of Polymers	After studying this unit students will: • Learn to do chemical analysis of polymers. • Learn the use of spectroscopic methods and X-ray diffraction analysis for the testing and analysis of polymers. • Learn to analyze tensile strength, fatigue, impact, tear resistance etc. by using physical methods. • Utilize this knowledge of polymer analysis and testing in advanced study and polymer research.
Unit - 4	Inorganic Polymers	After studying this unit students will: • Understand the structure and classification of inorganic polymers. • Learn the structure, properties and applications of boron, boranes and carboranes. • Understand the structural properties and applications of silicon-based polymers. • It will enhance the knowledge of students for the advanced study and research in polymer and material chemistry.

Unit - 5	Structure, Properties and Application of Polymers	After studying this unit students will: • Understand the structural properties and applications of various phosphorous-based polymers. • Also learn the structure and properties of sulfur-based polymers. • Learn the synthesis, properties and applications of coordination polymers and metal chelate polymers. • Motivated for the further advanced study and research in the polymer and material chemistry.

M. Sc. Fourth Semester

Paper I: Application of Spectroscopy (MCH-511)

Unit	Topic	Outcome
Unit - 1	Ultraviolet and Visible Spectroscopy	After studying this unit students will: • Understand the basics of UV-Visible spectroscopy • Learn to derive structural information from the UV-Vis. Spectra of various molecules. • Understand the applications of this technique for various purposes. • The knowledge of ultraviolet and visible spectroscopy is beneficial in further advanced study and research.
Unit - 2	Infrared Spectroscopy	The students will acquire knowledge of: • Basics of IR Spectroscopy. • Become aware of starching and banding of various bonds. • Interpretation of organic and inorganic compounds using IR spectra. • Characterization of various molecules. • The knowledge of IR spectroscopy is beneficial in further advanced study and research.
Unit - 3	Nuclear Magnetic Resonance of Paramagnetic Substances in Solution	After studying this unit students will: • Understand the properties of paramagnetic substances using NMR. • Learn contact and pseudo contact shifts. • Learn applications of this technique for the biochemical systems. • Use this knowledge in further advanced study and research.
Unit - 4	Carbon-13 NMR Spectroscopy Two Dimensional NMR Spectroscopy	After studying this unit students will: • Understand the basics of carbon-13 NMR. • Learn to interpret C-13 NMR spectra of various molecules and use this technique for the characterization of the compounds. • Enquire the knowledge of coupling constant and its use. • Learn 2D NMR spectroscopic techniques like COSY, NOESY, DEPT, HMBC and HMQC. • Utilize this knowledge in further advanced study and research.

Unit - 5	Mass Spectrometry	After studying this unit students will: • Understand the basics and applications of mass spectrometry. • Enquire the knowledge of various fragmentation techniques. • Learn to interpret the mass spectra of different organic molecules and functional groups. • Learn structural elucidation of molecules using IR, UV-Vis, NMR and Mass spectrometric techniques. • Utilize this knowledge in further advanced study and research.

Paper II: Solid State Chemistry (MCH-512)

Unit	Topic	Outcome
Unit - 1	Solid State Reactions	The students will acquire knowledge of: • Basic principles and experimental procedure of solid state reactions. • Enhance the knowledge of students for studying the kinetics of solid state reactions. • Co-precipitation in solid state reactions. • Use knowledge in further advanced studies and in research work.
Unit - 2	Crystal Defects and Non-Stoichiometry	After studying this unit students will: • Understand the difference between perfect and imperfect crystals. • Learn various defects in the crystals. • Learn thermodynamics of Schottky and Frenkel defects. • The knowledge of crystal defects and non-stoichiometry is beneficial in further advanced study and research.
Unit - 3	Electronic Properties and Band Theory	The students will acquire knowledge of: • Insulators and semiconductors. • Learn band theory and structures of metal insulators and semiconductors. • Understand p-n junction and superconductors. • Learn optical properties and applications of electron microscopy. • Understand magnetic properties.
Unit - 4	Organic Solids	After studying this unit students will: • Understand the electrically conducting solids. • Learn about organic charge transfer complexes. • Learn new semiconductors. • Study of organic solids will facilitate the students in advanced study and research work.
Unit - 5	Liquid Crystals	After studying this unit students will: • Understand the properties and types of liquid crystals. • Learn about nematic and smectic phases of liquid crystals. • Understand LCD and its applications. • This unit will enhance the knowledge of students for the further advanced, research

		and in industries.

Paper-III: Biochemistry (MCH-513)

Unit	Topic	Outcome
Unit - 1	Metal Ions in Biological Systems Bioenergetics and ATP cycle Transport and Storage of Dioxygen	After studying this unit students will: • Understand the importance of bulk and trace metals present in the human body. • Learn ATP cycle and understand how metal complexes transfer energy in the biological system. • Understand the process of photosynthesis in detail. • Learn about the oxygen transportation and storage in the human body by metal complexes of iorn. • Use this knowledge further advanced study and research work.
Unit - 2	Electron Transfer in Biology Nitrogen Fixation	After studying this unit students will: • Understand the structure and functions of metal proteins. • Learn the synthetic model of iron-sulfur protein. • Understand biological nitrogen fixation and its mechanism. • Learn the chemical nitrogen fixation. • utilize knowledge of this unit in advanced studies and research.
Unit - 3	Enzymes Mechanism of Enzyme Action Kinds of Reactions Catalyzed by Enzymes	After studying this unit students will: • Understand chemical and biological enzyme catalysis process. • Learn enzyme kinetics. • Understand the mechanism of enzyme action. • Learn various reactions and their mechanism catalyzed by enzymes. • Learn isomerization and rearrangement reactions caused by enzymes. • Become interested in the advanced study and research in the field of enzyme catalysis.

Unit - 4	Co-Enzyme Chemistry Biotechnological Applications of Enzymes	After studying this unit students will: • Learn the structure and functions of coenzymes. • Learn the reactions catalyzed by the various cofactors. • Understand the host-guest chemistry. • Learn large scale purification and immobilization of enzymes. • Understand clinical uses of enzymes. • Applythis knowledge in advanced study and research work.
Unit - 5	Biological Cells and its Constituents Bioenergetics Biopolymer Interactions Cell Membranes and Transport of Ions	After studying this unit students will: • Learn structure and functions of various proteins. • Understand the structure and functions of DNA and RNA. • Understand free energy changes and hydrolysis of ATP in biological systems. • Understand the structure and functions of cell membranes. • It will enhance the knowledge of students for the further advanced study and research.

Paper IV: Analytical Chemistry (MCH-516)

Unit	Topic	Outcome
Unit - 1	Introduction	After studying this unit students will: • Learn analytical methods and types of instrumental analysis. • Understand the gravimetric and volumetric techniques of analysis in detail. • Learn calibration of glassware and sample preparation. • Learn precision and accuracy and types of errors. • Use this knowledge of analytical chemistry in advances study, pharmaceutical & chemical industries and in research.
Unit - 2	Food Analysis	After studying this unit students will: • Learn the analysis of moisture, ash, crude protein, fat, sodium, potassium etc. in food. • Learnto analyze contaminated food. • Learn the applications of HPLC and GC for food analysis. • Learn the use of TLC for the identification of chemical pesticides in food. • The knowledge of food analysis will be utilized in advances study, food industries& in research.
Unit - 3	Analysis of Water Pollution	After studying this unit students will: • Understand the types of water pollutants and their effect. • Learn to analyze turbidity, color, TDS, pH, conductivity, hardness etc. present in the water. • Acquire the knowledge of measuring DO, BOD and COD in water. • Learn to analyze pesticides present in water. • Use this knowledge of analysis of polluted water in advances study,chemical industries, pollution control board and in research.
Unit - 4	Analysis of Soil, Fuel, Body Fluids and Drugs	After studying this unit students will: • Learn to analyze moisture, pH, nitrogen, phosphate, sulfur, magnesia etc. present in the soil. • Learn to analyze liquid and gaseous fuels. • Understand the ultimate and proximate analysis of coal.

		• Understand and learn to analyze flash and fire point of various fuels. • Utilize this knowledge in advanced study, petroleum refineries, chemical industries and in research.
Unit - 5	Clinical Chemistry Drug Analysis	After studying this unit students will: • Understand the composition of blood and its prevention. • Learn the analysis of blood urea nitrogen, blood glucose, blood uric acid, albumin, globulins etc. • Learn the analysis of narcotics and dangerous drugs by TLC and spectrometric techniques. • It will enhance the knowledge of students for further advanced study, in narcotics department, clinical labs and in research.

Paper V: Medicinal Chemistry (MCH-518)

Unit	Topic	Outcome
Unit - 1	Structure and Activity	After studying this unit students will: • Understand the relation between chemical structure and biological activity. • Become familiar with the receptor theory and approach to drug design. • Understand QSAR-free-Wilson analysis. • It will enhance the knowledge of students for further advanced study.
Unit - 2	Pharmacodynamics	After studying this unit students will: • Understand the elementary treatment of enzymes stimulation andenzyme inhibition. • Understand the drug metabolism and its significant in medicinal chemistry. • Understand membrane active drugs and biotransformation. • Utilize this knowledge of pharmacodynamicsin advanced study and medicinal research.
Unit - 3	Antibiotics and Antibacterials	After studying this unit students will: • Understand antibiotics and antibacterials. • Learn synthesis, properties and activities of various antibiotics and antibacterials. • Learn about anticancer drugs. • Utilize this knowledge of antibiotics and antibacterialsin advanced study and medicinal chemistry research.
Unit - 4	Antifungal Antimalarial	After studying this unit students will: • Acquire knowledge of antifungal and antimalarial drugs. • Learn synthesis, properties and activities of various antifungal and antimalarial drugs. • Utilize this knowledge of antifungal and antimalarial in advanced study and medicinal chemistry research.
Unit - 5	Non-steroidal Anti-inflammatory Drugs Antihistamine and Antiasthmatic Agents	After studying this unit students will: • Understand non-steroidal and anti-inflammatory drugs like diclofenac sodium, Ibuprofen and Netopam. • Acquire knowledge of antihistamine and Antiasthmatic agents. • Learn structure, properties and activity of various antihistamine and Antiasthmatic agents.

		• Get motivated for the further advanced study and research in the medicinal chemistry.

Program- M. Sc. Mathematics

M. Sc. I Semester

Paper-I **ADVANCED ABSTRACT ALGEBRA – 1**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Automorphisms, Normal and subnormal series of groups, composition series, Jordan-Holder Theorem	Student must be able to •Define Automorphisms and prove that the set of all automorphism of G is a group under composition of maps. •Explain Normal and subnormal series of groups. •Define Composition series •State and prove Jordan- Holder Theorem
UNIT-II	Commutator subgroup, Solvable series and Solvable groups. Central series and Nilpotent groups.	• Explain Commutator subgroup • Define Solvable series and solvable groups • Understands Central series and Nilpotent groups.
UNIT-III	Extension fields, Roots of polynomials, Algebraic and transcendental Extensions, Splitting fields, Separable and inseparable Extensions.	•Understands Extension fields, roots of polynomials •Define Algebraic and transcendental Extensions •Define Splitting Fields, Separable and inseparable Extensions.
UNIT-IV	Perfect fields, Finite fields, Algebraically closed fields.	• Understands field, Perfect fields, Finite fields. • Define Algebraically closed fields.
UNIT-V	Automorphism of Extensions, Galois extensions, Fundamental theorem of Galois theory, Solution of polynomial equations by radicals, Insolvability of the general equation of degree 5 by radicals	• Define Automorphisms of Extensions •State and prove Fundamental theorem of Galois theory • Solution of polynomial equations by radicals. •Insolvability of the general equation of degree 5 by radicals

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

M. Sc. I Semester

Paper-II REAL ANALYSIS

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Definition and existence of Riemann-Stieltjes integral, Properties of integral, integration and differentiation, the fundamental theorem of Calculus.	• Integrate functions a real variable in the sense of Riemann – Stieltjes. •Understands Properties of integral. • Applications of Integration and differentiation. •State of the fundamental theorem of Calculus.
UNIT-II	Integration of vector valued functions, Rectifiable curves. Rearrangement of terms of a series, Riemann's theorem. Sequences and series of functions, pointwise and uniform convergence.	• Understands how to integrate vector valued functions. • State & Apply Riemann's theorem. •Understands the concept of pointwise and uniform convergence applied in Sequences and series of functions.
UNIT-III	Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's test for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem,	•Understands Cauchy criterion for uniform convergence and how to apply Weierstrass M-test, Abel's and Dirichlet's test for uniform convergence. •Relation Between uniform convergence and continuity. •Understands uniform convergence and differentiation •State Weierstrass approximation theorem.
UNIT-IV	Power series, Uniqueness theorem for power series, Abel's theorem, Functions of several variables, linear transformations, Derivatives in an open subset of R", chain rule, partial derivatives, interchange of the order of differentiation, derivatives of higher orders. Taylor's theorem,	•Able to understands theorems on Power series. •Define linear transformations. • Apply chain rule in partial derivatives •How to compute derivatives of higher orders. •State Taylor's theorem and use it in power series problems.
UNIT-V	Inverse function theorem, Implicit function theorem, Jacobians, Lagrange's multiplier method, Differentiation of integrals, Partitions of unity, Differential forms, Stoke's theorem.	•State the Implicit function theorem, Jacobians •How to compute Jacobians and its application to show variables are independent or dependent. •How to differentiate integral •How to apply Stoke's theorem.

M. Sc. I Semester

Paper-III TOPOLOGY-I

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Countable and Uncountable sets. Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic Schroeder-Bernstein theorem Cantor's theorem and the continuum hypothesis Zorn's lemma Well ordering theorem	•Understands Countable and Uncountable sets. •Definition of Infinite sets and the Axiom of Choice. •Cantor's theorem and the continuum hypothesis. •know about Zorn's lemma, Well ordering theorem.
UNIT-II	Defintion and examples of topological spaces Closed sets, Closure. Dense subsets, Neighbourhoods, Interior, exterior and boundary. Accumulation points und derived sets	•Define Topological spaces with examples. •Understand Closed sets, Closure. Dense subsets, Neighbourhoods •Interior, exterior and boundary. Accumulation points und derived sets
UNIT-III	Bases and sub bases. Subspaces and relative topology, Product Topology, Metric Topology, Continuous functions and homomorphism	• Definition of Bases and sub bases. • Knowledge about Subspaces and relative topology • Definition of Product Topology, Metric Topology •Theorems based on Continuous functions and homomorphism
UNIT-IV	First and Second Countable spaces, Covering and Lindelofs spaces, Separable spaces, second countability and Separability	•Understands the definition of First and Second countable spaces. •Know about Covering and Lindelofs spaces •Understands Separable spaces, second countability and Separability • known relation between them.
UNIT-V	Connected spaces, connectedness on real line, components, Path connectedness, locally connected spaces	•Understands definition of Connected spaces. • know about Connectedness on real line •Definition of Components, Path connectedness, locally connected spaces

M. Sc. I Semester

Paper-IV **COMPLEX ANALYSIS-I**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Complex integration Cauchy-Gorsat Theorem Cauchy's integral Formula. Higher Order derivatives.	Student must be able to • understand the concept of complex integration. • State and use Cauchy's theorem, Cauchy's integral Formula to evaluate the complex integral. • Higher Order derivatives.
UNIT-II	Morera's Theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of Algebra. Taylor's theorem.	•How to apply Morera's theorem, Cauchy's inequality. • State and use Liouville's theorem. • State and use The fundamental theorem of Algebra • Use Taylor's theorem for power series representation.
UNIT-III	Maximum modulus principle Schwarz lemma. Laurent's series. Isolated singularities, Meromorphic functions. The argument principle. Rouche's theorem inverse function theorem.	•State & apply Maximum modulus principle Schwarz lemma. •How to expand function using Laurent's theorem. •How to classify singularities and poles. •Explain the argument principle. •Rouche's theorem inverse function theorem.
UNIT-IV	Mobius Transformations. Fixed Points, Cross Ratio, Bilinear transformations, their properties and classifications. Definitions and Examples of Conformal mappings	•Students understand Mobius Transformations. Definition of Fixed Points, Cross Ratio, •What is Bilinear transformations, their properties and classifications. •Definition of and Examples of Conformal mappings. Use conformal mappings and know about meromorphic functions.
UNIT-V	Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to arg z, log z and z	• How to compute the residues and evaluate complex integrals using the residue theorem. • Understands Contour integration. • Definition of Branches of many valued functions.

Regular	Private
Theory Marks : 25 C.C.E. marks : 10 Practical Marks : 15	Theory Marks : 35 Practical Marks : 15

M. Sc. I Semester

Paper-V **PROGRAMMING IN 'C'-I (OPTIONAL)**

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	An overview of programming languages	Student must be able to • Understands programming languages and their purpose.
UNIT-II	Classification. C Essentials-Programs development, functions	•Understands C Essentials.
UNIT-III	Anatomy of Function. Variables and Constants Expressions. Assignment Statements. Formatting Source files. Continuation Character, the Pre-processor.	• How to differentiate between variables and constraints. •How to use them in functions.
UNIT-IV	Scalar Data types-Declarations, Different Types of integers. Different kinds of Integer Constants Floating-point type Initialization	• Students able to understands different data types used in C.
UNIT-V	Mixing types Explicit conversions-casts. Enumeration Types. the void data type, Typedefs. Pointers	• Able to understands data type other than basic data types. •How to types cost.

Paper-VI Comprehensive Viva- Voce 50 Marks.

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

M. Sc. II Semester

Paper-I **ADVANCED ABSTRACT ALGEBRA – II**

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Introduction to Modules, Examples, Sub-modules and direct sums, Examples of sub-modules, Quotient Modules, R-Homomorphism and Examples of R-Homomorphism	• Understands definition of Module, sub module and how prove their problems. •Definition of Quotient Modules. •Theorems based on the concept of homomorphism.
UNIT-II	Finitely generated modules. Cyclic modules, Simple modules, Schur's Lemma, Free modules	• Study different types of Modules and their relation between them. • State Schur's Lemma.
UNIT-III	Noetherian and Artinian modules and rings, Hilbert basis theorem.	• Understands definition of Noetherian and Artinian modules. • State Hilbert basis theorem and applications.
UNIT-IV	Uniform modules. Primary modules and Noether-Lasker theorem.	•Understands Uniform. Primary Modules. •Understands Noether-Lasker theorem and its uses.
UNIT-V	Algebra of linear transformations, Characteristic roots, Similarity of linear transformations, Invariant subspaces, Reduction to triangular forms, Nilpotent transformations, Index of nilpotency, Invariants of a nilpotent transformation, The primary decomposition theorem.	• Understands Algebra of linear transformations, Characteristic roots, Similarity of linear transformations • Procedure of Reduction to triangular forms. • Definition of Nilpotent transformations, Index of nilpotency. • How to show that Invariants of a nilpotent transformation. •State The primary decomposition theorem.

M. Sc. II Semester

Paper-II **LEBESGUE MEASURE AND INTEGRATION**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Lebesgue outer measure. Measurable sets, Regularity. Measurable functions. Borel and Lebesgue measurability. Non-measurable sets.	Students able to know about • Lebesgue outer measure. Measurable sets, Regularity. Measurable functions. • Results on Borel and Lebesgue measurability. • Define Non-measurable sets.
UNIT-II	Integration of Non-negative functions. The General integral. Integration of Series. Riemann and Lebesgue integrals.	•How to integrate Non-negative functions and understand Integration of Series. • Results based on Riemann and Lebesgue integrals.
UNIT-III	The Four derivatives. Functions of bounded variation. Lebesgue Differentiation Theorem. Differentiation and Integration.	•Understand the concept of functions of bounded variation. • Understands Lebesgue Differentiation Theorem. • Results of Differentiation and Integration.
UNIT-IV	The L^p spaces, Convex functions, Jensen's inequality, Hölder and Minkowski inequalities, Completeness of L^p.	• The L' spaces, Convex functions. • Understands Jensen's inequality, Hölder and Minkowski inequalities • How to apply Completeness of L
UNIT-V	Dual of space, Convergence in Measure, Uniform convergence and Almost uniform convergence.	•How to find Dual of space. •Convergence in Measure, Uniform convergence and Almost uniform convergence and their relation.

M. Sc. II Semester

Paper-III TOPOLOGY-II

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Separation axioms T_0, T_1, T_2, $T_3^{1/2}$, T_4, their characterization and basic properties. Urysohn's lemma. Tietze extension theorem.	Student must be able to • Sepration axioms and T_0, T_1, T_2,,$T_3^{1/2}$, T_4, their characterization • Understands Urysohn's lemma. • Understands Tietze extension theorem.
UNIT-II	Compactness. Continuous functions and compact sets. Basic properties of compactness, Compactness and finite intersection property. Sequentially and countably compact sets. Local Compactness and one point compactification. Stone-Cech compactification	•Students able to understands compactness, Sequentially and countably compact sets and their properties •Understands Local Compactness and one point compactification. •Stone-Cech compactification.
UNIT-III	Tychonoff product, Projection maps. Separation axioms and product spaces. Connectedness and product spaces Compactness and product spaces (Tychonoff Theorem). Embedding lemma and Tychonoff embedding	•Definition of Tychonoff product and product spaces. •Use Compactness and connectedness in product spaces. • Understands Embedding lemma and Tychonoff embedding.
UNIT-IV	First Nets and Filters. Topology and Convergence of nets. Hausdorffness and nets. Compactness and nets. Filters and their convergence. Canonical way of converting nets to Filters and vice versa. Ultrafilters and compactness	•Understands nets and filters and example •Understands Convergence of nets and filter. •Understands Ultrafilters and compactness.
UNIT-V	The fundamental group and covering spaces-Homotopy of paths. The fundamental group. Covering spaces. The fundamental group of the circle and the fundamental theorem of algebra.	Students able to •Homotopy of paths. •The fundamental group. Covering spaces. • The fundamental theorem of algebra.

M. Sc. II Semester

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

Paper-IV COMPLEX ANALYSIS-II

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Weierstrass' factorisation theorem. Gamma function and its properties Riemann Zeta function. Riemann's functional equation.	Student must be able to • Understands Weierstrass' factorisation theorem. • Gamma function and its properties. •Definition of Riemann Zeta function. •How to apply Riemann's functional equation.
UNIT-II	Runge's theorem. Mittag-Leffler's theorem. Analytic Continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation.	•Understands Runge's theorem. Mittag-Leffler's theorem. • Understand analytic continuation and uniqueness of direct analytic continuation. •How to check uniqueness of analytic continuation along a curve. and the method of power series of analytic continuation.
UNIT-III	Schwarz Reflection principle. Monodromy theorem and its consequences. Harmonic functions on a disk.	• Know about Schwarz Reflection principle. • Understands Monodromy theorem and its consequences. • Definition of Harmonic functions on a disk.
UNIT-IV	Harnack's inequality and theorem. Dirichlet problem. Green's function. Canonical products, Jensen's formula. Poisson - Jensen formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.	•Student able to understands Harnack's inequality and theorem. • Green's function. Canonical products. • Jensen's formula. Poisson - Jensen formula •Hadamard's three circles theorem. •Order of an entire function. Exponent of Convergence. •Borel's theorem. Hadamard's factorization theorem
UNIT-V	The range of an analytic function. Bloch's theorem. The little Picard theorem. Schottky's theorem. Montel Caratheodary and great Picard theorem. Univalent function. Bieberbach conjecture and the 1/4 theorem.	• The range of an analytic function. • Bloch's theorem. The little Picard theorem. Schottky's theorem. • Montel Caratheodary and great Picard theorem. Univalent function. Bieberbach conjecture and the 1/4 theorem.

M. Sc. II Semester

Regular	Private
Theory Marks : 25 C.C.E. marks : 10 Practical Marks : 15	Theory Marks : 35 Practical Marks : 15

Paper-V(iv) PROGRAMMING IN 'C'-II (OPTIONAL)

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Control Flow-Conditional Branching, the Switch Statement. looping, nested loops.	Student must be able to • Understands Control flow structure of programme using loops.
UNIT-II	The Break and Continue statement. the goto statement infinite loops.	•Students able to understands the use of Break and continue statement. • Understands the goto statement infinite loops.
UNIT-III	Operators and Expressions - Precedence and associatively. Unary plus and Minus operators. Binary Arithmetic operators, arithmetic assignment operators. Increment and decrement operators, Comma Operator, Relational operators, logical operators, bit-Manipulation operators, Bitwise assignment operators. Cast operators size of Operators, Conditional Operators, memory operator.	•Students able to understand all the types of Operators which can be used in C Programming.
UNIT-IV	Arrays and multidimensional Arrays. Storage Classes - fixed vs. Automatic Duration Scope, global variable	•Student must be able to understand different derived variables & storage classes.
UNIT-V	The Register Specificer Structures and Unions.	• Students Understands the Register Specificer Structures and Unions.

Paper-VI Comprehensive Viva- Voce 50 Marks.

M. Sc. III Semester

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

Paper-I INTEGRATION THEORY AND FUNCTIONAL ANALYSIS-I

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Signed measure. Hahn decomposition theorem, mutually singular measures, Radon Nikodim theorem. Lebesgue decomposition. Riesz representation theorem.	Students able to •Understands signed measure, mutually singular measure. • Understand Hahn decomposition theorem. • Understand Radon Nikodim theorem. •State Lebesgue decomposition. •Understand Riesz representation theorem.
UNIT-II	Outer measure, Extension theorem Caratheodory theorem, Lebesgue-Stieltjes integral, , Fubini's theorem.	• Understand Outer measure, product measures • Understands theorems related to them: Extension theorem, Caratheodory theorem & Fubini's theorem.
UNIT-III	Normed linear spaces. Banach spaces, Further properties of Normed Spaces, Finite dimensional Normed Spaces and Subspaces and Quotient Normed linear space.	•Understand Normed linear spaces, Completeness, Banach Space. • Understands Finite dimensional Normed Spaces and Subspaces. •Definition of Quotient Normed linear space.
UNIT-IV	Compactness and finite dimension, Linear Operators. Bounded and Continuous Linear Operators.	Students able to understands • Compactness and finite dimension • Linear Operators. • Bounded and Continuous Linear Operators.
UNIT-V	Linear Functionals, Linear Operators and functional on finite dimensional Spaces, Normed Spaces of Operators and Dual Space.	•Understands Linear Functionals, Linear Operators and functional on finite dimensional Spaces • Understands Normed Spaces of Operators and Dual Space.

M. Sc. III Semester

Paper-III (II(4)) **ADVANCED SPECIAL FUNCTION-I**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Gamma and Beta Functions: The Euler or Mascheroni Constant?, Gamma Function, A series For'(z) /Γ(z), Difference equation Γ (z+1)=z Γz.	Student must be able to • Understands Gamma and Beta Functions. • Mascheroni Constant?. •A series For'(z) /Γ(z), Difference equation Γ (z+1)=z Γz.
UNIT-II	Beta function, value of Γz. Γ(1-z), Factorial Function, Legendre's duplication formula, Gauss multiplication theorem	•How to find value of Beta function, value of Γz. Γ(1-z), Factorial Function •Legendre's duplication formula, •Gauss multiplication theorem
UNIT-III	Hypergoemetric and Generalized Hypergeometric functions: Function 2F1(a,b;c;z) A simple integral form evaluation of 2F1 (a, b;c;z)	•Understands Hypergoemetric and Generalized Hypergeometric functions, Function 2F1(a,b;c;z). •A simple integral form evaluation of 2F1 (a, b;c;z).
UNIT-IV	Contiguous function relations, Hyper geometrical differential equation and its solutions, F(a,b;c;z) as function of its parameters,	Students able to understands •Contiguous function relations. •Hyper geometrical differential equation and its solutions. •F(a,b;c;z) as function of its parameters.
UNIT-V	Elementary series manipulations, Simple transformation, Relations between functions of z and 1-z.	Students able to understands •Elementary series manipulations, Simple transformation, •Relations between functions of z and 1-z.

M. Sc. III Semester

Paper-IV(IV-1) **OPERATION RESEARCH-I**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Operations Research and its scope, Nature and Meaning of OR, Origin and Development of OR, Necessity of OR in Industry, Case studies of OR. Model in OR, Main Face of OR Uses and limitation of OR, Scope of OR, and role of OR in decision making.	After learning the contents of this unit the student must be able to • Origin & development of OR. •Necessity of OR in Industry, Case studies of OR. Model in OR, Main Face of OR. • Uses and limitation of OR, Scope of OR. •Role of OR in decision making. • It is used to find optimal or near optimal solutions to complex decision making problems. • It is used in finding maximum (of profit or yield) in real-world objective.
UNIT-II	Linear Programming Problem, Mathematical Formulation, Graphical Solution Method. Graphical Solution in some exceptional cases. Geometrical properties of L.P.P. General Formulation of L.P.P. Slack and Surplus Variables, Standard form of LPP. Assumptions in L.P.P. Limitation of L.P.P.	Student will be able to: • Understands the procedure to formulate LPP. • Graphical Solution Method. Graphical Solution in some exceptional cases. • Slack and Surplus Variables •Limitation of L.P.P.
UNIT-III	Linear Programming Problem -Simplex Method with exceptional cases, Computational procedure of simplex method, artificial variable techniques; Big M method, two phase Method, Problem of degeneracy.	Students able to Solve LPP •By simplex method artificial variable techniques; Big M method, two phase Method, Problem of degeneracy. • It is used in data envelopment. • It has strong ties to computer science and analytics.
UNIT-IV	Duality: Fundamental properties of Duality and Theorem of Duality.	• Understands fundamental properties of Duality. •Theorem of Duality.
UNIT-V	Transportation Problems, Initial Feasible Solution to T.P., North-West comer rule, Row minima, Colum Minima, Matrix Minima, VAM. Optimality test for the initial Feasible solution, Degeneracy in T.P., Assignment Problems Hungarian Method for assignment Problem and unbalanced assignment Problem.	• Solution of Transportation problem using North-West comer rule, Row minima, Colum Minima, Matrix Minima, and VAM. • How to apply optimality test for the initial Feasible solution, Degeneracy in T.P., • How to solve assignment Problems Hungarian Method for assignment Problem and unbalanced assignment Problem. OR is used in our daily life for example in decision making, in supermarket, in hospital management, Financial services, Govt policies, accounting, Construction, Finance, manufacturing, marketing, purchasing, R & D. etc.

M. Sc. III Semester

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

Paper-IV(4) INTEGRAL TRANSFORM-I (OPTIONAL)

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Application of Laplace Transforms	Student must be able to •Calculate the Laplace transform of standard functions both from the definition and by using tables. •Select and use the appropriate shift theorems in finding Laplace and inverse Laplace transforms. • Applications of Laplace transform, which are used in various branches of engineering.
UNIT-II	Laplace's equations,	Student must be able to •Laplace equations and its solution. •Learn the required conditions for transforming variable or variables in functions by the Laplace transform.
UNIT-III	Laplace's wave equation	Students able to understands • Laplace's wave equation and its solution under each cases. •Learn the application of Laplace transform in engineering analysis.
UNIT-IV	Application of Laplace Transforms	•How to use of available Laplace transform tables for transformation of functions and the inverse transformation. •Learn to use partial fraction and convolution methods in inverse Laplace transforms. •Application of Laplace transforms to solve ordinary and partial differential equations. •How to use of special functions in solving indeterminate beam bending problems using Laplace transform methods.
UNIT-V	Heat conduction equation.	•How to applied Laplace transforms to solve Heat conduction equation

M. Sc. III Semester

Paper-V(1) FUNDAMENTALS OF COMPUTER SCIENCE-I (OPTIONAL)

Regular	Private
Theory Marks : 25 C.C.E. Marks : 10 Practical Marks : 15	Theory Marks : 35 Practical Marks : 15

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Object Oriented Programming Paradigm, Basic Concepts, Benefits and Applications of Oriented Programming	After learning the contents of this unit the student must be able to •Object Oriented Programming Paradigm. •Basic Concepts, Benefits and Applications of Oriented Programming.
UNIT-II	C++ - Introduction, Tokens, Keywords, Identifiers and Constants, Basic Data Types, User-Defined Data Types, Derived Data Types, Variables, Operators in C++, Expressions, Implicit Conversions.	Students able to understands • How to write a simple program in C++. •Tokens, Keywords, Identifiers and Constants •Basic Data Types, User-Defined Data Types, Derived Data Types •Variables, Operators in C++, Expressions, Implicit Conversions.
UNIT-III	Operator Overloading. Operator Precedence, Control Structure. The if Statement. The switch Statement, The do...while Statement, The while Statement, The for statement.	Student able to understands • Operator overloading, Operator Precedence, Control Structure • know about Statements and uses.
UNIT-IV	Functions in C++, The main Function, Function Prototyping, Call by Reference, Inline Function, Function Overloading, Friend and Virtual Functions.	Student able to understands • Functions in C++ and their purpose.
UNIT-V	Classes and Objects: Specifying a Class, Defining Member Function, Nesting of Member Function, Private Member Functions, Arrays within a Class, Static Data Members, State Member Functions, Pointers to Members	Student able to understands • Classes and Objects.

Paper-VI Comprehensive Viva- Voce 50 Marks.

M. Sc. IV Semester

Paper-I **FUNCTIONAL ANALYSIS- II**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Hahn-Banach theorem, Hahn-Banach theorem for complex vector space and Normed spaces, Reflexive spaces, Category Theorem and Uniform boundedness theorem.	Students able to understands • Hahn-Banach theorem, Hahn-Banach theorem for complex vector space. • Definition & problem based on Normed spaces, Reflexive spaces. • Category Theorem and Uniform boundedness theorem.
UNIT-II	Strong and Weak convergence Open Mapping Theorem, Closed Linear Operators and closed Graph Theorem., Closed Range Theorem.	• Learnt Strong and Weak convergence •Understands Open mapping Theorem. • Understands Closed Graph theorem. • Understands Closed range theorem.
UNIT-III	Inner product spaces, Hilbert spaces, further properties of inner product spaces, Orthogonal complements and Direct Sums (Projection Operator)	• What is Inner product spaces, Hilbert space • Properties of IPS. •Definition of Orthogonal sums and direct sums.
UNIT-IV	Complete Orthonormal sets and Bessel's Inequality, Convergence Theorems and fourier coeifficients,total Orthonormal sets and sequences Parseval's Relation Riesz representation theorem	Students able to understands •Complete Orthonormal sets and Bessel's Inequality. •Convergence Theorems • Fourier coefficients •Total Orthonormal sets and sequences Parseval's Relation •Understands Riesz representation theorem
UNIT-V	Representation of Functionals on Hilbert space (Riesz theorem, Riesz representation). Hilbert adjoint operator, Self-adjoint operators, Unitary operators and Normal operators	Students able to understands •Riesz theorem •Definition of Hilbert adjoint operator, self adjoint operators •Unitary operators and Normal operators.

M. Sc. IV Semester

Paper-II (II(4))ADVANCED SPECIAL FUNCTION-II

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Bessel function and Legendre polynomials: Definition of Jn (z), Bessel's differential equation Generating function, Bessel's integral with index half and an odd integer.	After learning the contents of this unit the student must be able to • Bessel' differential equation and Generating function of Jn(x). • Express poly as Legendre polynomials. • Bessel's integral with index half and an odd integer.
UNIT-II	Generating function for Legendre polynomials Rodrigues formula, Bateman's generating function, Additional generating functions, Hypergeometric forms of Pn(X), Special properties of Pn(X), Some more generating functions, Laplace's first integral form, Orthogonality	Understands •Generating function of Legendre's polynomials. • Rodrigues formula. • Hypergeometic forms of Pn(x). •Orthogonality.
UNIT-III	Special properties of Pn(X), Some more generating functions, Laplace's first integral form, Orthogonality.	Students must be able to understands • Some special Properties of Pn(x) •Laplace's first integral form •Orthogonality
UNIT-IV	Definition of Hermite polynomials Hn(x), Pure recurrence relations, Differential recurrence relations, Rodrigue's formula, Other generating functions. Othogonality, Expansion of polynomials, more generating functions.	Understands the followings: •Hermite Polynomials Hn(x). •Recurrence relation. •Rodrigue's Formula. •Orthogonality.
UNIT-V	Laguerre Polynomials: The Laguerre Polynomials Ln(X), Generating functions, Pure recurrence relations, Differential recurrence relation, Rodrigue's formula, Orthogonal, Expansion of polynomials, Special properties, Other generating functions.	Understands the followings: •Laguerre Polynomials Ln(x). • Generating Functions. •Rodrigue's Formula. •Orthogonality. •Other generating function.

M. Sc. IV Semester

Paper-IV(IV-1) **OPERATION RESEARCH-II**

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Network analysis, constraints in Network, Construction of network, Critical Path Method(CPM) PERT, PERT Calculation, Resource Levelling by Network Techniques and advances of network (PERT/CPM).	After learning the contents of this unit the student must be able to • Network analysis, constraints of network • Critical Path method(CPM), PERT calculation • Resource Levelling by Network Techniques and advances of network
UNIT-II	Dynamic Programming - recursive equation approach, Characteristic of Dynamic Program ming, Computational procedure, Integer programming Gomory's all I.P.P.method, Branch and Bound Technique.	• Learnt about Dynamic Programming. • Understands Integer programming • How to apply Gomory's all I.P.P.method, Branch and Bound Technique.
UNIT-III	Game theory - Two person Zero-sum games, Maximix-Minimax principle, games without saddle points - Mixed strategies, Graphical solution of 2Xn and Mx2 Games. Solution by Linear Programming.	• Students learn about game theory, two person zero sum games. • Understands Maximix-Minimax principle •Games without saddle point •Graphical solution of 2Xn and MX2 games. • Solution of Linear Programming.
UNIT-IV	Non-linear programming: Mathematical Formulation, General Non-linear Programming Problems, Problems of Constrained Maxima and Minima (Kuhn-Tucker Condition). Non-negative Constraints.	•How to formulate non linear programming • Understands Kuhn- Tucker condition. • Understands Non-negative constraints.
UNIT-V	Quadratic programming: Wolfe's Modified Simplex method, Beale's Method, Separable programming, Convex programming, Separable programming algorithms.	Students able to understands • Wolfe's Modified, simplex method, Beale's Method for Quadratic programming. • Understands Scrabble programming. • Understands Convex programming.

M. Sc. IV Semester

Paper-IV(V-4) INTEGRAL TRANSFORM-II (OPTIONAL)

Regular	Private
Theory Marks : 40 C.C.E. marks : 10	Theory Marks : 50

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Application of Laplace Transform to Boundary Value Problems.	After learning the contents of this unit the student must be able to • various method to compute Laplace transform. • How to solve Boundary Value Problems by using Laplace transform.
UNIT-II	Electric Circuits. Application to Beams.	Students able to understands • Electric circuits • Application of beams.
UNIT-III	The complex Fourier Transform, Inversion Formula, fourier cosine and sine transform.	• What is definition of complex fourier transform? •How to apply Inversion formula. • How to compute fourier cosine and sine transform. •Application of Fourier transforms to solve differential and integral equation as well as many areas in science & Engineering.
UNIT-IV	Properties of Fourier Transforms, Convolution & Parseval's identity	Students able to Understands • Various properties of fourier transform. • Convolution theorem and its uses. • How to prove Parseval's identity.
UNIT-V	Fourier Transform of the derivatives, Finite Fourier Sine & Cosine Transform, Inversion Operational and combined properties Fourier Transform.	• How to compute fourier transform of derivative of function. • Finite fourier sine & cosine transform • Understands Inversion, Operational and combined properties.

M. Sc. IV Semester

Paper-V(VI-1) FUNDAMENTALS OF COMPUTER SCIENCE-II (OPTIONAL)

Regular	Private
Theory Marks : 25 C.C.E. Marks : 10 Practical Marks : 15	Theory Marks : 35 Practical Marks : 15

UNITS	PROGRAM CONTENTS	PROGRAM LEARNING OUTCOMES
UNIT-I	Inheritance, Single Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Templates including Class Templates.	After learning the contents of this unit the student must be able to • Inheritance, single. Multilevel, Multiple, Hierarchical, Hybrid Inheritance. • Templates.
UNIT-II	C++ Streams, C++ Stream Classes, put () and get() functions, getline() and write() Functions. Expressions, Implicit Conversions.	Learn how to use • C++ streams, write functions. • Expressions, Implicit conversions.
UNIT-III	Database Systems- Role of Database Systems, Database Systems Architecture.	Students understands: • Role of Database • Database systems architecture.
UNIT-IV	SQL- Basic Features including views, Integrity Constraints, Key, Functional dependency, Multivalued functional Dependency, Database Design- Normalization up to BCNF.	Students able to understands the concept of • SQL- Basic features. • Integrity key, functional dependency, multi -valued functional dependency. • Database design- normalization up to BCNF.
UNIT-V	Operating Systems-User Interface, Processor Management, memory management, Network and Distributed Systems.	After completion of this unit student must be able to: • Operating Systems-User interface • Memory management • Network and distributed Systems.