Deccan Education Society's

Fergusson College (Autonomous), Pune

Program Specific Outcomes(PSOs) and Course Outcomes (COs) 2019-20

Department of Chemistry

Programme: M.Sc. Analytical Chemistry

PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence:** (i) State and describe fundamental and advanced concepts in chemistry with analytical point of view. (ii) Illustrate broad knowledge and understanding of fundamental and advanced concepts in different areas of chemistry. (iii) Demonstrate skills related to basic and specialized techniques, modern instrumentations for chemical analysis and separation.
PSO2	**Personal and Professional Competence:** (i) Execute critical thinking and theoretical concepts for efficient problem solving and seeking solutions to difficulties that emerge in various fields of chemistry and interdisciplinary fields. (ii) Apply different methodology to conduct chemical synthesis, analysis and other chemical investigation; and apply appropriate understanding. (iii) Identify problems, use relevant concepts and methods to solve them.
PSO3	**Research Competence:** (i) Interpret and evaluate the findings and compare with the reference data. (ii) Illustrate and draw conclusions from the data through experiment/ investigation/ theoretical aspects. (iii) Recognise cause and effect relationships, ability to plan, execute and report the scientific conducts.
PSO4	**Entrepreneurial and Social competence:** (i) Build teamwork culture and execute skills for scientific investigation and academic uprightness. (ii) Articulate communication skills through oral presentations/ seminars/ group discussion and the compiling of information in the form of reports. (iii) Develop awareness in academic and research ethics, scientific misconduct, misrepresentation and manipulation of data. (iv) Generate potential to compete for the available employment opportunities or work independently in research, industries and other analytical based fields.

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	**Fundamentals of Physical Chemistry (CHA4101)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall basic concepts and define different terminologies in thermodynamics, quantum chemistry and chemical kinetics. Differentiate order and molecularity, classical and quantum mechanics.	1
CO2	Classify the chemical reactions based on order. Determine the rate equations for the given chemical reaction, Schrödinger equation, wave equation and energy for particle in box.	2
CO3	Use simple models to predict the physical phenomenon associated with thermodynamics, quantum chemistry and chemical kinetics.	3
CO4	Explain and illustrate quantum mechanical models and statistical thermodynamic properties. Relate the role of quantum mechanics in statistical mechanics.	4
CO5	Criticize different theories of Reaction rates. Justify activation energy concept and Arrhenius theory for reaction rate.	5
CO6	Formulate and solve scientific problems based on the fundamentals of physical chemistry. Calculate and integrate the physicals parameters for given problems.	6
Title of the Course and Course Code	**Fundamentals of Inorganic Chemistry (CHA4102)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Outline the concept of symmetry to imagine molecules in three dimensions and identify the symmetry elements and symmetry operations and be able to pass through the molecule. Describe the selection rule and construction of microstate tables for various configurations.	1
CO2	Classify the symmetry elements possessed by a molecule and assign it to a point group and determine optical activity and dipole moment. Explain the construction of a matrix representation.	2
CO3	Generalise the importance of Orthogonality Theorem and learn the rules for constructing character tables. Outline the fundamental requirement for interpretation of electronic spectra of metal compounds for prediction of their properties.	3
CO4	Explain molecular structure by the use of character tables and projection operator techniques. Identify the factors responsible for different magnetic behaviour of materials.	4
CO5	Review the concept of SALC, spectrochemical and Nephelauxetic series. Develop the ability to generate a representation of SALC and	5

	to reduce it to its irreducible components. Evaluate numerical based on crystal field parameters.	
CO6	Specify and correlate the application of symmetry to spectroscopy to find out which modes are IR and Raman active. Specify the various Quenching of orbital angular momentum.	6
Title of the Course and Course Code	**Advanced Organic Chemistry and Spectroscopy (CHA4103)**	**Number of Credits : 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall the concept of aromaticity and its application to identify various organic compounds. Predict and cite examples of aromaticity of heterocyclic and non-heterocyclic compounds.	1
CO2	Discuss aromatic substitution reactions and predict the products/intermediates and explain the type of reactions and write their mechanisms	2
CO3	Applications of organometallic compounds, ylides and predict products. Determine selectivity and demonstrate their advantages.	3
CO4	Identify the products of oxidation-reduction reactions, give examples and determine selectivity of reagents and demonstrate their nature.	4
CO5	Review various terms in stereochemistry and explain aspects of configurations in various chiral compounds, prochirality, stereospecific and stereoselective reactions.	5
CO6	Revise basic principles of spectroscopy and demonstrate applications of spectroscopic techniques. Propose structures using spectroscopic data.	6
Title of the Course and Course Code	**Analytical Chemistry Practical – I (CHA4104)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Outline and recall basic knowledge of fundamentals and application of organic and physical chemistry through chemical and scientific theories.	1
CO2	Perform the experiment and tabulate the observations.	2
CO3	Use of safety responsibilities residing in working with chemicals.	3
CO4	Separate components from ternary mixture of organic compounds and determine type of given mixture and physical constants. Demonstrate and employ skills in procedures and instrumental methods applied in organic and physical chemistry practical.	4

CO5	Standardize/calibrate the apparatus and instrument. Carry out purification techniques.	5
CO6	Write the experimental results and interpret it.	6
Title of the Course and Course Code	**Analytical Chemistry Practical – II (CHA4105)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Outline and recall basic knowledge of fundamentals and application of inorganic and physical chemistry through chemical and scientific theories.	1
CO2	Perform the experiment and tabulate the observations.	2
CO3	Illustrate safety measures related to experiments carried out.	3
CO4	Separate components from different analytes using various methods/techniques	4
CO5	Standardize/calibrate the apparatus and instrument.	5
CO6	Develop skills in procedures and instrumental methods applied in practical tasks. Interpret, conclude and write the experimental results.	6
	F.Y. M.Sc. Semester II	
Title of the Course and Course Code	**Advanced Physical Chemistry (CHA4201)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and define basic terminologies in spectroscopy, chemical bonding and nuclear chemistry.	1
CO2	Illustrate, classify and compare theoretical and instrumental aspects for various spectroscopic and radio analytical techniques. Summarize different molecular spectroscopic concepts and rules to deduce the molecular structures.	2
CO3	Solve and work with numerical based on spectroscopic, radio analytical and chemical bonding concepts. Interpret different types of molecular spectra and structure to evaluate valuable data from it.	3
CO4	Explain molecular orbital theory for homonuclear, heteronuclear and polynuclear molecules using quantum rules.	4
CO5	Review and relate the concepts involved in different spectroscopic techniques.	5
CO6	Formulate and solve scientific problems based on the advanced physical chemistry concepts. Specify the applications of spectroscopy, radio analytical techniques and concepts of chemical bonding in chemistry and interdisciplinary fields.	6

Title of the Course and Course Code	**Advanced Inorganic Chemistry (CHA4202)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall the importance of bioinorganic chemistry. Describe the structure and bonding aspects of simple organometallic compounds. Outline basics of substitution reactions of octahedral complexes.	1
CO2	Discuss the role of metals in Metalloproteins. Classify the different types of organo-transition metal complexes, catalyzed reactions and factors affecting it.	2
CO3	Illustrate the importance and transport of metal ions. Identify back bonding in organometallics and outline the mechanism of hydrolysis in the octahedral system.	3
CO4	Explain catalytic reaction involving organometallic compounds. Describe the metal carbonyls, metal clusters, metal nitrosyls and its preparation, structures and properties.	4
CO5	Justify the importance and function of metal ions in metalloprotein. Evaluate problems based on electron count in organometallics.	5
CO6	Develop basic understandings about redox reaction or electron transfer reactions. Specify the environmental impact of the most inorganic compounds produced on the industrial scale and know different applications of organometallic compounds in medicines.	6
Title of the Course and Course Code	**Reaction Mechanism in Organic Chemistry (CHA4203)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Define and explain recall principles of photochemistry.	1
CO2	Explain pericyclic reactions and justify their mechanisms by using correlation diagrams and FMO approach.	2
CO3	Demonstrate concepts of Carbanions, Enamines and Ynamines and explain their stability, reactivity, selectivity and predict the products.	3
CO4	Classify rearrangements. Predict the product and illustrate the reactions involving rearrangements.	4
CO5	Review carbenes, nitrenes, free radicals and discuss their methods of synthesis and predict products in related reactions.	5
CO6	Specify neighbouring group participation (NGP) and predict the products in reactions involving NGP. Explain different mechanisms of ester and amide hydrolysis.	6

Title of the Course and Course Code	**Analytical Chemistry Practical – III (CHA4204)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Describe the theoretical principles and concepts related to experiments.	1
CO2	Represent the results of scientific work in oral, written, graphical and electronic formats.	2
CO3	Apply laboratory skills in organic and physical chemistry. Carry out single stage preparation along. Demonstrate software related to chemistry.	3
CO4	Identify and analyse the product obtained by different techniques. Demonstrate purification technique.	4
CO5	Justify the steps to standardize the methods and instruments .	5
CO6	Perform experiments, analyze and interpret the experimental results.	6
Title of the Course and Course Code	**Analytical Chemistry Practical – IV (CHA4205)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Describe the theoretical principles and concepts related to experiments.	1
CO2	Represent the results of scientific work in oral, written, graphical and electronic formats.	2
CO3	Execute chemical analysis for different samples. Implement problem solving, critical thinking and analytical reasoning as applied to scientific problems.	3
CO4	Analyze data from a range of physical techniques to characterise different compounds.	4
CO5	Justify the steps to prepare and standardize different solutions.	5
CO6	Design and perform scientific experiments. Interpret and write the experimental results with standards.	6

S.Y. M.Sc. Semester III		
Title of the Course and Course Code	**Advanced Analytical Techniques CHA5301 (Special-1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall and describe the basic concepts of electro analytical, thermal, atomic spectroscopic and laser-based techniques.	1
CO2	Explain the working principles and instrumentation of electro analytical, thermal, atomic spectroscopic and laser-based techniques.	2
CO3	Illustrate the applications of advanced analytical techniques for various types of chemical analysis. Interpret experimental/spectral data and apply knowledge to solve simple to advanced numericals.	3
CO4	Identify and explain the given scientific problems based on an advanced analytical approach.	4
CO5	Compare electro analytical, thermal, atomic spectroscopic and laser-based techniques based on their principles and applications	5
CO6	Design and specify applications of advanced analytical techniques in various fields and develop capability to apply different techniques to assess physico-chemical properties.	6
Title of the Course and Course Code	**Extraction Techniques and Metallurgy CHA5302 (Special-2)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Define basic and advanced concepts of extraction techniques. State composition of soil, types of ores, alloys, plant nutrients with their functions.	1
CO2	Distinguish and explain types of ores and alloys, disintegration of ore, refining techniques, and methods of metal dressing & concentration of ore. Discuss the working principles and instrumentation for extraction techniques.	2
CO3	Illustrate metallurgical processes, different elements, factors affecting soil formation. Outline application of Elingham diagram and advance extraction methods	3
CO4	Identify and analyze components and parameters from given samples. Explain various processes in metallurgy, magnetron and online SPE.	4
CO5	Review soil properties, steps in metallurgical processes and their environmental effects. Justify CO2 as supercritical fluid and recommend solvent selection for various SPE sorbents and remedies	5

	for emulsion in LLE.	
CO6	Propose offline protocols for extraction of organic compounds. Formulate and solve scientific problems based on extraction techniques and metallurgy.	6
Title of the Course and Course Code	**Pharmaceutical Chemistry CHA5303 (D Elect-1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	List the importance and role of FDA. Define basic concepts related to pharmaceutical chemistry.	1
CO2	Discuss and explain various pharmaceutical concepts and techniques of analysis. Summarize different separation techniques and system suitability parameters.	2
CO3	Illustrate the role of drug activity in pharmaco-kinetics and dynamics. Solve the numericals based on pharmaceutical concepts.	3
CO4	Analyze different pharmaceutical samples. Explain analytical techniques used in pharmaceutical industries.	4
CO5	Compare different dosage forms, route of administration, pattern of drug release.	5
CO6	Propose and specify methods for analyzing pharmaceutical samples. Compile processes to increase separation efficiency of multicomponent products.	6
Title of the Course and Course Code	**Structure Determination by Analytical Methods CHA5304 (G Elect-1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Define and describe basic principles of spectroscopy and Mass spectrometry and demonstrate their applications.	1
CO2	Explain spin systems and propose correct structures from spectral data. Distinguish compounds using spectroscopic methods	2
CO3	Solve problems based on - UV, IR, NMR, CMR, mass spectral data. Use suitable experiments of 2D spectroscopy for structure elucidation.	3
CO4	Explain techniques used to interpret chemical shift for ^{13}C NMR	4
CO5	Determine structures from fragmentation data and discuss factors controlling fragmentation.	5
CO6	Propose structures of compounds using spectroscopic data.	6

Title of the Course and Course Code	**Analytical Chemistry Practical V CHA5306 (P-Special 1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall basic concepts used in analysis.	1
CO2	Represent the results of scientific work in oral, written, graphical and electronic formats. Articulate statistical knowledge to maintain its accuracy.	2
CO3	Implement problem solving, critical thinking and analytical reasoning as applied to scientific problems.	3
CO4	Analyze given inorganic, pharmaceutical and biological samples.	4
CO5	Standardize different chemical reagents.	5
CO6	Compile experimental findings in a scientific manner.	6
Title of the Course and Course Code	**Analytical Chemistry Practical VI CHA5307 (P-Special 2)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall concepts of analytical instrumentation.	1
CO2	Represent the results of scientific work in oral, written, graphical and electronic formats.	2
CO3	Carry out analysis of various samples using different instrumentation techniques.	3
CO4	Analyze and interpret experimental data using standard statistical methods and computational methods.	4
CO5	Standardize/calibrate the instruments.	5
CO6	Plan and perform experiments using correct procedure for different samples.	6

S.Y. M.Sc. Semester IV		
Title of the Course and Course Code	**Forensic science and Toxicology CHA5401 (D Elect-1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Outline the terms and role of forensic science, analytical toxicology and different units of crime lab.	1
CO2	Discuss the types of evidence, collection and preservation of samples. Explain different techniques involved in interpreting evidence obtained at a crime scene.	2
CO3	Outline the basic facts, concepts, principles related to various techniques used in forensic science.	3
CO4	Identify and explain different evidence, drugs, poisons from crime scenes and body fluids.	4
CO5	Review various techniques involved in crime scene investigation. Evaluate evidence obtained at crime scene.	5
CO6	Propose steps for analyzing various samples obtained at crime scenes and develop critical thinking and investigate in a stepwise manner.	6
Title of the Course and Course Code	**Chemistry of Natural Products and Chiron Approach CHA5402 (G Elect-1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	State and describe retrosynthetic analysis of important natural products, roles of reagents, stereochemical and selectivity aspects in synthesis. Arrange reagents in the synthetic route of target molecules.	1
CO2	Explain the types of terpenoids, alkaloids and propose mechanisms of their biogenesis.	2
CO3	Illustrate the shikimate pathway and predict the product.	3
CO4	Explain chirons and their use in synthesis of drug molecules along with retrosynthetic analysis.	4
CO5	Determine retrosynthetic pathway and discuss synthesis of chiral drugs.	5
CO6	Write aspects of synthesis of various chiral drug molecules.	6

Title of the Course and Course Code	**Analytical Spectroscopy CHA 5404 (D Elect-2)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall the basic terminologies in spectroscopy and regions of the electromagnetic spectrum.	1
CO2	Illustrate, classify and compare theoretical and instrumental aspects for various advanced spectroscopy.	2
CO3	Solve numericals based on analytical spectroscopic techniques. Interpret and compute the spectral data.	3
CO4	Relate different concepts and apply them to identify the molecular structures and spectrum.	4
CO5	Review the concepts involved in different spectroscopic techniques.	5
CO6	Formulate and compile scientific problems based on analytical spectroscopy. Specify the applications of analytical spectroscopy in chemistry and interdisciplinary fields.	6
Title of the Course and Course Code	**Advanced Synthetic Organic Chemistry CHA5405 (G Elect-2)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Define role of metals as catalyst and contribution of transition metals as catalyst.	1
CO2	Discuss use of transition metal complexes in organic synthesis. Discuss various reactions for C=C formation.	2
CO3	Predict products in metal and non-metal mediated reactions and justify the nature of the product.	3
CO4	Explain and discuss Multi-component reactions (MCR) and metathesis.	4
CO5	Review boron and silicon chemistry.	5
CO6	Specify mechanisms of different name reactions.	6

Title of the Course and Course Code	**Polymer Chemistry CHA 5407 (D Elect-3)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall the basic concepts and history of polymers. Outline the polymers based on their synthesis, properties and types.	1
CO2	Discuss various reaction mechanisms, polymer processing and testing methods. Illustrate the additives used in industrial products and specify their functions.	2
CO3	Generalize the molecular weight concept for polymers and Predict average molecular weights with various physical methods.	3
CO4	Differentiate polymerization approaches and relate the analysis methods with properties polymers.	4
CO5	Review the properties of polymers, various factors affecting on it and separation techniques based on molecular size.	5
CO6	Propose applications of polymers for industrial utilisation as well as interdisciplinary field of science. Specify synthesis mechanism and applications of different industrially important polymers.	6
Title of the Course and Course Code	**Designing Organic Synthesis and Asymmetric Synthesis CHA 5408 (G Elect-3)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Describe the use of retrosynthetic analysis to work out and compare alternative syntheses of complex organic molecules. Outline the important classical and modern reactions used in organic synthesis.	1
CO2	Predict the correct product based on choice of reagents and conditions. Design and discuss synthetic routes for the target molecules and problems related to process development.	2
CO3	Apply different methods of protection and deprotection in designing synthetic strategies.	3

CO4	Explain the concept of umpolung, state its importance and use in organic synthesis.	4
CO5	Determine and discuss different methods for asymmetric synthesis.	5
CO6	Specify the role and use of organocatalysts in asymmetric synthesis.	6
Title of the Course and Course Code	**Analytical Chemistry Practical VII CHA 5410: (P-Special 1)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Identify and tell theoretical concepts of forensic and polymer science through experiments.	1
CO2	Summarize the results of scientific work in oral, written, graphical and electronic formats.	2
CO3	Implement chemical analysis for ores, alloys and prepare metal complexes.	3
CO4	Structure the protocols using appropriate practical aspects.	4
CO5	Standardize different chemical reagents.	5
CO6	Perform various tests for analyzing food samples, blood samples and plant materials.	6
Title of the Course and Course Code	**Analytical Chemistry Practical VIII CH5411 (P- Special 2)**	**Number of Credits: 04**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Recall skills of handling, calibration, standardization of basic and advanced analytical instruments. Identify appropriate techniques for analyzing specific components from samples.	1
CO2	Represent the scientific finding in graphical and electronic formats.	2
CO3	Apply the laboratory skills and concepts to carry out the experiments using advanced analytical instruments.	3
CO4	Structure the protocols using appropriate practical knowledge.	4
CO5	Compare and justify the results with literature.	5
CO6	Generate technical skills in handling instruments and calculation methods.	6

Title of the Course and Course Code	**Analytical Chemistry Practical VIII CH5412 (P- Special 2)**	**Number of Credits: 08**
On completion of the course, the students will be able to:		**Bloom's Cognitive level**
CO1	Identify and state scientific findings in the research area.	1
CO2	Outline the specific research problem based on literature survey.	2
CO3	Execute defined scientific problems using different analytical tools .	3
CO4	Compare and criticize results based on scientific literature.	4
CO5	Justify findings of the experiments	5
CO6	Write and organise experimental data in the form of a dissertation, and presentation. Develop research culture and understand the purpose and value of ethical decision making.	6