

Shri Yashwantrao Patil Science College Solankur

Programme Outcome 2020-21

Sr. No.	Degree Programme	Programme Outcomes
1.	B.Sc.	<p>Students taking admission to this program of B.Sc. are expected to get equipped with following outcomes:</p> <ul style="list-style-type: none"> <li>✓ Explaining the basic scientific principles and methods.</li> <li>✓ Inculcating scientific thinking and awareness among the student.</li> <li>✓ Ability to communicate with others in regional language and in English.</li> <li>✓ Ability to handle the unexpected situation by critically analyzing the problem.</li> <li>✓ Understanding the issues related to nature and environmental contexts and sustainable development.</li> </ul>
2.	M.Sc.	<ul style="list-style-type: none"> <li>✓ The M.Sc. analytical chemistry program at Shivaji University, Kolhapur provides the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry and particularly in analytical chemistry enabling them to interface not only with various branches of chemistry (organic, inorganic, physical, biological, industrial, environmental, pharmaceuticals etc) but also with the related fields, and for professional courses and areas of research including medical, forensic, food, agriculture, dental, law, intellectual property, business programs etc.</li> <li>✓ Students will be able to solve various problems by identifying the essential parts of a problem,</li> </ul>

		<p>formulate strategy for solving the roleplaying appropriate techniques to arrive at a solution, test the precision and accuracy of the solution and interpret the results.</p> <ul style="list-style-type: none"><li>✓ Students will be able to acquire domain specific knowledge and technical skills needed for employment in industries, teaching fields and pursue research. Students will be skilled in problem solving, critical thinking and analytical reasoning</li><li>✓ Students will be able to apply the fundamental knowledge to address the cross-cutting issues such as sustainable development</li><li>✓ Students will get perfect insight into qualitative and quantitative analytical chemistry and research ethics for production of quality research.</li><li>✓ Students will be able to communicate effectively i.e. being able to articulate, comprehend and write effective reports, make effective presentations and documentation and capable of expressing the subject through technical writing as well as through oral presentation.</li></ul>
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Sr No.	Subject	Programme specific outcome
1	Botany	<ul style="list-style-type: none"> <li>✓ Identifying different resources helpful for human life.</li> <li>✓ Identifying different groups of plants</li> <li>✓ Acquiring knowledge about inheritance, biochemical and metabolic activities.</li> <li>✓ Development of horticultural skill.</li> <li>✓ Acquiring knowledge about importance of environment.</li> </ul>
2	Chemistry B.Sc.	<ul style="list-style-type: none"> <li>✓ Creating interest in environmental issue.</li> <li>✓ Increasing working knowledge of instruments.</li> <li>✓ Obtaining the knowledge of pharmaceutical tables</li> <li>✓ Social awareness about the quality of water and soil .</li> <li>✓ Increasing the practical skill of the students.</li> <li>✓ Awareness about plastic garbage.</li> </ul>
	M.Sc. Chemistry	<ul style="list-style-type: none"> <li>✓ Students will be able to prepare and qualify subject specific competitive exams like NET, SET and GATE and also other general public administration exams like M.P.S.C. and U.P.S.C. etc. exams.</li> <li>✓ Student will be able to utilize the knowledge and analytical skills in QA-QC and R&amp;D departments in almost all the industries enabling them to secure jobs where analytical chemistry is the core requirement to ensure and ascertain the quality of the product.</li> <li>✓ Students will have opportunity for higher education leading to Ph.D. program.</li> <li>✓ Students will be able to explore contemporary research in chemistry and allied fields of science and technology, collaborate in team projects, communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.</li> <li>✓ Students can start their own laboratories/startups/ chemical industry/ business (entrepreneurship).</li> <li>✓ Students will be able to interpret data from the state of art Analytical instruments for ascertaining the product/material</li> </ul>
3	Mathematics	<ul style="list-style-type: none"> <li>✓ Ability to calculate and reason to design complex and critical financial models for Bank and Insurance Companies.</li> <li>✓ Ability to understand both concrete and abstract problems.</li> <li>✓ Ability to make critical observations.</li> <li>✓ Ability to accurately organize, analyze and interpret data.</li> </ul>
4	Physics	<ul style="list-style-type: none"> <li>✓ Identifying and describing physical systems with their professional knowledge.</li> <li>✓ Developing their scientific intuition, ability and techniques to tackle problems either theoretical or experimental in nature.</li> <li>✓ Knowledge of general physics like sound, wave, friction, forces and laws of motion and use of mathematics.</li> <li>✓ Information of electrical current, circuits, construction and the rise.</li> </ul>

		<ul style="list-style-type: none"> <li>✓ Learning about concepts of nuclear physics and nuclear energies and importance of their use for mankind.</li> <li>✓ Knowing about the light and its importance in life, its characteristics, properties and use in various instruments</li> </ul>
5	Statistics	<ul style="list-style-type: none"> <li>✓ Application of statistics in various walks of life.</li> <li>✓ Ability to apply various statistical tools to research problem.</li> <li>✓ Understanding how to collect, present, analyze and interpret the data.</li> <li>✓ Ability to analyze the data by using MS-Excel.</li> <li>✓ Knowing the statistical organization in India and Abroad.</li> <li>✓ Ability to build statistical knowledge.</li> <li>✓ Application of various distributions to real life situation.</li> </ul>
6	Zoology	<ul style="list-style-type: none"> <li>✓ Improving the knowledge about criteria for animal classification.</li> <li>✓ Study of salient features of chordates and non-chordates.</li> <li>✓ Improving the knowledge of animals about their special adaptations and evolutionary relationship.</li> <li>✓ Scientific study of their nature of habitat with environment.</li> <li>✓ Improving information about external morphology and anatomy of animals including human being.</li> </ul>

## B.Sc. Botany Programme Outcomes

**PO1. Knowledge and understanding of:** 1. The range of plant diversity in terms of structure, function and environmental relationships. 2. The evaluation of plant diversity. 3. Plant classification and the flora of Maharashtra. 4. The role of plants in the functioning of the global ecosystem. 5. A selection of more specialized, optional topics. 6. Statistics as applied to biological data.

**PO2. Intellectual skills – able to:** 1. Think logically and organize tasks into a structured form. 2. Assimilate knowledge and ideas based on wide reading and through the internet. 3. Transfer of appropriate knowledge and methods from one topic to another within the subject. 4. Understand the evolving state of knowledge in a rapidly developing field. 5. Construct and test hypothesis. 6. Plan, conduct and write a report on an independent term project.

**PO3. Practical skills:** Students learn to carry out practical work, in the field and in the laboratory, with minimal risk. They gain introductory experience in applying each of the following skills and gain greater proficiency in a selection of them depending on their choice of optional modules. 1. Interpreting plant morphology and anatomy. 2. Plant identification. 3. Vegetation analysis techniques. 4. A range of physiochemical analyses of plant materials in the context of plant physiology and biochemistry. 5. Analyse data using appropriate statistical methods and computer packages. 6. Plant pathology to be added for sharing of field and lab data abstained.

**PO4. Transferable skills:** 1. Use of IT (word-processing, use of internet, statistical packages and databases). 2. Communication of scientific ideas in writing and orally. 3. Ability to work as part of a team. 4. Ability to use library resources. 5. Time management. 6. Career planning.

**PO5. Scientific Knowledge:** Apply the knowledge of basic science, life sciences and fundamental process of plants to study and analyse any plant form.

**PO6. Problem analysis:** Identify the taxonomic position of plants, formulate the research literature, and analyse non reported plants with substantiated conclusions using first principles and methods of nomenclature and classification in Botany.

**PO7. Design/development of solutions:** Design solutions from medicinal plants for health problems, disorders and disease of human beings and estimate the phytochemical content of plants which meet the specified needs to appropriate consideration for the public health

**PO8. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and development of the information to provide valid conclusions.

**PO9. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern instruments and equipment's for Biochemical estimation, Molecular Biology, Biotechnology, Plant Tissue culture experiments, cellular and physiological activities of plants with an understanding of the application and limitations.

**PO10. The Botanist and society:** Apply reasoning informed by the contextual knowledge to assess plant diversity, its importance for society, health, safety, legal and environmental issues and the consequent responsibilities relevant to the biodiversity conservation practice.

**PO11. Environment and sustainability:** Understand the impact of the plant diversity in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO12. Ethics:** Apply ethical principles and commit to environmental ethics and responsibilities and norms of the biodiversity conservation.

**PO13. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO14. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO15. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO16. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **Course Outcomes**

### **Botany**

#### **B.Sc. Part-I, Semester-I**

##### **Paper-I: Diversity in Non vascular Plants**

On completion of the course, students are able to:

1. Understand the diversity among Algae.
2. Know the systematic, morphology and structure, of Algae.  
Understand the life cycle pattern of Algae.
3. Understand the useful and harmful activities of Algae.
4. Understand the Biodiversity of Fungi

5. Know the Economic Importance of Fungi
6. Understand the morphological diversity of Bryophytes.
7. Understand the economic importance of the Bryophytes.

**Paper II: Plant Biochemistry, Physiology and Ecology**

On completion of the course, students are able to:

1. Understand the Biochemical nature of cell.
2. Know the chemical nature of biomolecules.
3. Understand the different types of interaction in Biomolecules.
4. Structure and general features of enzymes.
5. Concept of enzyme activity and enzyme inhibition.
6. Learn about the movement of sap and absorption of water in plant body.
6. Understand the plant movements.

**Semester-II:**

**Paper-III: Diversity in Vascular Plants:**

On completion of the course, students are able to:

1. Understand the morphological diversity of Bryophytes and Pteridophytes and Gymnosperms.
2. Understand the economic importance of the Bryophytes and Pteridophytes and Gymnosperms.
3. Know the evolution of Bryophytes and Pteridophytes and Gymnosperms.
4. Understand the habit of the angiosperm plant body.
5. Know the vegetative characteristics of the plant.
6. Learn about the reproductive characteristics of the plant.
7. Understand the plant morphology and basic taxonomy.

**Paper IV: Cytology, Genetics and Utilization of Plants:**

On completion of the course, students are able to understand

1. The eukaryotic cell cycle and mitotic and meiotic cell division
2. Structure and organization of cell membrane
3. Process of membrane transport and membrane models
4. Mendelian and Neo-mendelian genetics
5. To study the phenomenon of dominance, laws of segregation, independent assortment of genes.
6. To understand the different types of genetic interaction, incomplete dominance, codominance, inter allelic genetic interactions, multiple alleles and quantitative inheritance etc.

**B.Sc. Part-II, Semester- III**

**Paper-V: Algae, Fungi, Bryophytes and industrial applications**

On completion of the course, students are able to:

- 1) Understand the diversity among Algae.
- 2) Know the systematic, morphology and structure, of Algae.
- 3) Understand the life cycle pattern of Algae.
- 4) Understand the useful and harmful activities of Algae.
- 5) Understand the Biodiversity of Fungi
- 6) Know the Economic Importance of Fungi
- 7) Understand the morphological diversity of Bryophytes.
- 8) Understand the economic importance of the Bryophytes.
- 9) Know the taxonomic position, occurrence, thallus structure, reproduction of Bryophytes.
- 10) Become aware of applications of different plants in various industries.
- 11) To highlight the potential of these studies to become an entrepreneur.
- 12) To equip the students with skills related to laboratory as well as industries based studies

**Paper-VI: Plant Physiology, Ecology and Horticulture**

On completion of the course, students are able to:

1. Know importance and scope of plant physiology.
2. Understand the plants and plant cells in relation to water.

3. Understand the process of photosynthesis in higher plants with particular emphasis on light and dark reactions, C<sub>3</sub> and C<sub>4</sub> pathways.
4. Understand the respiration in higher plants with particular emphasis on aerobic and anaerobic respiration.
5. Learn about the movement of sap and absorption of water in plant body
6. Understand the plant movements.

#### **B.Sc. Part-II, Semester-IV:**

##### **Paper VII: Pteridophytes, Gymnosperms, Angiosperms and Anatomy**

On completion of the course, students are able to:

1. Know the scope and importance of the discipline.
2. Understand plant communities and ecological adaptations in plants.
3. Know the concept of methodology in taxonomy.
4. Learn about conservation of biodiversity, Non-conventional Energy and Pollution.
5. Discover botanical regions of India and vegetation types of Maharashtra.
6. Understand Bioremediation, Global warming and climate change.

##### **Paper VIII: Cytogenetics and Utilization of Plant Resources**

1. On completion of the course, students are able to:
2. Gain knowledge about "Cell Science".
3. Understand Cell wall Plasma membrane, Cell organelles and cell division.
4. Learn the scope and importance of molecular biology.
5. Understand the biochemical nature of nucleic acids, their role in living systems, experimental evidences to prove DNA as a genetic material.
6. Understand the process of synthesis of proteins and role of genetic code in polypeptide formation
7. Understand the role plants in human welfare.
8. Gain knowledge about various plants of economic use.
9. Know importance of plants & plant products.
10. Understand the chemical contents of the plant products.
11. Know about the utility of plant resources.

#### **B.Sc. Part-III: Semester-V**

##### **Paper-IX: Biology of Non Vascular Plants and Palaeobotany.**

On completion of the course, students are able to:

- 1) Understand the diversity among Algae.
- 2) Know the systematic, morphology and structure, of Algae.
- 3) Understand the life cycle pattern of Algae.
- 4) Understand the useful and harmful activities of Algae.
- 5) Understand the Biodiversity of Fungi
- 6) Know the Economic Importance of Fungi
- 7) Understand the morphological diversity of Bryophytes.
- 8) Understand the economic importance of the Bryophytes.
- 9) Know the taxonomic position, occurrence, thallus structure, reproduction of Bryophytes.
- 10) Know the scope of Palaeobotany, types of fossils, its role in global economy and geological time scale.
- 11) Understand the various fossil genera representing different fossil groups.

##### **Paper – X: Genetics and Analytical Techniques in Plant Science.**

1. Understand the biochemical nature of nucleic acids, their role in living systems, experimental evidences to prove DNA as a genetic material.
2. Understand the process of synthesis of proteins and role of genetic code in polypeptide formation.
3. Know the details of Microscopy- Principles of light microscopy, electron microscopy (TEM and SEM).

4. Understand & perform Chromatography and cultural techniques in Botany.
5. Understand the methods used in Micrometry, Microtomy and Microphotography.

#### **Paper – XI: Fundamentals of Plant Physiology and Ecology**

On completion of the course , students are able to:

- 1) Learn and understand about mineral nutrition in plants.
- 2) Understand the growth and developmental processes in plants.
- 3) Know about Photosynthesis and Respiration in plants.
- 4) Understand the process of translocation of solutes in plants
- 5) Know the nitrogen metabolism and its importance.

#### **Paper XII: Plant Biochemistry**

- 1) Understand the properties of Monosaccharides, Oligosaccharides and Polysaccharides.
- 2) They will learn about the Significance of Carbohydrates.
- 3) Understand the Properties of saturated fatty acids, and unsaturated fatty acids.
- 4) Understand lipid metabolism in plants.
- 5) Understand the Beta Oxidation, Gluconeogenesis and its role in mobilization of fatty acids during germination.
- 6) They will learn about the Significance of lipids.
- 7) They will be able to understand Brief outline of biosynthesis of amino acid.
- 8) Understand the protein - structure and classification and protein biosynthesis in prokaryotes and eukaryotes.
- 9) They will learn about the nucleic acid metabolism.

#### **Semester VI**

#### **Paper – XIII Biology of Vascular Plants**

On completion of the course, students are able to:

- 1) Understand the diversity of Gymnosperms in India
- 2) Know the evolutionary trends and affinities of living gymnosperms with respect to external and internal features
- 3) Know the conceptual development of „taxonomy“ and „systematics“
- 4) Understand the Phylogeny of angiosperms -A general account of the origin of Angiosperms.
- 5) Understand the general range of variations in the group of angiosperms.
- 6) Trace the history of development of systems of classification emphasizing angiosperm taxa.
- 7) To learn the wide activities in angiosperm and trends in classification.
- 8) Learn about the characters of biologically important families of angiosperms.
- 9) Know the floral variations in angiosperm families, their phylogeny and evolution.
- 10) Understand various rules, principles and recommendations of plant nomenclature produces in plant identification.
- 11) Understand major evolutionary trends in various parts of angiosperm plants
- 12) Know the methods of pollination and fertilization.
- 13) Know fertilization, endosperm and embryogeny.
- 14) Understand the scope & importance of Anatomy.
- 15) Know various tissue systems.
- 16) Understand the normal and anomalous secondary growth in plants and their causes.
- 17) Perform the techniques in anatomy.
- 18) With respect to recent knowledge students should know about the different tools in the taxonomy so as to relocate the phylogenetic position of plant or taxa.

#### **Paper – XIV- Microbiology and Plant Pathology:**

On completion of the course, students are able to:

- 1) Understand the concept, principle and types of sterilization methods.
- 2) Know the concept and characteristics of antiseptic, disinfectant and their mode of action.



- 3) Know the cultivation methods of bacteria, yeast, fungi and virus.
- 4) Principle, working and applications of instruments viz, pH meters, spectrophotometer, centrifuge, viscometer, and laminar air flow.
- 5) Understand the Microbial Genetics and Recombination in Bacteria.
- 6) Know the terminologies in plant pathology.
- 7) Understand the scope and importance of Plant Pathology.
- 8) Know the prevention and control measures of plant diseases and its effect on economy of crops.

**Paper – XV: Plant breeding, Biostatistics, Ethnobotany and Horticulture**

On completion of the course, students are able to:

1. Understand the science of plant breeding.
2. To introduce the student with branch of plant breeding for the survival of human being from starvation.
3. To study the techniques of production of new superior crop varieties.
4. Understand the modern strategies applied in Genetics and Plant Breeding to sequence and analyse genomes
5. Get the detail knowledge about modern strategies applied in Plant Breeding for crop improvement i.e. Mass selection, Pure line Selection and Clonal selection.
6. Know about exploitation of Heterosis, hybrid and variety development and their release through artificial hybridization.
7. Understand the role plants in human welfare and various plants of economic use. 11. Know about the utility of plant resources.

**Paper – XVI Molecular Biology and Biotechnology:**

On completion of the course, students are able to Understand

- 1) Know about the genomic organization of living organisms, study of genes genome, chromosome etc.
- 2) Gain knowledge about the mechanism and essential component required for prokaryotic DNA replication.
- 3) Understand the fundamentals of Recombinant DNA Technology.
- 4) Know about the Genetic Engineering.
- 5) Understand the principle and basic protocols for Plant Tissue Culture.
- 6) The concept of operon and its structure and regulation.

## Course Outcomes

### Chemistry

#### B.Sc.-I: Semester- I and II

**Inorganic Chemistry: (Paper- I)**

Course Outcome	By the end of this Course students are:
CO-1	Getting to know the structure of atoms and their principles, details of periodic table.
CO-2	Knowing various types of ionic bond and ionic compound study.
CO-3	Knowing study of Molecular orbital Theory.

**Organic Chemistry: (Paper-II)**

Course Outcome	By the end of this Course students are:
CO-1	Understanding the fundamentals of Organic Chemistry.
CO-2	Imparting the knowledge of stereochemistry of different organic compounds among the students.

CO-3	Studying aromaticity, electrophilic substitution reactions and their mechanism
CO-4	Knowing various method of preparation and chemical reaction of cyclo alkane, cyclo alkene and alkadiene.

### Physical Chemistry (Paper –III)

Course Outcome	By the end of this Course students are:
CO-1	Impart knowledge regarding chemical thermodynamics and feasibility, direction and equilibrium condition of reactions.
CO-2	Understanding mechanism of reaction and to get optimum conditions for a reaction by utilising the study of Chemical Kinetics.

### Analytical Chemistry: (Paper-IV)

Course Outcome	By the end of this Course students are:
CO-1	Provide a basic understanding of the principles, instrumentation and applications of chemical analysis.
CO-2	Study various chromatographic techniques like paper, thin layer, column, and gas chromatography.
CO-3	Impart basic knowledge regarding titrimetric analysis.
CO-4	Making aware about water and fertilizer analysis.

## B.Sc.-II: Semester- III and IV

### Physical Chemistry (Paper –V)

Course Outcome	By the end of this Course students are:
CO-1	Understanding mechanism of reaction and get optimum conditions for a reaction by utilising the study of Chemical Kinetics.
CO-2	Making students capable of understanding redox reactions and to construct electrochemical cells. learn various laws of electrochemistry and their applications.
CO-3	Study the properties of liquids like surface tension, viscosity, refractive index and their experimental determination.
CO-4	Know about surface phenomena like adsorption w.r.t. its characteristics, determination and applications.

### Industrial Chemistry: (Paper-VI)

Course Outcome	By the end of this Course students are:
CO-1	Providing a basic understanding of the principles, instrumentation and applications of chemical analysis.
CO-2	Studying various chromatographic techniques like paper, thin layer, column, and gas chromatography electrochemistry and their applications.
CO-3	Explaining the difference between classical and industrial chemistry, unit operations, unit processes, flow sheets etc. Knowing the process of corrosion and how to deal with it by using electroplating.
CO-4	Getting familiar with the industrial process with respect to paper industry, soaps and detergents etc.

**Inorganic Chemistry: (Paper-VII)**

Course Outcome	By the end of this Course students are:
CO-1	Knowing study of 14 elements in the periodic table.
CO-2	Knowing the Studying of electronic configuration, oxidation state, colour spectra, and magnetic properties.
CO-3	Knowing about the study of solving energies of the metals, semiconductors and superconductors.
CO-4	Knowing the study of various organ metallic compounds is very useful in various fields like agriculture, pesticides, and pharmaceuticals.

**Organic Chemistry :(Paper- VIII)**

Course Outcome	By the end of this Course students are:
CO-1	Imparting knowledge about the synthesis, reactivity and applications of carboxylic acids.
CO-2	Knowing amines and diazonium salts with respect to classification, preparation and applications.
CO-3	Understanding the nomenclature and reactivity of aldehydes, ketones. Learning the basic knowledge of conformational analysis of organic compounds.
CO-4	Studying the classification, configuration and structure of carbohydrates.

**B.Sc. Part-III: Semester-V and VI****Physical Chemistry :( Paper-IX)**

Course Outcome	By the end of this Course students are:
CO-1	Making students capable of understanding redox reactions and to construct electrochemical cells and learning various laws of electrochemistry and their applications.
CO-2	Imparting the concepts of quantum mechanics, like Schrodinger equation and quantum numbers.
CO-3	Learning about interaction between radiation and matter which leads to molecular spectroscopy.
CO-4	Understanding various laws of photochemistry and photophysical processes.

**Inorganic Chemistry: (Paper-X)**

Course Outcome	By the end of this Course students are:
CO-1	Knowing the study of electronic configuration, oxidation state, colour spectra, and magnetic properties.
CO-2	Studying of co-ordination chemistry needs an understanding of the different terms used further topic covers Werner's theory, EAN, VBT, VSEPR, CFSE, and MO theory.
CO-3	Knowing the study of catalyst, non-aqueous solvents and chelation.

**Organic Chemistry :(Paper- XI)**

<b>Course Outcome</b>	<b>By the end of this Course students are:</b>
CO-1	Studying about introduction to spectroscopy. Understanding IR Spectroscopy and its application.
CO-2	Imparting the knowledge of UV, Visible spectroscopy and its application
CO-3	Studying NMR Spectroscopy and its application. Studying NMR Spectroscopy and its application.
CO-4	Solving combined spectroscopic problems

**Industrial Chemistry: (Paper-XII)**

<b>Course Outcome</b>	<b>By the end of this Course students are:</b>
CO-1	Studying various chromatographic techniques like paper, thin layer, column, and gas chromatography.
CO-2	Imparting basic knowledge regarding titrimetric analysis.
CO-3	Getting familiar with the industrial process with respect to sugar industry, soaps and detergents, heavy chemicals production industries etc.
CO-4	Getting introduction, the nano materials with respect to preparation, characterisation, and applications.

**Physical Chemistry: (Paper-XIII)**

<b>Course Outcome</b>	<b>By the end of this Course students are:</b>
CO-1	Understanding mechanism of reaction and get optimum conditions for a reaction by utilising the study of Chemical Kinetics.
CO-2	Knowing about surface phenomena like adsorption w.r.t. its characteristics, determination and application.
CO-3	Getting the knowledge about Phase equilibria, w.r.t. one, two and three component systems. study crystal structure by using Bragg's equation.
CO-4	Developing practical skill regarding chemical kinetics and get acquaint to handle various instruments like potentiometer, conductometer, refractometer, colorimeter, pH meter, viscometer, stalagmometer etc.

**Inorganic Chemistry: (Paper-XIV)**

<b>Course Outcome</b>	<b>By the end of this Course students are:</b>
CO-1	Knowing the various types of reaction mechanism of the inorganic co-ordinated compounds.
CO-2	Knowing that some biological role of alkali and alkaline earth metals, Hb, Mb, and some enzymes.
CO-3	Coming to know that manufacturing process of iron and steel and study of various methods.
CO-4	Knowing that nuclear energy may be boon and bane and know the radioactivity elements in the series of actinides.

**Organic Chemistry: (Paper- XV)**

<b>Course Outcome</b>	<b>By the end of this Course students are:</b>
CO-1	Making students capable of understanding Name reactions and their mechanism.

CO-2	Studying the applications of different reagents in organic synthesis.
CO-3	Knowing about pharmaceutical chemistry and study of different drugs.
CO-4	Understanding the knowledge of electrophilic addition to carbon-carbon double and triple bond compounds.

#### **Analytical Chemistry: (Paper-XVI)**

<b>Course Outcome</b>	<b>By the end of this Course students are:</b>
CO-1	Studying various chromatographic techniques like paper, thin layer, column, and gas chromatography.
CO-2	Imparting basic knowledge regarding titrimetric analysis.
CO-3	Learning about analytical techniques like potentiometry, conductometry, flame photometry, colorimetry, spectrophotometry, etc.
CO-4	Knowing about pharmaceutical chemistry and study of different drugs.

### **Program Specific Outcomes**

#### **Mathematics**

- Students gain a sound knowledge in foundational subjects related to pure and applied mathematics.
- Acquire various skills related to computational techniques and related software's.
- Learn to identify various areas of science, technology, industry etc. where the knowledge and skill imparted to them can be useful.
- To be able to select a specific problem from real life scenario as per liking of a student and his/her skill sets and knowledge.
- Being able to analyse the problem and propose a solution method and finalise the solution and the process of solution in consultation with the peer group and faculty.

#### **Course Outcomes**

#### **Mathematics**

#### **B.Sc. Part -I Semester – I and II**

##### **Theory paper I (DSC 5A): Differential Calculus**

- Students acquaint themselves with the idea of complex numbers.
- Learn algebraic and geometric properties of complex numbers.
- Understand Meaning and significance of Hyperbolic functions and their relation with circular functions.
- Learn the process of successive differentiation of standard functions.
- Get to know the significance of Leibnitz's theorem.
- Understand the concept of partial differentiation and learn to apply it for various problems in science and engineering.

##### **Theory paper II (DSC 6A): Calculus**

- Students grasp the concept of mean value theorems and its significance.
- Acquire the skill of applying Taylor's theorem for computation of power series expansions of functions.

- Study the special case of Taylor's expansion viz. Maclaurin Series and its practical use in computing values of standard transcendental functions.
- Learn the meaning and significance of Indeterminate forms and learn to apply it for various indeterminate limiting cases.

### **Theory paper III (DSC 5B): Differential Equations**

- Understand the meaning, motivation and significance of differential equations.
- Learn the classification of differential equations.
- Concept of order and degree is studied with examples.
- Learn how to form and solve first order first degree ordinary differential equations.
- Learn the methods of solving equations of first order and higher degree.
- Getting acquainted with operator formalism. Solving higher order ordinary linear linear differential equations.
- Study the homogeneous linear differential equations with constant coefficients and learn the method of solution.

### **Theory paper IV (DSC 6B): Higher order Ordinary Differential Equations and Partial Differential equations.**

- Study the method of solution of general second order differential equation with variable coefficients.
- Understand the concept, formation, and method of solution of ordinary simultaneous equations.
- Understand the concept of total differential equation, learn the method of formation and method of solution of total differential equations.
- Study the motivation and concept of partial differential equations. Learn methods of solving Lagrange's equation and Charpit's method.

### **Practical Semester – I and II (Combined)**

#### **Practical Paper I (CCPM-I) (Core Course Practical in Mathematics I)**

- Students get acquainted with the field of numerical computational methods and various areas covered within the subject of numerical computations with a bird's eye view of applications.
- Learn to use electronic calculators and computers for simple calculations of algebraic and transcendental functions that are frequently required in science and technology.
- To carry out supervised learning of problem solving based on theory covered in theory papers.
- Teacher gets to know student specific queries / difficulties and helps students solve their individual problems with personal attention.

### **B.Sc. Part -II Semester –III AND IV**

#### **Theory paper V (DSC 5C): Real Analysis – I**

- Learning basic concepts of set theory.
- To learn the concept of relation and function and apply it to specific problems.
- Study the principle of mathematical induction and apply it for proving results.
- Acquire the concept of countability and determine countable and uncountable sets.
- Learn the fundamental properties of real numbers.

### **Theory paper VI (DSC 6C): Algebra – I**

- Understanding of the concept of Hermitian and Skew-Hermitian Matrix and their properties.
- Grasp the concept of normal form and convert given matrix to Normal form.
- Learn the concept of Eigen value and Eigen vector. To find Eigen values and Eigen vectors.
- Grasp Cayley – Hamilton theorem and use it for finding inverse of a matrix.
- Learn elements of group theory and be able to determine if given set with given operation is group or not.

### **Theory paper VII (DSC 5D): Real Analysis – II**

- Learn fundamental concept of sequence of real numbers with examples.
- Study the concept of monotonic and bounded sequences.
- Understand Epsilon-Delta concept of convergence of a sequence.
- Learn the concept of series and its convergence.
- Study the methods of testing convergence of series.

### **Theory paper VII (DSC 6C): Algebra – II**

- Understand the concept of Cosets.
- Learn the meaning of Normal subgroups of a group with examples.
- Study the concept of a Permutation group with examples.
- Learn the concept of a Ring structure with examples.

### **Practical Semester – III and IV (Combined)**

#### **Practical Paper II (CCPM-II): Algebra I, II and Analysis I, II**

- Learn to solve linear systems of equations by Gauss-Elimination, Gauss-Jordan, Gauss- Jacobi and Gauss-Seidel methods manually with use of electronic calculators.
- Learn root finding methods viz. Newton-Raphson method, Bisection method.
- Learn methods for evaluating numerical values of integrations using trapezoidal rule, Simpson's 1/3 rd. rule, Simpson's 3/8 th rule.
- Learn to solve 1st order ODE with Euler's and modified Euler's method.

#### **Practical Paper III (CCPM-III): Numerical Recipes in Scilab**

- Learn the basic keywords of C programming language and practice them in computer lab.
- Studying basic data types and input output methods in C and practice it in computer laboratory
- Learn Basic constructs of C Language programming like comparison, decision making, loop structures, system and user defined functions and practice based on it in computer laboratory.
- Apply the knowledge of C programming for preparing C programs for the solution of various numerical methods learned in the paper CML-II

### **B.Sc. Part III Semester V and VI**

#### **Theory paper IX (DSE E9): Mathematical Analysis**

- Students able to understand the integration of bounded function on a closed and bounded interval.
- Study some of the families and properties of Riemann integrable functions.
- Learn the applications of the fundamental theorems of integration.

- To understand the extension of Riemann integral to the improper integrals.
- Studying expansion of functions in Fourier series and half range Fourier series.

### **Theory paper X (DSE E10): Abstract Algebra**

- Learn basic concepts of group and rings with examples
- Able to identify whether the given set with the compositions form Ring, Integral domain or field.
- Understand the difference between the concepts Group and Ring.
- Apply fundamental theorem, Isomorphism theorems of groups to prove these theorems for Ring.
- Understand the concepts of polynomial rings, unique factorization domain.

### **Theory paper XI (DSE E11): Optimization Techniques**

- Provide student basic knowledge of a range of operation research models and techniques, which can be applied to a variety of industrial and real life applications.
- Formulate and apply suitable methods to solve problems.
- Identify and select procedures for various sequencing, assignment, transportation problems.
- Identify and select suitable methods for various games.
- To apply linear programming and find algebraic solution to games.

### **Theory paper XII (DSE E12): Integral Transforms**

- Understand concept of Laplace Transform.
- Apply properties of Laplace Transform to solve differential equations.
- Understand relation between Laplace and Fourier Transform.
- Understand infinite and finite Fourier Transform.
- Apply Fourier transform to solve real life problems.

### **Theory paper XIII (DSE F9): Metric Spaces**

- Acquire the knowledge of notion of metric space, open sets and closed sets.
- Demonstrate the properties of continuous functions on metric spaces.
- Apply the notion of metric space to continuous functions on metric spaces.
- Understand the basic concepts of connectedness, completeness and compactness of metric spaces.
- Appreciate a process of abstraction of limits and continuity to metric spaces

### **Theory paper XIV (DSE F10): Linear Algebra**

- Understand notion of vector space, subspace, and basis.
- Understand concept of linear transformation and its application to real life situation.
- Work out algebra of linear transformations.
- Appreciate connection between linear transformation and matrices.
- Work out eigen values, eigen vectors and its connection with real life situation.

### **Theory paper XV (DSE F11): Complex Analysis**

- Learn basic concepts of functions of complex variable.
- Be introduced to concept of analytic functions.
- Learn concept of complex integration and basic results thereof.
- Be introduced to concept of sequence and series of complex variable.
- Learn to apply concept of residues to evaluate certain real integrals.



### **Theory paper XVI (DSE F12): Discrete Mathematics**

- Use classical notions of logic: implications, equivalence, negation, proof by contradiction, proof by induction, and quantifiers.
- Apply notions in logic in other branches of Mathematics.
- Know elementary algorithms: searching algorithms, sorting, greedy algorithms, and their complexity.
- Apply concepts of graph and trees to tackle real situations.
- Appreciate applications of shortest path algorithms in computer science.

### **Practical Paper IV (CCPM-IV): Operation Research**

- To understand the linear programming problem and learn graphical method for solving these problems.
- Learn the nature of transportation problems and solve the examples.
- Learn the nature of assignment problems and solve the practical problems.
- Understand the concept of Game theory, its significance and applications to modern industrial engineering, military applications, and logistics and solve various problems.

### **Practical Paper V (CCPM-V): Laplace and Fourier Transform**

- To find Laplace and inverse Laplace transforms of various functions.
- Apply properties of Laplace Transform to problems.
- To find Fourier and inverse Fourier transforms of various functions.
- Apply Fourier transform to solve problems.

### **Practical Paper VI (CCPM-VI): Mathematical Computation Using Python**

- Learn the skills of using various keywords, data types, expressions and input output in Python.
- Learn and apply decision and loop constructs in Python.
- Study and practice the concept of arrays, inbuilt and user defined functions.
- Learn the basic data types and operations in Python.
- To solve problems of computational mathematics using Python.
- Grasp the idea of visualisation and graph plotting and apply it for plotting graphs of functions.

### **Practical Paper VII (CCPM-VII): Project**

- To survey and identify various areas related to science, engineering, technology, industrial setups where the application of various skills and theories learned during the course of study can be useful to solve the problems.
- To select a specific problem from above mentioned fields that is best suited for student's knowledge base and aptitude.
- To motivate students to figure out various solutions under the guidance of faculties and select one of the solutions and design appropriate methodology and plan for solution.
- To encourage students to work out the solution under the guidance of the faculty. If necessary, develop computer programs for the same.

## Course Outcomes Physics

### B. Sc. Part I Semester I and II

#### DSC- 1 A Mechanics-I

Course Name	Course Outcome
CO 1	With the basic knowledge of Vectors, students will be able to understand fundamentals of vectors.
CO 2	With this course students will understand basic mathematics involved in the physics.
CO 3	Students will be able to understand motion of an object.
CO 4	At the end of course students will be able to understand the mechanics of a rigid body.

#### DSC- 1 A Mechanics-II

Course Name	Course Outcome
CO 1	With the basic knowledge of gravitation students will understand gravitational force acting on any rigid body.
CO 2	With this course students will understand oscillatory motion of a body.
CO 3	With this course students will understand elasticity of a body.
CO 4	With the basic knowledge of surface tension students will understand surface properties of liquid.

#### DSC- B ELECTRICITY AND MAGNETISM-I

Course Name	Course Outcome
CO 1	With the basic knowledge of vectors analysis student will be able to understand scalar and vector fields involved in physics.
CO 2	With this course students will understand electrostatic field.

#### DSC- 2B ELECTRICITY AND MAGNETISM-II

Course Name	Course Outcome
CO 1	With the basic knowledge AC circuits, students will understand the phenomenon electric field.
CO 2	With this course students will understand magnetic field and their properties.

CO 3	At the end of this course students will be able to understand phenomenon of electromagnetic induction.
CO 4	With this course students will understand applications of electromagnetic induction.

### **B. Sc. Part II Semester III and IV**

#### **Thermal Physics And Statistical Mechanics- I**

<b>Course Name</b>	<b>Course Outcome</b>
CO 1	With this course Students will be able to understand fundamentals of Kinetic Theory of Gases and thermometry
CO 2	With this course Students will be able to understand Laws of Thermodynamics and the concepts involved in it.

#### **DSC-C2: WAVES AND OPTICS - I**

<b>Course Name</b>	<b>Course Outcome</b>
CO 1	With the basic knowledge of Superposition of Harmonic Oscillations students will understand oscillatory motion of a body.
CO 2	With this course students will understand Coupled Oscillations of a body.
CO 3	With this course students will understand Waves Motion and Ultrasonic waves and the different concepts related to this..
CO 4	With this course students will understand Sound and Acoustics of buildings.
CO 5	With this course students will understand Viscosity of fluid.
CO 6	With this course students will understand vacuum and the methods to create vacuum.

#### **Thermal Physics And Statistical Mechanics- II**

<b>Course Name</b>	<b>Course Outcome</b>
CO 1	With this course students will understand Thermodynamic Potentials.
CO 2	With this course students will understand Theory of Radiation of a body.
CO 2	At the end of this course students will be able to understand Classical statistics involved in the physics.
CO 2	At the end of this course students will be able to understand Quantum statistics involved in the physics.

#### **DSC- D2 - WAVES AND OPTICS-II**

<b>Course Name</b>	<b>Course Outcome</b>
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CO 1	With the basic knowledge Cardinal points students can understand different optical phenomenon.
CO 2	With this course students will understand Resolving Power of optical instruments
CO 3	At the end of this course students will be able to understand Polarization of light.
CO 4	With this course students will understand interference light.
CO 5	At the end of this course students will be able to understand Diffraction of light.

## B. Sc. Part III Semester V and VI

### Paper 9 Mathematical Physics

Course Outcome	By the end of this course, students
CO-1	are able to know about differential equations, Method of separation of variables for solving second order partial differential equations, Form of two dimensional Laplace differential equation (PDE) in Cartesian coordinates and its solution, 3D PDE, differential equation of progressive wave
CO-2	know Singular points of second order differential equations, Application of singularity to Legendre and Bessel differential equation, Series solution method
CO-3	get some Special Integrals such as gamma and beta functions, error function
CO-4	enable to know about Complex Analysis and its types

### Paper 10 Quantum Mechanics

Course Outcome	By the end of this course, students
CO-1	know about matter waves, uncertainty principle and its application
CO-2	are able to know about Schrodinger's Wave Equation
CO-3	know the various Operators in Quantum Mechanics
CO-4	can use the Applications of Schrodinger Equation

### Paper 11 Classical Mechanics and Classical Electrodynamics

Course Outcome	By the end of this course, students
CO-1	can solve Lagrangian Formulation, and its applications
CO-2	know the Techniques of Calculus of Variation
CO-3	get idea about Special Theory of Relativity
CO-4	have knowledge about Charged Particles Dynamics

### Paper 12 Digital and Analog Circuits and Instrumentation

Course Outcome	By the end of this course, students
CO-1	get an idea about Digital Electronics, logic gates, flipflops
CO-2	know the Transistors Amplifier and Sinusoidal Oscillators, their types
CO-3	know basics of Cathode Ray Oscilloscope
CO-4	getting complete idea about Operational Amplifier and Timer

#### **Paper 13 Nuclear and Particle Physics**

Course Outcome	By the end of this course, students
CO-1	get basic idea of General Properties of Nuclei and Nuclear Model
CO-2	knowledge about Particle Accelerators and their types
CO-3	are able to get Nuclear Detectors and their types, working, applications
CO-4	get idea about Particle Physics

#### **Paper 14 Solid State Physics**

Course Outcome	By the end of this course, students
CO-1	know basics of Crystal Structure
CO-2	get idea of X-Ray Diffraction
CO-3	know Magnetic Properties of Matter
CO-4	clear concepts of Elementary Band Theory of Solids

#### **Paper 15 Atomic and Molecular Physics and Astrophysics**

Course Outcome	By the end of this course, students
CO-1	With basic background of vector atom model, students will learn about optical spectra with examples and origin of fine doublet spectra due to spin-orbit interaction and the effect of magnetic fields on atomic spectra.
CO-2	To comprehend molecular spectroscopy and Raman Scattering, this paper will widen student's knowledge of possible applications of spectroscopy in the different fields.
CO-3	With Knowledge of cosmology students will be able to understand structure, origin and enormity of universe.
CO-4	The study of stellar evolution will help students to enrich their knowledge about astrophysics and astronomy and possible application of blackhole, gravitational waves and other compact stars.

#### **Paper 16 Energy Studies and Materials Science**

Course Outcome	By the end of this course, students
CO-1	learn about Energy and Wind Energy

CO-2	widen their knowledge about Solar Energy and Biomass energy
CO-3	get idea of Superconductivity
CO-4	are able to know about basics of Nanotechnology, and its applications

## **Course outcome Zoology:**

### **B. Sc. I.: Sem. I: Paper I-Animal Diversity**

CO 1: Imparting knowledge of biodiversity related to non-chordates from Protista to hemichordate.

CO 2: Making the Understanding the Characters, classification and phylogenetic relations among various phyla of non-chordates.

CO 3: Making aware of importance of biodiversity and its conservation.

### **Sem. I Paper-II: Animal Physiology**

CO 1: Understanding various normal physiological activities in mammalian body.

CO 2: Making aware of finely balanced metabolic activities carried out in the body and need for maintaining the homeostasis.

### **Semester II Paper III: Cell Biology and Evolution**

CO 1: Imparting knowledge of basic structural and functional unit of life and its organization.

CO 2: Imparting knowledge the structure and functions of various cell organelles.

CO 3: Imparting knowledge organic evolution and various theories of evolution.

CO 4: Imparting knowledge evidences of evolution and mass extinctions.

### **Sem. II Paper IV: Genetics**

CO 1: Imparting knowledge of science of inheritance.

CO 2: Imparting knowledge of patterns of inheritance CO dominance.

CO 3: Imparting knowledge of linkage and crossing over.

### **B. Sc. II: Semester III: Paper V Animal Diversity – III**

CO 1: Understanding the Characters, classification and phylogenetic relations among various phyla from Arthropoda to Hemichordate.

CO 2: Generating the interest for subject among the students by the study of some amazing invertebrates.

CO 3: Understanding the specialized characters of phyla by the study of representative animal of that phylum.

CO 4: Imparting knowledge of some highly specialized characters of the phyla with suitable examples.

### **Paper VI: Genetics and Biological Chemistry**

CO 1: Understanding the concepts of genetics like Linkage, crossing over, sex determination, gynandromorphs, and interaction of genes, lethal genes and human twins.

- CO 2: Understanding the concepts like pH and buffers.  
CO 3: Imparting the knowledge of classification and biological significance of carbohydrates, proteins and lipids.  
CO 4: Imparting knowledge about nucleic acids and enzymes.  
CO 5: Making aware about the significance of metal ions to Human.

**Semester IV Paper VII: Animal diversity-IV**

- CO 1: Understanding the Characters, classification and phylogenetic relations among reptiles, Aves and mammals.  
CO 2: Making aware about poisonous and non-poisonous snakes, venom and its effect, snake bite and first aid.  
CO 3: Understanding the detailed characters of mammalian by studying representative animal: rat.  
CO 4: Generating the interest for subject among the students by the study of amazing vertebrates.  
CO 5: Imparting knowledge of some highly specialized characters of the classes with suitable examples.

**Paper VIII: Histology and Physiology**

- CO 1: Imparting knowledge of histological structures of mammalian organs.  
CO 2: Imparting knowledge of hormones.  
CO 3: Understanding physiology of reproduction.  
CO 4: Making aware of contraceptives and their types.  
CO 5: Imparting knowledge of modern technique like IVF.  
CO 6: Understanding the defines mechanism of our body.

**B. Sc. III Semester V: Paper IX Comparative Anatomy of Chordates**

- CO 1: Imparting knowledge of integuments and endoskeleton among the vertebrates.  
CO 2: Imparting knowledge of basic structural and functional parts of digestive and respiratory system from lower vertebrates to higher vertebrates.  
CO 3: Imparting knowledge of excretory and nervous system of various classes of vertebrate.

**Paper X: Biostatistics, Bioinformatics and Medical Zoology**

- CO 1: Understanding the many biostatistics terms such as tabulation, measure of central tendency and correlation.  
CO 2: Getting aware about various pathogenic insect vectors.  
CO 3: Understanding the detailed characters of various human diseases such as malaria, dengue and chikungunya.  
CO 4: Imparting the knowledge of some highly advanced technology of computer in biology.

**Paper XI: Molecular biology, Biotechnology and Biotechniques**

- CO 1: Understanding the molecular concepts in biology.  
CO 2: Getting aware about various biotechnology.  
CO 3: Understanding the detailed mechanism of various biotechniques likes rDNA technology, animal cell culture, hybridoma, ELISA, electrophoresis.  
CO 4: Getting aware about application of biotechnology in medicine, animal husbandry and agriculture.

**Paper XII: Endocrinology, Environmental Biology and Toxicology**

- CO 1: Understanding the anatomy, histology, role, regulation and disorder various endocrine gland of human.  
CO 2: Getting aware about environment, conservation strategies, national parks and wild life sanctuaries in India

- CO 3: Understanding the effect of toxicant on human and various other animals.
- CO 4: Understanding the types of habitats such as fresh water, marine water and terrestrial.
- CO 5: Imparting knowledge of some highly specialized characters and adaptation of habitats.
- CO 6: Understanding the anatomy, histology, role, regulation and disorder various endocrinal and of human.

**Semester VI Paper XIII: Functional anatomy of Non-chordates**

- CO 1: Imparting knowledge of invertebrate phylum protozoa, coelenterate and Mollusca.
- CO 2: Imparting knowledge of basic structural and functional parts of leech and sea star.
- CO 3: Imparting knowledge of various insect metamorphosis.
- CO 4: Imparting knowledge the science of torsion and detorsion of gastrophoda.
- CO 5: Imparting knowledge the about minor phyla. CO 6: Making the students aware about human genetics and disorders like Phenylketonuria and Sickle Cell Anaemia

**Paper XIV: Developmental biology**

- CO 1: Understanding the early and late developmental process of Amphioxus.
- CO 2: Understanding the detailed development of chick up to 72 hrs.
- CO 3: Generating the interest for subject among the students by the study advanced techniques in developmental biology such as cloning.
- CO 4: Imparting the knowledge of placenta, organizer and retrogressive metamorphosis.

**Paper XV: Physiology**

- CO 1: Understanding the human nutritional requirement and balanced diet.
- CO 2: Understanding the importance of vitamins in diet and deficiency.
- CO 3: Imparting knowledge of classification and biological significance of carbohydrates, proteins and lipids.
- CO 4: Imparting the knowledge about various human physiology of respiration, circulation, excretion, muscle and nerve.

**Paper XVI: Applied Zoology**

- CO 1: Understanding the fisheries industry and economic importance of fishes.
- CO 2: Generating the interest for subject among the students by the pearl culture.
- CO 3: Understanding the economic importance of apiculture, lac culture emu, goat and vermiculture.
- CO 4: Imparting knowledge of some crop pests, house hold pests, store rain pests and their biological control.

**Course Outcomes**

**Statistics**

**B. Sc. I: Semester I and II**

**Descriptive Statistics I: (Paper I)**

Course Outcome	By the end of this course students are
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CO-1	To compute various measures of central tendencies, dispersion, moments, skewness, kurtosis and to interpret them.
CO-2	To analyse data pertaining to attributes and to interpret the results.

**Elementary Probability Theory: (Paper II)**

Course Outcome	By the end of this course students are expected to be able
CO-1	To distinguish between random and non-random experiments.
CO-2	To find the probabilities of various events.
CO-3	To understand concept of conditional probability and independence of events.

**Descriptive Statistics II: (Paper III)**

Course Outcome	By the end of this course students are expected to be able
CO-1	To compute correlation coefficient, interpret its value and use in regression analysis
CO-2	To compute various index numbers.

**Discrete Probability distributions: (Paper IV)**

Course Outcome	By the end of this course students are expected to be able
CO-1	To apply discrete probability distributions studied in this course in different situations.
CO-2	Distinguish between discrete variables and study of their distributions.
CO-3	To know some standard discrete probability distributions with real life situations.
CO-4	Understand concept of bivariate distributions and computation of related probabilities

**B. Sc. II: Semester III and IV**

**Probability distributions-I: (Paper V)**

Course Outcome	By the end of this course students are expected to be able
CO-1	understand concept of discrete and continuous probability distributions with real life situations.
CO-2	distinguish between discrete and continuous distributions.
CO-3	find the various measures of random variable and probabilities using its probability distribution.
CO-4	know the relations among the different distributions.
CO-5	understand the concept of transformation of univariate & bivariate continuous random variable.

**Statistical methods-I: (Paper VI)**

<b>Course Outcome</b>	<b>By the end of this course students are expected to be able</b>
CO-1	Understand the concept of Multiple Linear Regression.
CO-2	Understand the concept of Multiple Correlations and Partial Correlation.
CO-3	know the concept of sampling theory.
CO-4	understand the need of vital statistics and concept of mortality and fertility.

#### **Probability distributions-II: (Paper VII)**

<b>Course Outcome</b>	<b>By the end of this course students are expected to be able</b>
CO-1	know some standard continuous probability is attributions with real life situations.
CO-2	distinguish between various continuous distributions.
CO-3	find the various measures of continuous random airable and probabilities using its probability distribution.
CO-4	understand the relations among the different distributions
CO-5	understand the Chi-Square, t and F distributions with their applications and interrelations.

#### **Statistical methods-II: (Paper VIII)**

<b>Course Outcome</b>	<b>By end of this course students are expected to be able</b>
CO-1	know the concept and use of time series.
CO-2	understand the meaning, purpose and use of Statistical Quality Control, construction and working of control charts for variables and attributes
CO-3	Apply the small sample tests and large sample tests in various situations.

**Name of Department: Chemistry**  
**Name of Programme: M.Sc. Analytical Chemistry**

**Program Outcomes**

PO1: The M.Sc. analytical chemistry program at Shivaji University, Kolhapur provides the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry and particularly in analytical chemistry enabling them to interface not only with various branches of chemistry (organic, inorganic, physical, biological, industrial, environmental, pharmaceuticals etc) but also with the related fields, and for professional courses and areas of research including medical, forensic, food, agriculture, dental, law, intellectual property, business programs etc.

PO2: Students will be able to solve various problems by identifying the essential parts of a problem, formulate strategy for solving the roleplaying appropriate techniques to arrive at a solution, test the precision and accuracy of the solution and interpret the results.

PO3: Students will be able to acquire domain specific knowledge and technical skills needed for employment in industries, teaching fields and pursue research. Students will be skilled in problem solving, critical thinking and analytical reasoning

PO4: Students will be able to apply the fundamental knowledge to address the cross-cutting issues such as sustainable development

PO5: Students will get perfect insight into qualitative and quantitative analytical chemistry and research ethics for production of quality research.

PO6: Students will be able to communicate effectively i.e. being able to articulate, comprehend and write effective reports, make effective presentations and documentation and capable of expressing the subject through technical writing as well as through oral presentation.

### **Program Specific Outcomes**

PSO1: Students will be able to prepare and qualify subject specific competitive exams like NET, SET and GATE and also other general public administration exams like M.P.S.C. and U.P.S.C. etc. exams.

PSO2: Student will be able to utilize the knowledge and analytical skills in QA-QC and R&D departments in almost all the industries enabling them to secure jobs where analytical chemistry is the core requirement to ensure and ascertain the quality of the product.

PSO3: Students will have opportunity for higher education leading to Ph.D. program.

PSO4: Students will be able to explore contemporary research in chemistry and allied fields of science and technology, collaborate in team projects, communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

PSO5: Students can start their own laboratories/startups/ chemical industry/ business (entrepreneurship).

PSO6: Students will be able to interpret data from the state of art Analytical instruments for ascertaining the product/material.

## **Course Outcomes**

### **M.Sc. Analytical Chemistry**

#### **Part-I Semester-I CH-1.1 (Inorganic Chemistry – I)**

1. CO1: Students will be able to explain the basic chemistry of transition metals and its compounds, spectroscopic characteristics of such compounds, nomenclature, reactions and applications.
- CO2: Students will obtain knowledge about Preparation, structure, physical and chemical properties of metal carbonyls of transition metals.
- CO3: Students will be able to understand the all aspects of synthesis, bonding, structure and reactivity of organometallic compounds and their applications in homogenous catalysis.
- CO4: Student will be able determine the stability of the complexes and will be able to explain the nuclear stability and reactions.

#### **CH-1.2(Organic Chemistry – I)**

- CO1: Students will able to differentiate between various organic reactive intermediates.
- CO2: Students can recognize, classify, explain, and apply fundamental organic reactions.
- CO3: Students will have ability to distinguish between different kinds of isomers.
- CO4: Course will develop interest in writing and finding mechanisms of new reactions.

#### **CH-1.3(Physical Chemistry – I)**

- CO1: Students will be able to understand basic principles of thermodynamics and statistical mechanics
- CO2: Able to learn advanced topics like quantum statistics and molecular dynamic simulation methods.
- CO3: Develop abilities to understand how to estimate and analyze the physicochemical properties of condensed and gas phase materials.
- CO4: Able to utilize spectral data to estimate molecular thermodynamic properties through partition function calculations.
- CO5: Understand properties of detergents and colloidal materials
- CO6: Learns the principles and techniques to understand gas and liquid adsorptions on solid surfaces
- CO7: Can learn spectral techniques to study surface adsorption phenomena.
- CO8: Learn principles and techniques for estimation of average molecular weight of a polymer or biological macromolecules
- CO9: Develop abilities to characterize polymers through understanding theories of virial coefficients, concepts of glass transition temperatures, etc.

#### **CH.1.4:Analytical Chemistry-I**

- CO1: Students would acquire the knowledge about the fundamentals of Analytical Chemistry including the sampling, sample pre-treatment, basic techniques, methods and data handling, processing and statistical analysis of the same.
- CO2: Students would acquire the knowledge and understand the scope of Analytical Chemistry spanning various fields. The students will learn fundamentals of qualitative analysis using conventional techniques
- CO3: Students will learn the chromatographic techniques, choice of chromatographic techniques and tuning of the chromatographic technique as per the need based on the samples to deal with, learn electroanalytical techniques and computation chemistry which would groom them for alternative analytical strategies which form one of the important components of analytical chemistry.

CO4: Students will learn about referring to the standard reference books and infer information from the same. Analytical case study problems would be discussed to familiarize with the scope and advantages of Analytical Chemistry.

### **PCH-1.1(Practical – I)**

CO1: Ability in professional sampling and sample treatment before actual analysis

CO2: Ability to treat and evaluate the results of analysis

CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory

CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)

### **PCH-1.2 (Practical – II)**

CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm.

CO2: Determine the rate constants of various first order and second order reactions

CO3: Determine the redox potential of a system, relative strength of acid etc using potentiometer, conductometer

CO4: Know the formation of alloys like Brass, Bronze, phase diagram for binary and ternary systems studied in details like a composition, critical temperature, etc

CO5: Validity of Freundlich adsorption isotherms to remove toxic material such as dye, acetic acid, and other industrial effluents

## **Part-I Semester-II**

### **CH-2.1(Inorganic Chemistry – II)**

CO1: Students will get the knowledge of the basic chemistry of non-transition elements and their compounds, synthesis and structural features, and applications.

CO2: To be able to explain the structures of inorganic compounds based on different theories. Student will understand the chemistry of various types of solvents.

CO3: Be well versed with the knowledge about the chemistry of Lanthanides and Actinides with respect to occurrence, separation, compounds and applications.

CO4: To understand the three dimensional structures of solid-state materials of industrial importance and to get the knowledge of bio-inorganic Chemistry.

### **CH-2.2(Organic Chemistry – II)**

CO1: Illustration of modern synthetic methods and applications of reagents.

CO2: Provide knowledge of different organometallic compounds and various coupling reactions.

CO3: Understand principle & applications of protection & deprotection of various functional groups.

CO4: It will elaborate to understand the concept of chemo selectivity, regioselectivity and enantioselectivity.

### **CH2.3 (Physical Chemistry – II)**

CO1: Students will learn basics of quantum mechanics.

CO2: Knowledge of the course will form the basis or essential requirement for the course “Advanced Quantum Chemistry”

CO3: Able to understand selection rules and to predict the electronic spectra of conjugated organic molecules.

CO4: Able to study photochemical and photophysical phenomena

CO5: Capable of qualitative and quantitative analysis of various ingredients from industrial, food and pharma samples using techniques of emission spectroscopy.

CO6: Capable of understand the electrochemical aspects of materials, ionic processes and electrochemical sensors, battery materials and characterizations etc.

CO7: Able to study electrokinetic effects and their applications in the field of protein separation, characterization etc.

CO8: Understanding the molecular dynamics through kinetic studies. Applications to explore reaction pathways, protein-ligand binding rates, etc. will help to understand life governing processes.

#### **CH.2.4: Analytical Chemistry-II**

CO1: Students will acquire the knowledge of spectroscopic tools/instruments used in chemical analysis and interpretation of the data. The scope and limitations of the spectroscopic tools would be discussed so that the students learn about the type of samples which could be analysed by these tools offering choices among the spectroscopic tools.

CO2: Students will learn about the simple and advanced instruments used for analysis like NMR,

MS, AAS, ICP and thermal analysis (TGA, DTA, DSC etc.) techniques spanning wide variety of

samples to be considered for analysis.

CO3: Students will learn about the instrumentation, sample preparation and handling of sample, analysis and data interpretation and structural elucidation.

CO4: Learning about different instruments will give them idea about appropriate choice of the instrument for analysis based on the source and type of analyte(s) in the sample under consideration.

#### **PCH-2.1 (Practical – III)**

CO1: Students developed for precise sample solution preparation and sample treatment before actual analysis.

CO2: Students can be able to perform the calculations and error analysis

CO3: Develop understanding of basic chemical processes and deciding methods of analysis.

CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, high end thermometers, refractometer, pH meter etc.)

#### **PCH-2.2 (Practical – IV)**

CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm.

CO2: Determine the unknown concentration and thermodynamic parameters using conductometer

CO3: Student will explore how to estimate order of reaction and the catalysis

CO4: students can estimate refractive index and molecular weights of species.

CO5: Students can understand the estimation of equilibrium properties like redox potential, phase diagram etc

### **Part-II Semester-III**

#### **ACH-3.1 (Advanced Analytical Techniques)**

CO1: Develop knowledge of fundamental, instrumentation and working of state of art instrumental analytical techniques, effective use and choice of technique, written and/or oral communication of the concepts of analytical chemistry which will be useful as analytical chemist and R&D.

CO2: Acquire knowledge of mass spectrometry, type of MS, ionization types and specific practical applications of MS.

CO3: Acquire knowledge of basics of nano chemistry, nanomaterials and nanotechnology and application orientated synthesis and characterization of nanomaterials.

CO4: This course gives wide understanding about the instrumental analytical techniques (SEM, TEM, EDS, STM, AFM, Raman, XFS, ESR, XPS, AES, SIMS etc.) employed for qualitative and quantitative analysis for contemporary research.

#### **ACH-3.2 ( Organic Analytical Chemistry)**

CO 1: Students will gain knowledge of the instruments used at the interface of Analytical-Organic chemistry useful for R&D and structural elucidation using UV-Visible, IR, <sup>1</sup>H & <sup>13</sup>C NMR, Mass spectrometry data and interpretation of the same.

CO 2: Students will acquire knowledge about the drug, their classification, sources of impurities (chemical, atmospheric and microbial contamination) in pharmaceutical raw materials and analysis of the same.

CO 3: Students will gain knowledge about the conventional and advanced analytical approaches for analysis of drug, vitamin, body fluids and clinical samples.

CO 4: Students will have an idea of commonly used pesticides and their analysis and also about forensic science and forensic sample analysis.

### **ACH- 3.3: (Electroanalytical Techniques in Chemical Analysis)**

CO1: Fundamental knowledge of electrochemistry, electrodes, types of electrodes, its construction will lay foundation for the course.

CO2: Students will gain knowledge and skill in electroanalytical techniques like cyclic voltammetry and its types, polarography, coulometry and dynamic light scattering technique for qualitative and quantitative analysis.

CO3: Students will be familiar with the advanced electrodes used for chemical analysis, liquid-liquid membrane electrodes, enzymes and gas electrodes.

CO4: Students will learn about electrophoretic techniques, advances in electrophoresis techniques and its analytical applications.

### **ACH-3. 4 ) (A) (Environmental**

CO1: Students will acquire knowledge about sampling, criteria of good sampling, handling, preservation and storage of the samples, pre-treatment and post treatment of samples.

Chemical Analysis and Control)

CO2: Students will acquire knowledge of conditions and strategies required during sampling and electrochemical and spectral methods for analysis of environmental samples.

CO3: Students will learn about the air and water pollution, sources of pollution, typical parameters and properties (physical, chemical and biological) to be measured in air and water pollution with relevance to specific case studies.

CO4: Students will be acquainted with organic pollutants and their analysis with special reference to pesticide analysis.

### **ACH-3.4 ) (B) (Recent Advances in Analytical Chemistry)**

CO1: Students will be acquainted with ultra purity and ultra trace analysis required in electronic and semiconductor processing.

CO2: Students will learn Radio-Analytical techniques for analysis.

CO3: Student will be well versed with C13, P15 and O17 NMR Spectroscopy applications.

CO4: Student will learn about ESR spectrometry and its applications quantitative analysis.

### **ACH-3.4 (B) (Recent Advances in Analytical Chemistry)**

CO1: Students will be acquainted with ultra purity and ultra trace analysis required in electronic and semiconductor processing.

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CO3: Student will be well versed with C13, P15 and O17 NMR Spectroscopy applications.

CO4: Student will learn about ESR spectrometry and its applications quantitative analysis.

### **ACHP – V Practical -V**

CO1: In-depth training on laboratory solution preparations on all concentration scales

CO2: Training on laboratory safety and lab ethics in scientific work

CO3: Training on planning, design and execution of experiments

CO4: Training on uncertainty estimations for experimentally measured and derived properties of solutions

### **ACHP – VI Practical-VI**

CO1: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

CO2: Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.

CO3: Developing analytical skills

CO4: Training on qualitative and quantitative analysis of analyte

## **Part-II semester-IV**

### **ACH 4.1 (Modern Separation Method in Analysis)**

CO1: Students will learn about modern separation and chromatographic used for analysis of different type of samples.

CO2: The student will understand instrumentation and mechanism of various separation techniques.

CO3: Student will acquire knowledge regarding various choice of instrument and detectors to be used for analysis depending on the sample and matrix.

CO4: Student will learn fundamentals of extractive chromatography, types of extraction techniques, advances in extraction methods and their hyphenations with chromatography leading to addressing challenging problems in analytical chemistry.

### **ACH-4.2 (Organic Industrial Analysis)**

CO1: Acquire knowledge of handling and investigating the characteristics of the oils, fats, detergents and soap samples and analysis of the same providing opportunity in cosmetic, pharmaceuticals, dyes and polymers industries.

CO2: Student will gain knowledge and importance of food quality, probe for food adulteration and adulterants, food preservative, food flavours and analysis of their components.

CO3: Students will also gain knowledge about the animal food stuff and the additives added in the animal food stuff as antibiotics, dietary supplements and growth promoting drugs, preservatives etc. and analysis of the same.

CO4: Student will learn about the analysis of cosmetics, face powder, hair dyes and hair care products, types of cosmetics, precautionary measures and composition of the cosmetics and specific roles of the ingredients. Will acquire knowledge about the paints, pigments and petroleum products, composition and analysis of the same using conventional and instrumental techniques.

### **ACH- 4.3 (Advanced Methods in Chemical Analysis)**

CO1: Students will be skilled in the techniques like fluorescence, phosphorescence, types of quenching, FRET and applications of the same in Analytical Chemistry and for addressing research problems.

CO2: Students will gain knowledge of the kinetic methods of analysis supporting the analysis and data procured in research.

CO3: The students will acquire the knowledge of advanced method of chemical analysis XPS, XRF, fluorescence and phosphorescence spectroscopy which will be beneficial in research.

CO4: Students will acquire knowledge of identifying types of plastic and will also be able to and determination of metallic impurities in plastics

### **ACH-4.4 (A) (Industrial Analytical Chemistry)**

CO1: The students will acquire knowledge of analysis of metals, alloys, minerals and ores commonly used in the industry.

CO2: The students will be acquainted with the analysis of real samples like cement, plaster of Paris, different commercial ores, soil composition, soil fertility, fertilizers etc using conventional and instrumental methods of analysis.

CO3: Students will also gain the knowledge of analysis of commercial materials, explosives, polymers, resins, rubber, luminescent paints, lubricants and adhesives.



CO4: These would offer opportunity to the students to get employment in industries for quality assurance and quality control (QA-QC) of the product.

**ACH-4.4 (B) (Quality Assurance and Accreditation)**

CO1: Students will acquire knowledge of QA-QC which is essential for analytical chemist, This covers a variety of chemical fields and this knowledge would help students working on various materials, understanding the basics of samples, sampling, sample storage, and pre-post treatment of samples.

CO2: Students will acquire knowledge of good laboratory practices, professional ethics, and instrumental analytical chemistry, awareness of health hazards, remedial measures, analytical method development and validation.

CO3: The students would be aware of the importance of documentation for raw materials and finished products, their monitoring, maintenance and management. World-wide agencies involved in regulating the analytical protocols and establishing standards.

CO4: Students will gain knowledge about the quality assurance and accreditation, evolution and significance of quality management, available accreditation agencies and advantages of accreditation.

**ACHP – VIII Practical-VIII**

1. The students will acquire hands on training for conducting the representative experiments for the analysis of wide variety of samples of inorganic, organic and physical approaches by qualitative and quantitative analysis. Demonstrate professional and ethical attitude to serve the society

2. Students will have knowledge of safety signs on container of chemicals, safety in handling of chemicals, MSDS sheets, learn sample preparation & characterization for confirming the purity.

3. Students would acquire knowledge about the separation and estimation of amount of metal, metal ions, organic compounds etc. in given samples.

4. Based on the experience of project work, students will have ability to start their R & D laboratory.