Fergusson College (Autonomous)
Pune

Learning Outcomes-Based Curriculum

for F. Y. B. Sc. Chemistry

With effect from June 2019

Program Outcomes (POs) for B.Sc. Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of an graduate Programme. Execute strong theoretical and practical understanding generated from the specific graduate Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence** i. Understand the fundamental concepts of theoretical and experimental aspects of physical, organic, inorganic, analytical and allied chemistry subjects. ii. Explain and clarify the understanding of thermodynamic, spectroscopic, kinetic and quantum models, stereochemistry and mechanism of organic reactions, chemical bonding and structure elucidation, analytical techniques and solving numerical problems. iii. Correlate and apply the theoretical chemistry knowledge in explaining practical schemes
PSO2	**Personal and Professional Competence** i. Solve numerical problems, mechanisms, analytical interpretation using chemistry concepts and knowledge. ii. Execute the knowledge of spectroscopic techniques learnt to characterize and identify structures of molecules used in drugs and pharmaceutical products. iii. Analyse chemical species qualitatively and quantitatively using appropriate analytical techniques. iv. Build confidence, patience, time management, leadership and intangible skills to achieve the goals in competitive examinations for higher learning courses in chemistry to meet global competencies.
PSO3	**Research Competence** i. Identify and understand research literature and appropriate techniques used in chemistry related problems. ii. Create awareness and promote research attitudes among students. iii. Interpret spectroscopic data to identify basic organic compounds.
PSO4	**Entrepreneurial and Social competence** i. Understand and explain the processes needed in domain related industries and write their general aspects. ii. Apply information related to material safety data sheets (MSDS) needed in various industries. iii. Embrace reduce, recycle and restore chemicals (3R's) approach and gain the sense of ethical, social and environmental awareness and responsibility.

Programme Structure

Year	Course Code	Course Title	Credits
F. Y. B. Sc.	**Semester I**		
	CHE1101	Chemical Mathematics & Atomic Structure	2
	CHE1102	Basics of Organic Chemistry & Periodicity of Elements	2
	CHE1103	Chemistry Practical - I	2
	Semester II		
	CHE1201	Ionic Equilibrium & Chemical Bonding	2
	CHE1202	Stereochemistry, Hydrocarbons & Mole Concept	2
	CHE1203	Chemistry Practical - II	2

Year	Name of Paper	Paper Code	Title of Paper	No. of Credits
S. Y. B. Sc.	**Semester III**			
	Theory Paper - 1	CHE 2301	Physical Chemistry	2
	Theory Paper - 2	CHE 2302	Organic Chemistry	2
	Practical Paper - 1	CHE 2303	Chemistry Practical - III	2
	Semester IV			
	Theory Paper - 3	CHE 2401	Inorganic Chemistry	2
	Theory Paper - 4	CHE 2402	Analytical Chemistry	2
	Practical Paper - 2	CHE 2403	Chemistry Practical - IV	2

Year	Paper No.	Course code	Title	Credits	CE Maximum Marks	ESE Maximum Marks	Total Maximum Marks
T. Y. B. Sc.	**Semester V**						
	DSE-1A	CHE3501	Physical Chemistry I	2	50	50	100
	DSE-1B	CHE3502	Inorganic Chemistry I	2	50	50	100
	DSE-2A	CHE3503	Organic Chemistry I	2	50	50	100
	DSE-2B	CHE3504	Analytical Chemistry I	2	50	50	100
	DSE-3A	CHE3505	Industrial Chemistry I	2	50	50	100
	DSE-3B	CHE3506	Biochemistry I	2	50	50	100
	DSE-1	CHE3507	Physical Chemistry Practical I	2	50	50	100
	DSE-2	CHE3508	Inorganic Chemistry Practical I	2	50	50	100
	DSE-3	CHE3509	Organic Chemistry Practical I	2	50	50	100
	SEC-1*	CHE3511	Chemical Lab Safety and Waste management	2	50	50	100
	SEC-2*	CHE3512	Pharmacology	2	50	50	100
	Semester VI						
	DSE-4A	CHE3601	Physical Chemistry II	2	50	50	100
	DSE-4B	CHE3602	Inorganic Chemistry II	2	50	50	100
	DSE-5A	CHE3603	Organic Chemistry II	2	50	50	100
	DSE-5B	CHE3604	Analytical Chemistry II	2	50	50	100
	DSE-6A	CHE3605	Industrial Chemistry II	2	50	50	100
	DSE-6B	CHE3606	Biochemistry II	2	50	50	100
	DSE-4	CHE3607	Physical Chemistry Practical II	2	50	50	100
	DSE-5	CHE3608	Inorganic Chemistry Practical II	2	50	50	100
	DSE-6	CHE3609	Organic Chemistry Practical II	2	50	50	100
	SEC-3*	CHE3611	Polymer Chemistry	2	50	50	100
	SEC-4*	CHE3612	Analytical Methods	2	50	50	100

F.Y. B.Sc. Semester I		
Title of the Course and Course Code	**Chemical Mathematics & Atomic Structure CHE1101**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall and outline the fundamental concepts of atomic structure, states of matter and mathematics for chemistry.	
CO2	Discuss atomic models and interpret atomic spectrum. Explain the concept of wave-particle duality and wave equation, quantum numbers and rules of orbital electron distribution.	
CO3	Apply mathematics for chemistry using graphical representation, differentiation and integration. Solve numerical problems based on Chemical Mathematics, Gaseous State, Liquid State and Atomic Structure.	
CO4	Explain Kinetic theory of a gas, evaluate average, root mean square and most probable molecular velocities. Compare the ideal gas equation with modified equations.	
CO5	Review the properties of liquids with respect to intermolecular force of attraction.	
CO6	Specify the physical properties of a liquid using techniques.	

Unit No.	Title of Unit and Contents	No.of Lectures
I	**Chemical Mathematics** Logarithm - Rules of logarithm, Characteristic and mantissa, Change of sign and base, Problems based on pH and pOH. Graphical representation of Equations-Rules for drawing graph co-ordinates etc., Equation of straight line, slope and intercept, plotting the graph from the data of chemical properties and problems, Derivative - Rules of differentiation and partial differentiation, Algebraic, logarithmic and exponential functions and problems, Integration- Rules of integration, Algebraic and exponential functions and problems.	6
II	**Gaseous State** Kinetic molecular model of a gas, postulates and derivation of the kinetic gas equation, collision frequency, collision diameter; mean free path, Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, Law of equipartition of energy, degrees of freedom and molecular basis of heat capacities, Behaviour of real gases, Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases, Causes of deviation from ideal gas behaviour, van der Waals equation of state, its derivation, van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms.	12

III	**Liquid State** Qualitative treatment of the structure of the liquid state, physical properties of liquids, vapour pressure, surface tension and coefficient of viscosity and their determination, Effect of addition of various solutes on the surface tension and viscosity, Explanation of cleansing action of detergents, temperature variation of viscosity of liquids and comparison with that of gases, qualitative discussion of structure of water.	6
IV	**Atomic Structure** Rutherford atomic model, electromagnetic spectrum, Bohr's theory, its limitations and atomic spectrum of hydrogen atom, de Broglie equation, Heisenberg's Uncertainty, Principle and its significance, Schrödinger's wave equation (derivation not required), significance of ψ and ψ^2, quantum numbers and their significance, normalized and orthogonal wave functions, sign of wave functions, Radial and angular wave functions for hydrogen atom, radial and angular distribution curves, shapes of *s*, *p*, *d* and *f* orbitals, Pauli's Exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, variation of orbital energy with atomic number.	12

References:

1. Principles of PhysicalChemistry by Maron and Prutton, 1992.
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa, 2004.
3. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP, 200.
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson, 2013.
5. Essentials of physical chemistry Bhal, Tuli and S. Chand, 2010.
6. J.D. Lee Concise Inorganic Chemistry: Fifth Edition, Wiley, 2008.
7. Bodie Douglas and DarlMcdanielConcepts and Models of Inorganic Chemistry Third Edition, Wiley, 1983.
8. Duward Shriver, P. W. Atkins Inorganic Chemistry, Fifth Edition, Oxford University Press, 2002.
9. Donald A. Tarr, Gary Miessler Inorganic Chemistry Third Edition, Pearson, 2013.
10. A. Bahl, B. S. Bahl, and G.D. Tuli, Essentials of Physical Chemistry, S. Chand and Co Pvt Ltd 2014. (pages 1-96 for Atomic Structure)

Title of the Course and Course Code	Basics of Organic Chemistry & Periodicity of Elements CHE1102	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define basic concepts and describe electronic factors in organic chemistry and types of bonds.	
CO2	Explain the mechanisms of organic reactions and classify the organic compounds based on their nomenclature and their basic properties. Arrange the elements according to their physical properties as well as chemical properties.	
CO3	Apply basic concepts to classify and differentiate organic compounds. Calculate the charge on given chemical species and solve the given chemical reaction.	
CO4	Distinguish between the compounds or elements on the basis of their chemical and physical properties.	
CO5	Justify the chemical and physical properties for organic compounds as well as for given elements.	
CO6	Develop the relation between trend and the chemical properties of compounds or elements. Synthesize the given organic compound with a suitable route.	

Unit No.	Title of Unit and Contents	No.of Lectures
I	**Basics of Organic Chemistry** Organic Compounds: Covalent bond, hybridization, shapes of molecules, influence of hybridization on bond properties, inter and intra molecular hydrogen bonding, Electronic Displacements: Inductive, resonance and mesomeric effects, hyper conjugation, tautomerism and their applications, dipole moment, organic acids and bases, their relative strength, strength of acids and bases, pK_a and pK_b values of common organic acids and bases, Homolytic and heterolytic fission with suitable examples, curly arrow rules, formal charges; electrophiles and nucleophiles nucleophlicity and basicity, types, shape and their relative stability of carbocations, carbanions, free radicals and carbenes. Introduction to types of organic reactions and their mechanism, addition, elimination, substitution and rearrangement reactions.	13
II	**Chemistry of Hydrocarbons** Introduction to Hydrocarbons, Classification of hydrocarbons (up to aromatic hydrocarbons), Alkanes: IUPAC nomenclature, formation of alkanes, Wurtz reaction, Wurtz-Fittig reactions, free radical substitutions: Halogenation-relative reactivity and selectivity, Alkenes: IUPAC nomenclature, formation of alkenes by elimination reactions, mechanism of E1, E2, E1cb reactions, Saytzeff and Hofmann eliminations, Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-	9

	demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation), 1, 2 and 1, 4 addition reactions in conjugated dienes, Diels-Alder reaction, allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene and their industrial application of hydrocarbons, Alkynes: IUPAC nomenclature, acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, alkylation of terminal alkynes.	
III	**Research in India in the field of Chemistry** Introduction to Premier Indian Research Institutes in Chemistry, ShantiswaroopBhatnagar awardees in last 5 years in Chemistry.	2
IV	**Periodicity of Elements** Long form of periodic table, *s, p, d, f* block elements, Classification of elements, electronic configuration, detailed discussion of the following properties of the elements with reference to *s* and *p*-block, Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, Atomic and ionic radii, Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. Applications of ionization enthalpy, Electron gain enthalpy (Electron affinity) and trends in groups and periods, Electro-negativity, Pauling's scale. Variation of electro-negativity with bond order and hybridization.	12

References:

1. Clayden, J., Greeves, N., & Warren, S. G. *Organic chemistry*. Oxford: Oxford University Press, 2012.
2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, 6th Edition, (Pearson Education), 1992.
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 1964.
4. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. J. D. Lee Concise Inorganic Chemistry: Fifth Edition, Wiley, 2007.
6. Bodie Douglas and DarlMcdaniel Concepts and Models of Inorganic Chemistry Third Edition, Wiley,1994.
7. Duward Shriver, P. W. Atkins Inorganic Chemistry, Fifth Edition, Oxford University Press, 2002.
8. Donald A. Tarr, Gary Messler Inorganic Chemistry Third Edition, Pearson, 2013.
9. F. Albert Cotton and Geoffrey Wilkinson Advanced Inorganic Chemistry, Sixth Edition, 2013.

Title of the Course and Course Code	Chemistry Practical - I CHE1103	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Tabulate the tests for inorganic and organic qualitative analysis. Recall examples of cations and Anions. List out types of organic compounds and purification procedures.	
CO2	Outline the systematic tests that lead to identify basic and acidic radicals in the unknown binary inorganic mixtures and organic compounds.	
CO3	Carry out experiments that are needed for analysis of inorganic and organic compounds, interpret the observations of each test and apply techniques to find out physical constants of compounds.	
CO4	Analyze the results of preliminary, dry and wet tests to co-relate to the findings.	
CO5	Compare results of all the tests to confirm the findings. Validate the techniques with different types of unknown samples.	
CO6	Design a systematic procedure to analyze the unknown inorganic and organic samples. Compile all the interpretations and write the result table.	

Sr. No.	Topic	No. of Practicals
I	**Laboratory Safety**	**1**
II	**Organic Chemistry Practicals** Purification of Organic Compound by Crystallization Method by using different solvents (two compounds) Distillation (Demonstration), Sublimation Method (one compound) Qualitative analysis / characterization of organic compound containing C, H, (O), N, S elements (no element test), Separation of a mixture of ortho and para nitrophenol OR ortho and para nitroaniline by thin layer chromatography (TLC), Use of ChemDraw Software	5
III	**Inorganic Chemistry Practicals [Any FIVE Mixtures without Phosphate & Borate]** Semi-micro inorganic qualitative analysis of binary mixture containing two cations and two anions.	5

References:

1. Khosla, B.D.; Garg, V. C. and Gulati Senior practical physical chemistry, R. Chand & Co.: New Delhi, 2011.
2. Garland, C. W.; Nibler, J.W. and shoemaker, D. P Experiments in physical chemistry 8th Ed. McGraw-Hill: New work, 2003.
3. Mendham, J., A. I. Vogel's Qualitative Organic Chemical Analysis 6th Ed., Pearson, 2009.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education, 2009.
5. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson, 2012.
6. Vogel's Qualitative Inorganic Analysis 7th Edn, Revised by G Svehla, Pearson 2009.

F.Y. B.Sc. Semester II		
Title of the Course and Course Code	**Ionic Equilibrium & Chemical Bonding CHE1201**	**Number of Credits : 02**

Course Outcomes (COs)

On completion of the course, the students will be able to:

CO1	Recall and outline the fundamental concepts of Ionic Equilibrium, Colligative Properties, Solid State and Chemical bonding.
CO2	Explain theory of weak and strong electrolyte and make use of solubility and ionic products in qualitative analysis.
CO3	Apply colligative properties to calculate molecular weight of non-electrolyte and electrolyte. Examine Van't Hoff's factor and degree of dissociation of electrolyte by colligative property.
CO4	Explain and elaborate fundamental laws of crystal structure, identify and draw seven crystal systems. Explain Bragg's equation and analyze X-ray diffraction of the crystal system.
CO5	Compare theories of chemical bonding and classify the types of hybridization and explain geometries of molecules.
CO6	Solve numerical problems based on Ionic Equilibrium, Colligative Properties, Solid State.

Unit No.	Title of Unit and Contents	No of Lectures
I	**Solid State** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, Qualitative idea of point and space groups, seven crystal systems and Bravais lattices, X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method, Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Relation between radius and edge, packing fraction and density of crystal.	10
II	**Ionic Equilibrium** Ostwald dilution law, verification, limitations. Theory of strong electrolyte, Debye-Huckel theory, degree of dissociation, common ion effect, factors which influence degree of dissociation, Solubility equilibria, solubility product and ionic product and its application in qualitative analysis.	6
III	**Theory of dilute solutions: Colligative Properties** Colligative properties, lowering of vapour pressure, measurement of lowering of Vapour pressure, boiling point elevation, measurement of elevation of boiling point by Landsberger 's method, depression in freezing point method, Beckmann's method, Osmotic Pressure, Application of colligative properties to determine molecular weight of non-electrolyte, abnormal	8

	molecular weight, Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property and numerical.	
IV	**Chemical Bonding** Electronic theory of valence, attainment of stable configuration, Types of bonds – ionic, covalent, coordinate, metallic bonds - qualitative idea. Types of overlaps: s-s, s-p, p-p, p-d, d-d and their examples, Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation. Born-Haber cycle and its application, solvation energy, Covalent bond: Lewis structure, Valence Bond Theory (Heitler-London approach). Pauling-Slater Theory. Concept of hybridization, equivalent and non-equivalent hybrid orbitals. Types of hybridization involving s, p, & d orbitals, hybridization geometries in the molecules like i) BeF_2 ii) BF_3 iii) $[MnCl_4]^{2-}$ iv) $[Ni(CN)_4]^{2-}$v) $Fe(CO)_5$ vi) $[Cr(H_2O)_6]^{2+}$, vii) IF_7, Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, PCl_6^-, SF_6, SO_4^{2-}, ClF_3, Cl_2O, BrF_5, I_3^-, BrF_2^+, $TeCl_4$, XeO_3.	12

References:

1. Principles of Physical Chemistry by Maron and Prutto, 1992.
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa, 2004.
3. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP, 2000.
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson, 2013.
5. Essentials of physical chemistry Bhal, Tuli and S. Chand, 2010
6. Fundamentals of Analytical Chemistry, Skoog, West and Haller, 1963.
7. J. D. Lee Concise Inorganic Chemistry: Fifth Edition, Wiley, 2008.
8. Bodie Douglas and DarlMcdaniel Concepts and Models of Inorganic Chemistry Third Edition, Wiley, 1983.
9. Duward Shriver, P. W. Atkins Inorganic Chemistry, Fifth Edition, Oxford University Press 2002.
10. Donald A. Tarr, Gary Miessler Inorganic Chemistry Third Edition, Pearson, 2013.
11. F. Albert Cotton and Geoffrey Wilkinson Advanced Inorganic Chemistry, Sixth Edition2013.
12. A. Bahl, B. S. Bahl, and G.D. Tuli, Essentials of Physical Chemistry, S. Chand and Co Pvt Ltd 2014. (pages 172-207 for Chemical Bonding).

Title of the Course and Course Code	Stereochemistry, Hydrocarbons & Mole Concept CHE1202	Number of Credits : 02
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall the basic concepts of Chemistry and define terms related to oxidation-reduction, stereochemical and mole concept.	
CO2	Explain the interconversions of stereochemical formula, principles in volumetric analysis and classify isomerism in stereochemistry and distinguish the type of stereoisomers.	
CO3	Solve the problems based on equivalent weight of oxidants, reductants and apply rules to assign Oxidation number.	
CO4	Identify the aromaticity of different chemical compounds and examine reactivity of aromatic compounds. Explain directing effects of the groups in aromatic hydrocarbons.	
CO5	Measure the concentrations of solutions and solve the problems based on acid-base titration. Predict the chirality and determine the configuration of given compounds and compare different agents in chemistry.	
CO6	Propose the reaction mechanism and identify different intermediates in a given reaction mechanism.	

Unit. No.	Title of Unit and Contents	No.of Lectures
I	**Stereochemistry** Introduction to isomerism and its classification. Fischer Projection, Newmann and Sawhorse Projection formulae and their inter conversions. Conformational isomerism in alkanes (Ethane, propane and n-butane) with energy profile diagrams, Geometrical isomerism Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules, Optical isomerism**:** Optical activity, specific rotation, chirality/asymmetry, enantiomers, molecules with two or more chiral-centres, distereoisomers, meso structures, racemic mixture and resolution, relative and absolute configuration, D/L, R/S and E/Z designations.	12
II	**Aromatic Hydrocarbons (10 L)** Aromaticity: Hückel's rule, aromatic character of arenes, homocyclic and polycyclic aromatic hydrocarbons (benzene, naphthalene, anthracene), cyclic carbocations/carbanions and heterocyclic compounds with suitable examples (Pyrrole, furan, thiophene, pyridine and its basicity) with their relevance to industry, Electrophilic aromatic substitution: Reactions of benzene, naphthalene and anthracene sulphonation, nitration, halogenation, Friedle Craft alkylation/acylation reactions, with their mechanis, Directing effects of the groups. Industrial application of aromatic hydrocarbons.	10

III	**Recent Trends in Chemistry** Introduction to research journals in chemistry, search Engine like Sci-Finder, Google Scholar, C on CD, Reaxis, Nobel Prize winners in Chemistry in last five years.	2
IV	**Mole Concept (12 L)** Mole concept – GMV relationship, problems based on mole concept, methods of expressing concentrations, strength, normality, molarity, molality, %w/v, %v/v, ppm, standardization of solutions, primary and secondary standard substances, preparation of standard solution of acids and bases, problems related to acid base titration. Principles involved in volumetric analysis (from practical experiments) to be carried out, Oxidation and Reduction – Definitions of related terms, oxidizing and Reducing agents, Oxidation number, Rules to assign oxidation number. Balancing redox reactions by ion-electron method (both acidic and alkaline medium), Problem based on equivalent weight of oxidants and reductants. Standard Electrode Potential and its application to redox reactions.	12

References:

1. Clayden, J., Greeves, N., & Warren, S. G. (**2012**). *Organic chemistry*. Oxford: Oxford University Press, 2012.
2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, 6th Edition, (Pearson Education), 1992.
3. Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
4. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
5. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
6. J. D. Lee Concise Inorganic Chemistry: Fifth Edition, Wiley, 2007.
7. Bodie Douglas and DarlMcdaniel Concepts and Models of Inorganic Chemistry Third Edition, Wiley, 1994.
8. Duward Shriver, P. W. Atkins Inorganic Chemistry, Fifth Edition, Oxford University Press, 2002.
9. Donald A. Tarr, Gary Miessler Inorganic Chemistry Third Edition, Pearson, 2013.
10. F. Albert Cotton and Geoffrey Wilkinson Advanced Inorganic Chemistry, Sixth Edition, 1962.
11. Sarin and Sarin Numerical problems in Chemistry, 1980.

Title of the Course and Course Code	Chemistry Practical - II CHE1203	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	List the different glass apparatus and identify the correct volumetric glass apparatus required for experiment.	
CO2	Interpret powder diffraction pattern and compare viscosity of different liquids.	
CO3	Apply colligative properties like depression in freezing point and elevation in boiling point to the experiment to find out molecular weight of solute. Use gravimetry to find percentage composition of ZnO and ZnCO3 in the given mixture.	
CO4	Explain and determine heat of solution by measuring the temperature change of solvent during the addition of solute.	
CO5	Measure the pH of solution and evaluate dissociation constant of weak acid and rate constant of acid catalysed ester hydrolysis. Calculate the values of molar gas constants (R) in different units using Eudiometric method.	
CO6	Devise an appropriate titrimetric method to determine strength of different solution, presence of hydroxide/sulphate, carbonate, Mg (II), Fe(II) and minimize error in measuring by calibration of volumetric glasswares. Prepare scientific graphs using MS Excel.	

Unit. No.	Topic	No. of Practicals
I	**Physical Chemistry Practicals (Any FIVE):** Polar plots of *s*, $p_z$orbitals, Relative viscosity of given organic liquids by viscometer, Molar gas constants (R)in different units by eudiometric method, Interpretation of powder diffraction pattern of salts, Dissociation constant of a weak acid by *p*H metryTo determine molecular weight of solute by depression in freezing point method. Naphthalene – Sulphur, To determine molecular weight of given electrolyte (KCl) and on-electrolyte (Urea) by Landberger's method and to study abnormal molecular weight of electrolyte, Scientific graphing of following functions using MS-Excel, Exponential, logarithmic, linear Determination of rate constant of acid catalyzed ester hydrolysis, Heat of solution of potassium nitrate in water.	5
II	**Analytical Chemistry Practicals (Any FIVE)** Cleaning and Maintenance of apparatus and instruments. Calibration of apparatus: Burette, Pipette, Volumetric flask, Thermometers ($1/10^{th}$, 110^0C and 360^0C) Preparation standard solution of 0.05N oxalic acid(exact) and standardization and determination of strength of given 0.05N (approx) $KMnO_4$ solution using two burette method, Determination of acetic acid in vinegar by titrimetric method, Determination of percentage composition of ZnO and $ZnCO_3$ in the given mixture	5

	gravimetrically, Estimation of hydroxide/sulphate and carbonate present together in mixture, Estimation of Fe(II) by using standardized 0.05N (approx) $KMnO_4$ solution. Estimation of the amount of Mg (II) present in the given solution complexometrically.	

References:

1. Khosla, B.D., Garg, V. C. and Gulati Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi, 2011.
2. Garland, C. W. Nibler, J.W. and Shoemaker, D. P. Experiments in Physical Chemistry, 8th Ed. McGrawHill, New York, 2003.
3. Mendham, J., Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2008.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education,2009.
5. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson, 2012.