



गोंय विद्यापीठ

ताळगांव पठार

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(Accredited by NAAC)

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GU/Acad –PG/BoS -NEP/2023/102/33

Date: 21.06.2023

CIRCULAR

The University has decided to implement the UGC Curriculum and Credit Framework for the Undergraduate Programme (CCFUP) of **Bachelor of Science in Chemistry/Bachelor of Science in Chemistry (Honours)** under the National Education Policy (NEP) 2020 from the Academic Year 2023-2024 onwards.

The approved Syllabus of Semesters I and II of the **Bachelor of Science in Chemistry/Bachelor of Science in Chemistry (Honours)** Programme is attached.

Principals of Affiliated Colleges offering the **Bachelor of Science in Chemistry/Bachelor of Science in Chemistry (Honours)** Programme are requested to take note of the above and bring the contents of this Circular to the notice of all concerned.

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,

1. The Principals of Affiliated Colleges offering the Bachelor of Science in Chemistry /Bachelor of Science in Chemistry (Honours) Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa.
2. The Dean, School of Chemical Sciences, Goa University.
3. The Vice-Deans, School of Chemical Sciences, Goa University.
4. The Chairperson, BOS in Chemistry (UG).
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Goa University

Programme Structure for Semester I to VIII Under Graduate Programme- Chemistry

Semester	Major -Core	Minor	MC	AEC	SEC	I	D	VAC	Total Credits	Exit
I	CHC-100 Fundamentals of Chemistry (3T+1P)	CHC-111 Basic Concepts in Chemistry (4)	CHC-131 Introduction to Chemistry (3)		CHC-141 (SEC-1) Water and Soil Analysis (1T+ 2P) OR CHC-142 (SEC-2) Skills in Qualitative Organic Analysis (1T+ 2P) OR CHC-143 (SEC-3) Chemistry of Cosmetics and Perfumes (1T+ 2P)					
II										
III	CHC-200 Concepts in Inorganic and Physical Chemistry (4) CHC-201 Concepts in Organic and Analytical Chemistry(4)	CHC-211 Basic Industrial Chemistry (4)	CHC-231(MC-2) General Introduction to Environment and Sustainability (3)		CHC-241 (SEC-4) Mathematical Aspects in Chemistry (1T+ 2P) OR CHC-242 (SEC-5) Introductory skills in Green Chemistry (1T+ 2P) OR CHC-243 (SEC-6) Drug Synthesis and Analysis (1T+ 2P)					

IV	<p>CHC-202 Organic Chemistry-I (4)</p> <p>CHC-203 Inorganic Chemistry-I (4)</p> <p>CHC-204 Physical Chemistry-I (4)</p> <p>CHC-205 Pharmaceutical Chemistry (2)</p>	<p>CHC-221 (Minor Vocational-1) Chemistry of Laboratory Management (4)</p>								<p>EXT-2 XXX-16X (Course Title) (4)</p>
V	<p>CHC-300 Organic Chemistry-II (4)</p> <p>CHC-301 Inorganic Chemistry-II (4)</p> <p>CHC-302 Physical Chemistry-II (4)</p> <p>CHC-303 Green Chemistry Techniques (2)</p>	<p>CHC-321 (Minor Vocational-2) Food Science and Nutrition (4)</p>				<p>CHC-361 (I) [2] Internsh ip</p>				
VI	<p>CHC-304 Instrumentation in Industrial Chemical Analysis (4)</p> <p>CHC-305 Industrial Pharmaceutical Chemistry (4)</p> <p>CHC-306 Advanced Physical Chemistry-I (4)</p>	<p>CHC-322 (Minor Vocational-3) Instrumentation and Analysis (4)</p>								

	CHC-307 Project (4)									
VII	CHC-400 Advanced Organic Chemistry-II (4) CHC-401 Advanced Inorganic Chemistry-II (4) CHC-402 Advanced Physical Chemistry-II (4) CHC-403- Introduction to Bio-Inorganic chemistry (4)	CHC-411 Advanced Analytical Techniques-I (4) OR CHC-412 Advanced Pharmaceutical Analysis-I (4)								
VIII	CHC-404 Seminar based course (4) CHC-405 Polymer science and technology (4) CHC-406 Solid state chemistry (4) CHC-407 Organometallics (4)	CHC-413 Advanced Analytical Techniques-II (4) OR CHC-414 Advanced Pharmaceutical Analysis-II (4)					CHC-462 Dissertation (D) [12] Dissertation			

* List of Exit Courses along with the syllabus will be provided separately.

Name of the Programme: **B.Sc.(Chemistry)**

Course Code: **CHC-100**

Title of the course: **Fundamentals of Chemistry**

Number of Credits: **3T+1P**

Effective from AY: **2023-24**

Pre-requisites	Nil
Course Objectives:	<ul style="list-style-type: none">● To study the postulates of kinetic theory of gases and understand the deviations of real gases from ideal behaviour.● To study the surface tension and viscosity of liquids.● To introduce the concepts of atomic structure.● To understand the basic concepts in organic chemistry.● To understand the preparation and reactivity of alkanes, alkenes and alkynes.
Content	
Fundamentals of Physical Chemistry Gaseous state Postulates of Kinetic Theory of gases and deviation from ideal behaviour, Vander Waal's equation of state. Critical phenomenon; PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation relation between critical constants and Vander Waal's constants. Law of corresponding states, reduced equation of state. Molecular velocities: root mean square, average and most probable velocities, Qualitative discussion of Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Numerical problems. Liquid State Surface Tension, Units of Surface Tension, Determination of Surface Tension by Capillary Rise Method and stalagmometer method. Viscosity, Units of Viscosity, Poiseuille equation, Measurement of Viscosity by Ostwald Method, Effect of Temperature on Viscosity of a Liquid. Numerical problems.	No of hours 10 05
Fundamentals of Inorganic Chemistry Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to atomic structure. Introduction to Schrodinger equation (equation not to be derived) and wave function. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers and their significance, Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	15

	<p>Fundamentals of Organic Chemistry</p> <p>Basic Organic Chemistry</p> <p>Curved arrow notation, drawing electron movement with arrows, half and double headed arrows, in organic reaction mechanisms. Physical Effects, Electronic Displacements: Inductive Effect, Mesomeric effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pKa values. Aromaticity: Benzenoids and Hückel's rule.</p> <p>Aliphatic Hydrocarbons: Functional group approach for the following reactions</p> <p>(Preparations & reactions) to be studied in context to their structure</p> <p>Alkanes: Preparation: Wurtz reaction, Kolbe's synthesis, Reactions: Free radical Substitution: Halogenation. Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides Reactions: Addition of HX (Markownikoff's and anti-Markownikoff's addition) Alkynes: Preparation: Acetylene from CaC₂ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of HX and bromine.</p>	08
		07
	Total:	45
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	<ol style="list-style-type: none"> 1. A. Bahl and G. D Tuli Essentials of physical chemistry ,S. Chand Publications 2020 2. Puri, Sharma, Pathania Principles of Physical Chemistry ,Vishal publishing Co. 2021 3. G. W. Castellan Physical Chemistry 4th Edition Addison-Wesley Publishing Co.2004 4. C. N. R. Rao University General Chemistry, Macmillan Publishers 1973 5. J. N. Gurtu Physical Chemistry Vol. I , Pragati Prakashan,10th Edition 2016 6. Gurtu and Gurtu Advanced Physical Chemistry, Pragati Prakashan 2019 7. J. D. Lee, <i>Concise Inorganic Chemistry, 5th Edn.</i>; Wiley India, (2003). 8. B. E. Douglas and D. H. McDaniel, <i>Concepts & Models of Inorganic Chemistry</i>, Oxford, 1970. 9. M. C. Day and J. Selbin, <i>Theoretical Inorganic Chemistry</i>, ACS Publications, 1962. 10. B. R. Puri, L. R. Sharma and K. C. Kalia, <i>Principles of Inorganic Chemistry</i>, 33rd Edn, Vishal Publishing Co. 2020 11. S. Prakash, G. D. Tuli, S. K. Basu and R D. Madan, <i>Advanced Inorganic Chemistry</i>, Vol 1, S. Chand & Company Pvt. Ltd. 2013. 12. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. <i>Organic Chemistry</i>, John Wiley & Sons. 2014. 13. McMurry, J.E. <i>Fundamentals of Organic Chemistry</i>, 7th Ed. Cengage Learning India Edition, 2013. 14. Sykes, P. A <i>Guidebook to Mechanism in Organic Chemistry</i>, Orient Longman, New Delhi. 1988. 15. Finar, I. L. <i>Organic Chemistry</i> (Vol. I & II), E.L.B.S., 5th Edition. 2001. 16. Morrison, R.T. & Boyd, R.N. <i>Organic Chemistry</i>, Pearson, 2010. 17. Bahl, A. & Bahl, B.S. <i>Advanced Organic Chemistry</i>, S. Chand, 2010. 18. Francis Carey, <i>Organic Chemistry</i>; 4th edition Edition, Tata McGraw Hill India. 2000. 19. Paula Yurkanis Bruice, <i>Organic Chemistry</i>; 3rd Edition, Pearson Education Asia. 2018. 20. Jerry March, <i>Advanced Organic Chemistry</i>; 4rd Edition, John Wiley, 2007. 	

Course Outcome:	At the end of the course, students will be able to <ol style="list-style-type: none"> 1. Identify the properties of liquid and gases. 2. Explain the applications of liquid and gases. 3. Elucidate the atomic structure based on Quantum theory. 4. Identify the use of curved arrow notations in organic reaction mechanisms. 5. Understand various methods of preparation and reactions of alkanes, alkenes and alkynes.
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Title of the course: Fundamentals of Chemistry

Number of Credits: 01 (Practicals)

Pre-requisites	Nil	
Course Objectives:	<ul style="list-style-type: none"> ● To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required for chemistry. ● To introduce the fundamentals and basic techniques of volumetric and gravimetric estimations. 	
Content		No of hours
	1. Determination of surface tension of two unknown liquids or dilute solutions by stalagmometer method.	04
	2. Determination of viscosity of two unknown liquids or dilute solutions by using Ostwald's viscometer.	04
	3. Study of the variation of viscosity of an aqueous solution with concentration of solute.	02
	4. Pre-Lab session (Laboratory safety, concept of normality and molarity and stoichiometric calculations)	02
	5. Calibration of Burette and Pipettes.	02
	6. To prepare 100 mL of standard 0.1 M $K_2Cr_2O_7$ solution and carry out dilution to 0.05, 0.01, 0.005, and 0.001 M in 100 mL standard flasks	02
	7. Volumetry: To prepare 100 ml of 0.1 N KHP solution and standardize the given approximate 0.1 N NaOH solution.	02
	8. Gravimetric analysis: Determination of percentage composition of the given mixture $ZnO + ZnCO_3$	02
	9. Purification of organic compounds: <ol style="list-style-type: none"> i) Recrystallization of Benzoic acid by using water as solvent and determination of melting point. ii) Distillation of Acetone and determination of boiling point. iii) Sublimation of Naphthalene and Determination of Melting point. 	06
	10. Determination of solubility and chemical nature of both solids and liquids. Water insoluble (Acid//phenol/ Base/Neutral) and water soluble (Acid/Neutral) of given compound. (8 compounds to be analysed)	04
	Total:	30
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Each of the experiments should be done individually by the students.	
References / Readings	<ol style="list-style-type: none"> 1. S. W. Rajbhoj and T. K. Chondhekar, <i>Systematic Experimental Physical Chemistry</i>, Anjali Publication, Second Edition 2000. 2. Khosla, B. D.; Garg, V. C. & Gulati, A. <i>Senior Practical Physical Chemistry</i>, R. Chand & Co.: New Delhi (2011). 3. O. P. Pandey, D. N. Bajpai, S. Giri, <i>Practical Chemistry</i>, S. Chand Publication 2013. 	

	<ol style="list-style-type: none"> 4. Shikha Gulati, J. L. Sharma & Shagun Manocha, <i>Practical Inorganic Chemistry</i>, CBS Publishers, 2017. 5. G. H. Jeffery J. Bassett J. Mendham R C. Denney, <i>Vogel's Textbook of Quantitative Chemical Analysis</i>, 5th Edn., John Wiley, New York. 1989. 6. J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas, <i>Vogel's Textbook of Quantitative Inorganic Analysis</i>, 6th Edn., Pearson Education Asia, 2000. 7. Svehla, G. <i>Vogel's Qualitative Inorganic Analysis</i>, Pearson Education, 2012. 8. A.I. Vogel, A., R. Tatchell, B. S. Furniss, A.J. Hannaford, <i>Vogel's Textbook of Practical Organic Chemistry</i>, 5thEd., Prentice Hall; 2011. 9. D. Pasto, C. Johnson and M. Miller, <i>Experiments and Techniques in Organic Chemistry</i>, 1st Ed., Prentice Hall, 1991. 10. L.F. Fieser, K.L. Williamson, <i>Organic Experiments</i>, 7th edition D. C. Heath, 1992. 11. R.K. Bansal, <i>Laboratory Manual in Organic Chemistry</i>, New Age International, 5thEdition, 2016. 	
Course outcomes	<ol style="list-style-type: none"> 1. To acquire the knowledge and skill of basic volumetric and gravimetric estimations. 2. The students will be able to get hands on experience on the purification techniques for organic compounds. 3. The students will be able to get hands on experience on the identification of chemical nature of organic compounds 	

Name of the Programme: B.Sc.(Chemistry)

Course Code: CHC-111

Title of the course: Basic Concepts in Chemistry

Number of Credits: 4

Effective from AY: 2023-24

Pre-requisites	Nil	
Course Objectives:	<ul style="list-style-type: none">● To define the terms and state laws involved in thermodynamics and chemical equilibrium.● To solve numerical based on chemical energetics and chemical equilibrium.● To understand the development of periodic table and periodic trends.● To explain the theories of acids and bases.● To understand IUPAC nomenclature of organic compounds.● To understand the types of organic reactions, reactive intermediates and importance of selected organic compounds.	
Content		No of hours
	Thermodynamics I Thermodynamics I: Definition of thermodynamic terms, system, surroundings etc. Types of thermodynamic systems and thermodynamic processes. Intensive and extensive properties. Concept of heat and work, first law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and reversible conditions. Numerical problems are expected	08
	Solutions Solutions of liquids in liquids, Raoult's law and deviation from Raoult's Law (Ways of expressing concentration: Molarity, Normality, Molality Mole fraction, parts per million) Solutions of gases in Liquids: Factors influencing the solubility of gases. Henry's law. Numerical problems	05
	Chemical Equilibrium Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Definition of ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.	07
	Introduction to the periodic table Development of the periodic table- Dobereiner's Triads, Newland's Law of Octaves, Mendeleev's periodic table and Modern periodic table (Theories and limitations), Classification of the elements into s,p,d and f -block elements on the basis of electronic configuration, Trends in the periodic table (atomic and ionic size)	12
Acid- Base Theories Arrhenius Concept, Bronsted Theory, The Lux – Flood Solvent Systems, Solvent System theory and Lewis Concept of Acids and Bases. (Theories and limitations)	08	

	<p>Carbon, IUPAC nomenclature of organic compounds, and aromaticity. Valency of carbon-structure of methane, sp³ hybridisation. Selected functional group of organic compounds with IUPAC nomenclature (alkanes, alkenes, alkynes, alcohols, ethers, carboxylic acids, esters, thiol, amine, amides, halides, nitriles, nitro compounds aldehydes and ketones). Concept of aromaticity, Huckel's Rule, nomenclature of benzenoids (halo, nitro, alkyl), naphthalene and anthracene compounds.</p> <p>Types of organic reactions and structure, properties and uses of selected organic compounds Types of organic reactions with two examples of each: addition, elimination, substitution, oxidation, reduction and rearrangement. Structure and stability of intermediates carbocation, carbanion, free radical. Structure, properties and uses of the following selected organic compounds. Ethanol, acetone, ethyl acetate, formaldehyde, acetylene, benzoic acid, n-butane, chloroform, diethyl ether, cresol, benzaldehyde, aniline, urea, glucose, lauric acid. Preparation of ethanol, benzoic acid, acetone, acetylene, ethyl acetate, diethyl ether.</p>	<p>10</p> <p>10</p> <p>Total: 60</p>
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	<ol style="list-style-type: none"> 1. A. Bahl, B.S Bahl and G.D. Tuli, <i>Essentials of Physical Chemistry</i>, S. Chand Publication. 2009. 2. Puri, Sharma and Pathania, <i>Principles of Physical Chemistry</i>. 47th edition. 2020. 3. Castellan, G.W. <i>Physical Chemistry</i> 4th Ed. Narosa. 2004. 4. C. N. R. Rao., <i>University General Chemistry</i>, Macmillan Publishers. 1973 5. J.N.Gurtu <i>Physical Chemistry Vol.I</i>, Pragati Prakashan, 10th Edition. 2016 6. Gurtu and Gurtu <i>Advanced Physical Chemistry</i>, Pragati Prakashan. 2019. 7. Samuel Glasstone <i>Textbook of Physical chemistry</i> Macmillan Publications 2nd Edition. 1953. 8. R.L.Madan <i>Chemistry for degree students</i> S.Chand Publications 2nd revised edition. 2014. 9. J. D. Lee, <i>Concise Inorganic Chemistry</i>, 5th Edn. Wiley India. 2003. 10. P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller & F. A. Armstrong, <i>Shriver & Atkins' Inorganic Chemistry</i>, 5th Edn.; Oxford University Press. 2010.. 11. N. N. Greenwood & A. Earnshaw, <i>Chemistry of the Elements</i>, 2nd Edn., Pergamon Press, Exeter. 1984. 12. F. A. Cottton, G. Wilkinson and P. L. Gaus, <i>Basic Inorganic Chemistry</i>. 3rd Edn. Wiley India. 2007. 13. B. R. Puri, L. R. Sharma and K. C. Kalia, <i>Principles of Inorganic Chemistry</i>, 33rd Edn, Vishal Publishing Co. 2020. 14. S. Prakash, G. D. Tuli, S. K. Basu and R D. Madan, <i>Advanced Inorganic Chemistry</i>, Vol 1, S. Chand & Company Pvt. Ltd. 2013. 15. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. <i>Organic Chemistry</i>, John Wiley & Sons. 2014. 16. McMurry, J.E. <i>Fundamentals of Organic Chemistry</i>, 7th Ed. Cengage Learning India Edition, 2013. 17. Sykes, P. A <i>Guidebook to Mechanism in Organic Chemistry</i>, Orient Longman, New Delhi. 1988. 18. Finar, I.L. <i>Organic Chemistry</i> (Vol. I & II), E.L.B.S., 5th Edition. 2001 19. Morrison, R.T. & Boyd, R.N. <i>Organic Chemistry</i>, Pearson, 2010. 20. Bahl, A. & Bahl, B.S. <i>Advanced Organic Chemistry</i>, S. Chand, 2010. 21. Francis Carey, <i>Organic Chemistry</i>; 4th Edition, Tata McGraw Hill India. 2000 	

	<p>22. Paula Yurkanis Bruice, <i>Organic Chemistry</i>; 3rd Edition, Pearson Education Asia. 2018</p> <p>23. Jerry March, <i>Advanced Organic Chemistry</i>; 4rd Edition, John Wiley, 2007.</p> <p>24. https://www.jagranjosh.com/general-knowledge/list-of-important-organic-compounds-1456306311-1</p>
Course Outcome:	<p>At the end of the course, students will be able to</p> <ol style="list-style-type: none">6. Explain the terms involved in chemical thermodynamics and equilibrium.7. Evaluate different thermodynamic parameters.8. Discuss the development of Modern Periodic table and periodic trends9. Classify the acids and bases using the various theories.10. Write the names and structures of the organic compounds using IUPAC nomenclature.11. Understand the importance of selected organic compounds.

Name of the Programme: B.Sc.(Chemistry)

Course Code: CHC-131

Title of the Course: Introduction to Chemistry

Number of Credits: 3

Effective from AY: 2023-2024

Pre-requisites for the Course:	Nil	
Course Objectives:	<ul style="list-style-type: none">● To introduce chemistry as a scientific discipline● To describe the development of chemistry● To describe the utility of chemistry in medical and industrial fields.● To explain the underlying chemical aspects of chemistry in environment and pollution.● To introduce important Indian scientists and discuss their valuable contributions.	
Content:		No of hours
	1. Importance of science in life Towards scientific approach, involvement of science in daily life, different branches of science: significance and applications (viz: chemistry, physics, biology, microbiology, medical science etc.)	04
	2. History and development of Chemistry History of Chemistry, Different branches of chemistry (Organic, Physical, Inorganic, Analytical, Pharmaceutical, Green chemistry): their evolution and progress. Wöhler's synthesis of urea, Relations of heat to chemical phenomena, Antoine Lavoisier-Mercury Calx, M. Tswett's invention of Chromatography, P. Anastas's principles of Green Chemistry, Important Discoveries in chemistry: Hydrogen, Oxygen, Concept of Atom, X-ray, Rubber, Penicillin, Nuclear reactor, Plastic.	08
	3. Chemistry in medical sciences Classification of Drugs, names and uses of the following drugs with one example each: Antibiotics, Analgesics, Antihistamines, Anticonvulsant, Hypnotics and Sedatives.	04
	4. Medicinal plants Introduction: Importance of plant kingdom in general and medicinal plants in particular. Viz. Tulsi, Aloe vera, Turmeric, Vinca rosea, Cinchona, Datura etc. Compounds obtained from them, their uses and applications.	05
	5. Chemistry & Industry Minerals and ores: general awareness, chemical plants: cost, environmental impact and recycling.	04
	6. Chemistry of Environment & Pollution Introduction to segments of Environment (Atmosphere, Hydrosphere, Lithosphere) Definition of pollutant, pollution. Air Pollution: Composition of Air, Acid rain, Greenhouse effect and Global warming, ozone layer depletion. Water Pollution: Water cycle, Hardness of water, Factors deteriorating the water quality, Eutrophication, Fluoride in drinking water Soil Pollution: Chemical composition of Soil, Soil pollutants, Effects of soil pollution, Control of soil pollution.	08
	7. Indian Scientists and their contributions to nation 1. Jagdish Chandra Bose – Physicist (1858-1937). 2. Anandibai Joshi – Physician (1865 - 1887). 3. Sir C. V. Raman – Nobel laureate & Physicist (1888-1970). 4. Janaki Ammal – Botanist (1897 - 1984).	12

	5. Kamala Sohonie – Bio-chemist (1912 – 1998). 6. Asima Chatterjee – Chemist (1917 – 2006) 7. Anna Mani – Physicist and meteorologist (1918- 2001). 8. Rajeshwari Chatterjee – Scientist (1922-2010). 9. A.P. J. Abdul Kalam – Scientist (1931-2015) 10. Darshan Ranganathan – Chemist (1941 – 2001). 11. Prof. C.N.R Rao- Chemist (1934) 12. S. Nambi Narayanan- Aerospace Scientist (1941) 13. Raghunath Mashelkar- Chemical Engineer (1943)	
	Total:	45
Pedagogy:	Mainly lectures and tutorials with assignments	
References/Readings:	1. A History of Chemistry by Sir Edward Thorpe, The Rationalist Press Association, Ltd., 1909, Vol I. 2. Chemistry by Richard Harwood, Cambridge University press. published 1998. 3. Organic Chemistry. Morrison, Boyd, Bhattacharjee. Pearson. 2010 4. Fundamentals of Chemistry, Vol. 1. A History of Chemistry. Fabrizio Tuifivo and Ferruccio Trifivo from UNESCO - Encyclopedia Life Support Systems 5. Food Science, Nutrition and Safety, Sukhneet Suri and Anita Malhotra, Pearsons. 2013 6. Medicinal Chemistry by A. Kar. New Age International Pvt. Ltd Publishers, 2007 7. Jagdish Chandra Bose by Sanjay Goyal. Prabhat Prakashan. 2015. 8. First lady doctor of India. The Telegraph. Retrieved 2016-05-01. 9. Lilavati's Daughter's-The Women Scientists of India by Indian Academy of Sciences (Bangalore) 2008.* 10. Prof. C. V. Raman: A biography by Uma Parameswaran., Penguin, Ed. 2011 11. https://ethw.org/Rajeshwari_Chatterjee 12. https://www.sanskritimagazine.com/rajeswari-chatterjee-first-woman-scientist/ 13. https://www.indiatimes.com/technology/news/rajeshwari-chatterjee-karnataka-women-engineer-518515.html 14. Wings of fire: An Autobiography by A. P. J. Abdul Kalam. Universities Press. 2009 15. https://medium.com/sci-illustrate-stories/darshan-ranganathan-84c88a96d3a 16. https://feminisminindia.com/2019/03/19/darshan-ranganathan-organic-chemistry/ 17. https://www.jncasr.ac.in/sites/default/files/2022-04/CV-PROF%20CNR%20RAO.pdf 18. https://journalsofindia.com/c-n-r-rao-and-his-contributions/ 19. https://en.wikipedia.org/wiki/Nambi_Narayanan 20. https://www.outlookindia.com/magazine/story/a-gladiator-in-the-space-ring/299101 21. https://www.beaninspirer.com/raghunath-anant-mashelkar-story-indomitable-will-great-scholar-indian-chemical-engineer/ 22. Durdamya Aashawadi Dr Raghunath Mashelkar, Dr. Sagar Deshpande, Sahyadri Prakashan. [A Marathi Book] 23. S. M. Khopkar, Environmental Pollution Analysis, New Age International Limited, Publishers, New Delhi. 2020 24. A.V. Salker, Environmental Chemistry: Pollution and Remedial Perspective, Narosa Publishing House, Navi Mumbai. 2017 [*Contains Anandibai Joshi, Janaki Ammal, Kamala Sohonie, Asima Chatterjee, Anna Mani, Darshan Ranganathan]	
Course Outcomes:	Students will be able to: 1. Describe the chemistry as a scientific discipline. 2. Describe the development and branches of Chemistry 3. Appreciate the utility of chemistry in day-to-day life. 4. Explain the preliminary chemical aspects of environment and pollution. 5. Describe and appreciate the contributions of important Indian scientists.	

Name of the Programme: B.Sc.(Chemistry)

Course Code: CHC-141

Title of the course: Water and Soil Analysis

Number of Credits: (1T+2P)

Effective from AY: 2023-24

Pre-requisites	Nil	
Course Objective:	<ul style="list-style-type: none">● To define the various terms encountered in sampling and study the techniques involved.● To study methods that can be employed for the determination of the various physico-chemical parameters of water and soil.	
Content		No of hours
	1. Sampling Techniques: Terms encountered in sampling: the population or the universe, Sample, Sampling unit, increment, the gross sample, the sub sample, Analysis sample, Bulk ratio, Size to weight ratio, Random sampling, Systematic sampling, Multistage sampling, Sequential sampling. Sampling of Liquids and Solids. Preservation, storage and preparation of sample solution.	05
	2. Analysis of soil: Composition of soil, Concept of pH and pH measurement, chelation, chelating agents, use of indicators. Bulk density, Specific gravity, moisture content, water holding capacity, pH, electrical conductivity, alkalinity, calcium, magnesium and organic matter.	05
	3. Analysis of water: Definition of pure water, sources responsible for contaminating water, water purification methods (For domestic and industrial waters). Water analysis: Dissolved oxygen, free carbon dioxide, B.O.D., C.O.D. and total carbohydrates	05
	Total:	15
Pedagogy	Mainly lectures and tutorials. Seminars / term papers / assignments / presentations / industry visits / mini projects / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	<ol style="list-style-type: none">1. A. K. De, <i>Environmental Chemistry</i>. New age international Publishers, 4th Edition. 20072. B. K. Sharma, <i>Environmental Chemistry</i>. Krishna Prakashan Media (P) Ltd. 2014.3. Svehla, G. <i>Vogel's Qualitative Inorganic Analysis</i>, Pearson Education, 2012.4. Mendham, J. <i>Vogel's Quantitative Chemical Analysis</i>, Pearson, 2009.5. Dr Sunita Rattan <i>Experiments in Applied chemistry</i>, 3rd Edition, -S. K. Kataria and Sons. 20116. Pandey, O.P., Bajpai D. N. & Giri S. <i>Practical Chemistry</i>, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014	
Course Outcome:	At the end of the course students will be able to <ol style="list-style-type: none">1. Understand the fundamentals and techniques of water and soil sampling.2. To describe the methods for the determination of various physico-chemical parameters of soil and water	

Title of the course: Water and Soil Analysis**Number of Credits: 02 (Practicals)**

Pre-requisites	Nil	
Course Objectives:	<ul style="list-style-type: none">• To help in better understanding of the techniques of sampling soil and water studied in theory, through demonstration.• To apply the knowledge studied in theory for the determination of various physico-chemical parameters of soil and water and thereby develop related skills.	
Content		No of hours
	<ol style="list-style-type: none">1. Techniques of soil sampling (Demonstration)2. Determination of pH of soil sample3. Determination of Bulk density of soil sample4. Determination of Moisture content of soil sample5. Determination of conductivity of soil sample6. Determination of organic content in soil sample7. Techniques of water sampling (Demonstration)8. Determination of pH and conductivity of a water sample9. Determination of dissolved oxygen (DO) in a given water sample10. Determination of magnesium content11. Determination of total hardness in the water sample12. Determination of acidity of a water sample13. Determination of alkalinity in a given water sample14. Measurement of dissolved CO₂15. Determination of total solids in water.	15 x 4 = 60
	Total:	60
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Minimum two samples each to be analysed for every experiment involving soil and water analysis (4 hours each practical session).	
References / Readings	<ol style="list-style-type: none">1. A. K. De, <i>Environmental Chemistry</i>. New age international Publishers, 4th Edition. 20072. B. K. Sharma, <i>Environmental Chemistry</i>. Krishna Prakashan Media (P) Ltd. 2014.3. Svehla, G. <i>Vogel's Qualitative Inorganic Analysis</i>, Pearson Education, 2012.4. Mendham, J. <i>Vogel's Quantitative Chemical Analysis</i>, Pearson, 2009.5. Dr Sunita Rattan <i>Experiments in Applied chemistry</i>, 3rd Edition, -S. K. Kataria and Sons. 20116. Pandey, O.P., Bajpai D. N. & Giri S. <i>Practical Chemistry</i>, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014.	
Course outcomes	At the end of the course students will be able to: <ol style="list-style-type: none">1. Observe and understand the techniques employed for soil and water sampling.2. Develop skill for the determination of the various physico-chemical parameters of soil and water.	

Name of the Programme: B.Sc.(Chemistry)

Course Code: CHC-142

Title of the course: Skills in Qualitative Organic Analysis

Number of Credits: (1T+2P)

Effective from AY: 2023-24

Pre-requisites	Nil	
Course Objective:	<ul style="list-style-type: none">To understand the theoretical aspects of qualitative organic analysisTo explain mechanistically the chemical tests in qualitative organic analysis.	
Content		No of hours
	1. Chemical nature of organic compounds Nature of organic compounds based on physical state of the following compounds: benzoic acid, m-nitroaniline, β -naphthol, acetone, aniline, naphthalene, benzophenone, m-dinitrobenzene (to be shown with structure); presence of saturated and unsaturated compounds using bromine water, potassium permanganate solution; water solubility of organic compounds (any two water soluble and water insoluble compounds); chemical nature of organic compounds (to be explained with reactions)- water insoluble acid/phenol/base/neutral, water soluble acid/phenol/neutral.	07
	2. Analysis of hetero elements and functional groups Detection and presence of hetero elements - N/S/X (to be explained with reactions); Detection and presence of functional groups – CH(O) acid- salicylic acid, CH(O) phenol- β -naphthol, CH(O) neutral- acetone, benzaldehyde, ethyl acetate and ethanol, CH(O)N acid p-nitrobenzoic acid, CH(O)N phenol -nitrophenol, CH(O)N base - nitroaniline , CH(O)N neutral- urea, CH(O)N,S neutral- thiourea, CH(O)Cl neutral-chlorobenzene (to be explained with reactions).	06
	3. Purification Techniques Recrystallisation, distillation, sublimation. Determination of physical constants of organic compounds- melting point, boiling point.	02
	Total:	15
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / mini projects / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	<ol style="list-style-type: none">Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., <i>Textbook of Practical Organic Chemistry</i>, Prentice-Hall, 5th edition, 1996.Mann, F.G. & Saunders, B.C. <i>Practical Organic Chemistry</i> Orient-Longman, 1960.Pandey, O.P., Bajpai D. N. & Giri S. <i>Practical Chemistry</i>, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014.N. K. Vishnoi, <i>Advanced Practical Organic Chemistry</i>, third edition, 2010	
Course Outcome:	At the end of the course students will be able to <ol style="list-style-type: none">Explain reactions involved in identifying the chemical nature of organic compounds.Understand role of sodium fusion extract in detecting the presence of heteroelements.Explain the reactions of various functional groups present in organic compounds.Understand the need for purification techniques in organic analysis.	

Laboratory Course
Number of Credits: 02

Pre-requisites	Nil	
Course Objective:	<ul style="list-style-type: none"> To get hands on experience for the systematic qualitative analysis of the organic compounds. To learn the purification techniques for organic compounds. 	
Content		No of hours
	1. Purification of organic compounds:	
	i) Solids by recrystallization process using water and ethanol as solvent and determination of melting point.	4
	ii) Simple distillation of acetone and determination of boiling point.	2
	iii) Sublimation of naphthalene/ anthracene/ camphor and determination of melting point.	2
	2. Identification of unknown organic compounds based on water solubility, chemical type, elemental analysis, group test and physical constants (organic spotting)	
	i) Water soluble solids (Acid and Neutral) – <i>Any 3</i>	(3×4 = 12)
	ii) Water insoluble solids (Acid, Base, Phenol and Neutral) – <i>Two compounds to be analysed of each category.</i>	(8×4 = 32)
	iii) Liquids: Water miscible neutral, water immiscible (base/ neutral)	(2×4 = 08)
	Total:	60
Pedagogy:	Mainly laboratory work to be demonstration to students, supervision of their labwork. Prelab and Post-lab exercises / journal assessment.	
References / Readings	<ol style="list-style-type: none"> Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960. Pandey, O.P., Bajpai D. N. & Giri S. Practical Chemistry, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014. N. K. Vishnoi, Advanced Practical Organic Chemistry, third edition, 2010 	
Course outcomes	At the end of the course students will be able to: <ol style="list-style-type: none"> Get hands on experience for the systematic qualitative analysis of the organic compounds. Acquire skills in applying purification and separation techniques for organic compounds 	

Name of the Programme: B.Sc.(Chemistry)

Course Code: CHC-143

Title of the course: Chemistry of Cosmetics and Perfumes

Number of Credits: (1T+2P)

Effective from AY: 2023-24

Pre-requisites	Nil	
Course Objective:	<ul style="list-style-type: none">● To explain the term Cosmeticology and define cosmetics.● To describe preparation and uses of cosmetic products.● To define herb and classify herbal cosmetics.● To study the formulation and preparation of herbal skincare and haircare products.● To understand the classification of perfumes and categorise as per the ingredients.● To understand the importance of essential oils in cosmetic industries.● To describe the general methods of obtaining volatile oils from plants and its composition of volatile oils.	
Content		No of hours
	1. Chemistry of Cosmetics Meaning of Cosmeticology. Definition of cosmetics as per EU and Indian guidelines. A general study including preparation and uses of the following: Hair dye, shampoo, face powder, shampoo, lipsticks, talcum powder, creams (cold, vanishing and shaving creams). Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Classification of herbal cosmetics. Herbal cosmetics for skin care (face packs, soaps). Herbal cosmetics for hair care: Henna and Hibiscus	08
	2. Chemistry of Perfumes Definition of Perfume. Formulation of Perfume. Sense of perfume smell-Top notes, middle notes and base notes. Classification of perfumes: Traditional and Modern. Fragrance Wheel. Comparison between deodorant and antiperspirant. Triclosan as antibacterial agent-Structure. Benefits and adverse effects of perfumes. Natural and artificial flavours with examples. Essential oils and the importance in cosmetic industries with reference to peppermint oil-Menthol, clove Oil-Eugenol, lemongrass-Geraniol, Structure, synthesis and use of 2-phenyl ethyl alcohol, Sources, Structure and uses of Jasmone, Civetone, Muscone. Methods of separation of essential oils (steam, water and vacuum distillation), solvent extraction, mechanical expression.	07
	Total:	15
Pedagogy	Mainly lectures and tutorials. Seminars / term papers / assignments / presentations / industry visits / mini projects / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	<ol style="list-style-type: none">1. Harry's Cosmeticology- Wilkinson, J. B., Harry, Ralph G. Hill Books, Leonard, 19732. Cosmetics science and Technology, Edward Sagarin, Inter Science Publications, 1957.3. De Navaree, The Chemistry and Manufacture of Cosmetics- vol. 1 to 4 (Von. Nostrand) 1962.4. Modern Cosmetics. Edgar George Thomssen, Francis Chilson (Universal Publishing). 19645. Formulation and Function of Cosmetics. Jellinek. S, Wiley Blackwell, 1971.6. Cosmetic & Skin. F.V. Wells and I. Lubowe, Reinhold Publications, 1964.7. Cosmetics- Formulation, manufacturing and Quality Control, P. P. Sharma, 5th Edition, 2014.	

	<ol style="list-style-type: none"> 8. The Principles and Practice of Modern Cosmetics: Cosmetic materials, their origin, characteristics, uses and dermatological action, Ralph Gordon Harry, Chemical Publishing Company, 1963. 9. Drug and Cosmetics Act 1940 10. Vimaladevi M. Textbook of herbal cosmetics, CBS Publishing 1st Ed. 2015. 11. H. Panda, The complete technology book on herbal beauty products with formulation and processes, Asia pacific business press Inc. 2005. 12. John Gordon, Essential oils: A practical guide, Aetheric publishing. 2017 13. Ernst T. Theimer, Fragrance Chemistry: The Science of the Sense of Smell, Academic Press, 1982. 14. Berger, Ralf Günter, Flavors and Fragrances: chemistry, bioprocessing and sustainability (ed.), 1st edition. 2007. 15. K. Husnu Can Baser, Gerhard Buchbauer, Handbook of Essential Oils: Science, Technology, and Applications, Second Edition, CRC Press, 2015. 16. Olindo Secondini, Handbook of Perfumes and Flavors, 1990.
<p>Course Outcome:</p>	<p>At the end of the course students will be able to</p> <ol style="list-style-type: none"> 1. Define cosmetics as per EU and Indian guidelines. 2. Describe the preparation and uses of various cosmetic products mentioned. 3. Describe the formulation and packaging of cosmetics for hair - Shampoo and hair dye. 4. Classify herbal cosmetics. 5. Explain the terms herbal medicine and herbal medicinal products. 6. Describe the preparation of herbal drug. 7. Describe the formulation and preparation of Herbal cosmetics for skin care and hair care. 8. Classify the perfumes and categorize the perfume ingredients. 9. Explain the importance of essential oil in cosmetic industries. 10. Describe the composition of different volatile oils and methods of obtaining them.

Laboratory Course
Number of Credits: 02

Pre-requisites	Nil	
Course Objective:	<ul style="list-style-type: none"> ● To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required for Cosmeticology and perfume chemistry. ● To understand the concept of cosmetics and develop formulation skills in the preparation of various cosmetic products. 	
Content		No of hours
	1. Preparation of cosmetic products. (Any 8) Explain in brief about cosmetic ingredients Talcum powder, face powder, Shampoo, hair dye, Cold cream, Vanishing cream, Nail polish, nail polish remover, Shaving cream, Toothpaste, Lipsticks, eyeliner.	(8 x 3) = 24
	2. Preparation of Herbal cosmetics and its evaluation. (Any 4) Turmeric face pack, Papaya face pack, Henna hair dye, Herbal lotion, Herbal soap, Herbal shampoo	(4 x 4) = 16
	3. Extraction of essential oils as perfumery and identification of compound. (Any 5) a) Steam distillation of cinnamon sticks to cinnamon oil and identification of Cinnamaldehyde. b) Steam distillation of cloves to clove oil and identification of Eugenol. c) Water distillation of lemon peel/Orange peel to give D-Limonene. d) Extraction of banana oil from bananas (Esters as perfumery). e) Extraction of rose oil f) Extraction of citronella oil from lemongrass plant. g) Extraction of caffeine from tea. h) Extraction of jasmine oil from Jasmine flowers and identification of jasmone.	(5 x 4) = 20
	Total:	60
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.	
References / Readings	1. A.I. Vogel, A., R. Tatchell, B. S. Furniss, A.J. Hannaford, Vogel's <i>Textbook of Practical Organic Chemistry</i> , 5 th Ed., Prentice Hall; 2011. 2. Belinda Carli, <i>Cosmetic Formulations: A beginners Guide</i> , 7 th Edn, 2020. 3. Andre O. Barel Marc Paye Howard I. Maibach, <i>Handbook of Cosmetic Science and Technology</i> -Third and fourth Edition, 2009. 4. ProFound Klaus Duerbeck, <i>Natural Ingredients for Cosmetics</i> , 2005.	
Course outcomes	At the end of the course students will be able to: <ol style="list-style-type: none"> 1. Understand the concepts of various cosmetic products. 2. Prepare various cosmetic products. 3. Prepare various herbal cosmetic products. 4. Extract naturally flavoured compounds/essential oils. 	