



Deccan Education Society's
Fergusson College (Autonomous)
Pune

Learning Outcomes - Based Curriculum
for 3/4 years B. Sc. / B. Sc. (Honours) Programme
as per guidelines of
NEP-2020

for
S. Y. B. Sc. (Chemistry)
With effect from Academic Year
2024-2025

Program Outcomes (POs) for B. Sc. Programme	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of a 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, exhibit 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 hypotheses 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 a 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	<p>Academic Competence:</p> <ul style="list-style-type: none"> 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	<p>Personal and Professional Competence:</p> <ul style="list-style-type: none"> 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	<p>Research Competence:</p> <ul style="list-style-type: none"> 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	<p>Entrepreneurial and Social Competence:</p> <ul style="list-style-type: none"> 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.

Semester	Paper	Paper Code	Paper Title	Type	Credits
III	Major	CHE-201	Physical and Analytical Chemistry	Theory	4
		CHE-200	Chemistry Practical - III	Practical	2
	Minor	CHE-211	Organic and Inorganic Chemistry	Theory	2
		CHE-212	Chemistry Practical - III	Practical	2
	OE-V	CHE-220	Nutritional Chemistry	Theory	2
	VSC	CHE-230	Industrial Skills for Chemists	Theory	2
	SEC-III	CHE-240	Basic Laboratory Skills	Theory	2
	CEP-I	CHE-245	Community Engagement Programme	Theory	2
IV	Major	CHE-251	Organic and Inorganic Chemistry	Theory	4
		CHE-250	Chemistry Practical - IV	Practical	2
	Minor	CHE-261	Physical and Analytical Chemistry	Theory	2
		CHE-262	Chemistry Practical - IV	Practical	2
	OE-VI	CHE-270	Chemistry of Cosmetology	Theory	2
	VSC	CHE-280	Biomolecules and Bioanalytical Techniques	Theory	2
	SEC-IV	CHE-290	Chemical Analysis	Theory	2
	FP-II	CHE-295	Field Project	Theory	2

**OE – Open Elective, SEC- Skill Enhancement Course. VSC- Vocational Skill Course, CEP- community Engagement programme, FP- Field Project*

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory / Practical	No. of Hours per Week Theory / Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

S. Y. B. Sc. Semester III		
CHE-201	Physical and Analytical Chemistry (Major- Theory)	Credits: 4 Hours: 60
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's cognitive level
CO1	Recall the fundamental concepts of chemical kinetics, solutions, and photochemistry. Recall fundamental concepts of structures, equations, laws and principles related to atoms, molecules, solution, reactions and analysis.	1
CO2	Classify the various chemical reactions on the basis of order and quantum yield. Interpret the vapour pressure-composition, temperature-composition diagrams of ideal and non-ideal solutions and colligative properties. Classify and explain different qualitative and quantitative analysis methods for compounds.	2
CO3	Solve the numerical based on chemical kinetics, solutions, photochemistry, common ion effect and solubility product. Apply concepts of chemistry in solving numerical and chemical properties. Apply the volumetric knowledge in commercial samples. Classify cations into groups.	3
CO4	Analyse the temperature composition diagram, effect of temperature, order and quantum yield of the chemical reactions. Perform standardisation of solution and calibrate volumetric glassware. Identify interfering anions and perform its removal.	4
CO5	Arrange and apply the integrated rate equation to study the chemical reactions. Select group reagent, precipitating agents for different cations, anions and a suitable indicator for titration. Analyse, detect, separate and confirm different acidic and basic radicals, elements and functional groups in a given compound.	5

CO6	Interpret the molecularity and order of reaction, temperature-composition curves and physical behaviour of solutions. Interpret titration curves and articulate the types along with the role of indicators.	6
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Unit	Content	No. of hours
I	<p>Chemical Kinetics:</p> <p>Introduction to Chemical kinetics, molecularity and order of reaction, reaction rates, rate laws, rate Constants, and its significance, Integrated rate law expression and its characteristics - zero order, first order, second order equal and unequal initial concentrations, third order reaction with equal concentration, differential rate laws for half-integral order reactions, pseudo molecular reactions, factors affecting rate of reaction, determination of order of reaction, collision theory of reaction rates, transition state theory, numerical.</p>	12
II	<p>Solutions and their properties:</p> <p>The solution process at molecular level, saturated solutions and solubility, factors affecting solubility, ways of expressing concentration, Solution of liquids in liquid , Raoult's law, ideal and non-ideal solutions, Problems based on Raoult's law and Henry's law, vapor pressure–composition diagram of ideal and non-ideal solution, temperature composition diagram of miscible binary solutions, distillation from temperature–composition diagram, azeotropes, Theory of fractional distillation, steam distillation, and solutions of solids in liquid.</p> <p>Physical behavior of solutions (colligative properties): lowering of vapour pressure solution, elevation of boiling point of solution, depression in freezing point of solution, osmotic pressure, and their methods of measurement.</p>	12
III	<p>Photochemistry:</p> <p>Introduction, difference between thermal and photochemical processes. Laws of photochemistry: Grothus - Draper law, Stark-Einstein law. Quantum yield, Factors affecting quantum yield and experimental methods for the determination of quantum yield. fluorescence, phosphorescence, chemiluminescence, and numericals.</p>	6
IV	<p>Introduction to Analytical Chemistry:</p> <p>Introduction, chemical analysis, applications of chemical analysis, sampling, types of analysis, common techniques, instrumental methods, other techniques, factors affecting the choice of method.</p>	2
V	<p>Errors in Quantitative Analysis:</p> <p>Introduction, Error, accuracy, precision, methods of expressing accuracy and precision, classification of errors, significant figures and computations, distribution of random errors, mean and standard deviations, reliability of results, numerical.</p>	4

VI	<p>Inorganic Qualitative Analysis:</p> <p>Basic principle, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals, removal of interfering anions (phosphate and borate), detection of acidic radicals.</p>	6
VII	<p>Qualitative & Quantitative Analysis of Organic Compounds:</p> <p>Qualitative Analysis: Types of organic compounds, analysis of binary mixtures. Quantitative Analysis: Analysis–estimation of C, H, (O) by combustion tube, detection of nitrogen, sulfur, halogen and phosphorous by Lassigen’s test, estimation of nitrogen by Dumas’s Kjeldahl’s method, estimation of halogen, sulphur and phosphorus by Carius Method, determination of empirical and molecular formula, numerical problems.</p>	8
VIII	<p>Non-Instrumental Volumetric Analysis:</p> <p>Introduction of volumetric (titrimetric) analysis, titrant, titrand, direct titration, indirect titration-back and blank titration Introduction, methods of expressing concentrations, primary and secondary standard solutions, Apparatus used and their calibration: burettes, micro burettes, volumetric pipettes, graduated pipettes, volumetric flask, methods of calibration,</p> <p>Acid–Base Titrations Acid base indicators, Ostwald’s Theory of acid base indicators, mixed and universal indicators Strong acid–Strong base, Weak acid– strong base, Weak Acid-Weak base titration, titration curve</p> <p>Redox Titrations Principle of redox titration, detection of equivalence point using suitable indicators, Titration of oxalic acid vs KMnO₄, Application</p> <p>Complexometric Titrations Principle, Mg-EDTA titration, Role of Metal ion indicators in EDTA titration, choice of indicators, Application</p> <p>Iodometric Titration: Iodometry (Direct and Indirect Titration) Principle, detection of end point, difference between iodometry and iodimetry, Standardization of sodium thiosulphate solution, Applications</p>	10

References:

1. Principles of Physical Chemistry by Maron and Prutton, 1992
2. Mortimer, R. G. Physical Chemistry 3rd Ed. elsevier: NOIDA, UP, 200.
3. Chemistry The Central Science 14 th Ed. Person
4. Mathematics in Chemistry by Sourav Pal and K V Raman 2004
5. Physical Chemistry: A Molecular Approach by Donald A. McQuarrie and John D. Simon.
6. Fundamentals of Analytical Chemistry by Skoog, West, Holler and Crouch
7. A textbook of macro & semi micro qualitative analysis by A.J. Vogel, fifth edition
8. Quantitative Organic Analysis, fourth edition, A.J. Vogel, ELBS
9. Vogel’s textbook of Quantitative Analysis, sixth edition J. Mendham, R.C. Denney, J.D. Barnes, and MJK Thomas.
10. Analytical Chemistry by G.D. Christian, 6th Edition. 6) Vogel’s Textbook of Quantitative Analysis, 6th Edition J. Mendham, R. C. Denney, J. D. Barnes, and MJK Thomas

S Y. B. Sc. Semester III		
CHE-200	Chemistry Practical - 3 (Major-Practical)	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the procedure, list the apparatus, chemicals and understand the objective of the experiment.	1
CO2	Carry out and examine the given experiment by using different techniques.	2
CO3	Analyze the physical properties using different methods and compare the observations with standard values. Apply computational data to explain chemical phenomena.	3
CO4	Validate and infer the rate constant, molecular weight, critical solution temperature, solubility product etc. and conclude the results	4
CO5	examine the techniques used while performing the experiments.	5
CO6	Propose the skills and techniques to industrial applications.	6

Expt. Type	Title of the Experiment (Any 15)
Physical Chemistry Practicals	<ol style="list-style-type: none"> Determination of the critical solution temperature of the phenol water system. Determination of the molecular weight of a given organic liquid by steam distillation. Study and compare the hydrolysis of an ester using HCl and H₂SO₄ catalyst. Determination of the solubility and solubility product of sparingly soluble salts (BaSO₄/PbSO₄) by conductometry. Determination of the molecular weight of a given substance using Landsberger's method. Determination of the molecular weight of a given solute by the freezing point of naphthalene. Evaluate the order of the reaction (a=b) of KI and K₂S₂O₈. Determination of solubility of benzoic acid at different temperatures and to determine ΔH of dissolution process. Optimize structure and spectra of molecules using standard softwares of computational chemistry Study the conformational isomers of ethane or butane using standard softwares of computational chemistry. Preparation of buffer solutions of different pH using pH meter.
Analytical Chemistry Practicals	<ol style="list-style-type: none"> Determination of Ca in presence of Mg using EDTA. a) Preparation of standard 0.05N oxalic acid solution and standardization of approx 0.05N KMnO₄ solution. b) Determination of the strength of given H₂O₂ solution with standard 0.05N

	<p>KMnO₄ solution.</p> <p>14. a) To determine the amount of Aspirin from a given tablet. b) To find the absolute error & relative error with reference to the mean of analysis. c) To find the standard deviation & relative standard deviation with reference to the mean of analysis.</p> <p>15. Estimation of Nickel/Aluminum from the given salt solution by using Eriochrome Black-T indicator (Back titration method).</p> <p>16. To determine the amount of copper from the given solution iodometrically.</p> <p>17. a) To choose the best indicator in the titration between standard 0.05N oxalic acid solution & approx. 0.05N NaOH. b) To standardize the approx. 0.05N NaOH solution against standard 0.05N oxalic acid solution using the best indicator.</p> <p>18. To determine the amount of acetic acid in commercial vinegar by titrating with approx. 0.05N NaOH solution using selected best indicator</p> <p>19. To find out the amount of Acetone in the given solution iodometrically.</p> <p>20. Synthesis of Copper nanoparticles and its characterisation spectrophotometrically.</p> <p>21. Report of one day industrial study tour / survey</p>
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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 8thEd. 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.

S. Y. B. Sc. Semester III		
CHE-211	Organic and Inorganic CHEMISTRY (Minor-Theory)	Credits: 2 Hours: 30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the basic concepts of Chemistry and define terms related to stereochemical and Aromatic compounds. Remember different terms of concentration.	1
CO2	Explain the interconversions of stereochemical formula, and classify isomerism in stereochemistry and distinguish the type of stereoisomers.	2
CO3	Solve the problems on Stereochemistry and Aromaticity. Solve the problems based on equivalent weight, molarity, molarity, normality.	3
CO4	Identify the aromaticity of different chemical compounds and examine reactivity of aromatic compounds. Explain directing effects of the groups in aromatic hydrocarbons.	4
CO5	Predict the chirality and determine the configuration of given compounds and compare different isomers. Measure the concentration of solution and solve the	3

	problems based on acid- base titration.	
CO6	Propose the reaction mechanism and identify different intermediates in a given reaction mechanism.	6

Unit	Content	No of Hours
I	Stereochemistry: Introduction to isomerism and its classification. Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions. Conformational isomerism in alkanes (Ethane, propane and n-butane) with energy profile diagrams, Geometrical isomerism: cis–trans and, syn-anti isomers, E/Z notations with C.I.P rules, Optical isomerism: Optical activity, specific rotation, chirality/asymmetry, enantiomers, molecules with two or more chiral-centres, diastereoisomers, meso structures, racemic mixture and resolution, relative and absolute configuration, D/L and R/S configuration.	10
II	Aromatic Hydrocarbons : 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), Electrophilic aromatic substitution: Reactions of benzene, naphthalene and anthracene sulphonation, nitration, halogenation, Friedel Craft alkylation/acylation reactions, with their mechanism. Directing effects of the groups.	10
III	Mole Concept: Mole concept – GMV relationship, problems based on mole concept, methods of expressing concentrations, strength, concept of equivalent weight, 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.	10

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 Darla Mcdaniel 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 Miessler Inorganic Chemistry Third Edition, Pearson, 2013.
9. F. Albert Cotton and Geoffrey Wilkinson Advanced Inorganic Chemistry, Sixth Edition, 2013.

S Y. B. Sc. Semester III		
CHE-212	Chemistry Practical - III (Minor-Practical)	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify the type of organic compounds and Inorganic compounds.. Define terms and principles of the basic principles of qualitative Organic and inorganic analysis.	1
CO2	Understand the procedure of the experiments. Carry out and examine the given experiment by using different techniques.	2
CO3	Analyze the experimental yield, physical constant, and compare the observations with standard values. Calculate and describe the results of the experiment.	3
CO4	Interpret the major findings and draw an outline of the experiment.	4
CO5	Record the major findings and draw a conclusion/ result at the end of each experiment.	5
CO6	Plan the procedure according to the experimental conditions and summarize the experiment.	6

Unit	Title of the Experiment	No. of Hours
I	Organic Chemistry Practicals A] Qualitative analysis of unknown binary organic compounds. Solid-Solid mixtures only (Including elemental test) B] Drawing of Organic structures and reactions on Chemdraw chemistry software C] Organic Preparation. (Any one) (Including Crystallization, MP, TLC) 1. Preparation of benzoic acid and benzyl alcohol from benzaldehyde 2. Preparation of phthalimide from phthalic anhydride, 3. Preparation of Aspirin from Salicylic acid, 4. Preparation of Glucosazone from D-glucose, 5. Preparation of 2:4- DNP derivative of aldehyde or ketone.	30
II	Inorganic Chemistry Practicals (a) Semi-micro inorganic qualitative analysis of binary mixture containing two cations and two anions. (b) Synthesis of Nickel/ Copper coordination complexes and determine Lambda Max with the help of UV- visible spectrophotometer	30

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

S. Y. B. Sc. Semester III		
CHE-220	Nutritional Chemistry (OE-5)	Credits: 2 Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive skills
CO1	Define chemical terms associated with nutrition and methods of cooking	1
CO2	Classify food and nutrients on the basis of its significance.	2
CO3	Apply the basic concepts of chemistry in understanding kitchen preparations	3
CO4	Analyse the components and additives in various food ingredients.	4
CO5	Select appropriate chemical reactions for variety of food preparation	5
CO6	Develop a balanced meal plan with food items that promote overall physical and mental well-being	6

Unit	Content	No. of hours
I	Kitchen chemistry and cooking techniques : Different Types of cooking techniques- Boiling and steaming methods, Double boiling method, Fermentation, Baking, Caramelisation, Oxidation, Emulsification, Maillard Browning, Acid base reaction, Sterilisation, Rancidity of oils and fats.	10
II	Dairy Chemistry: Types of milk, Composition of milk, qualitative analysis of milk components, isolation of casein/whey protein from milk, testing of milk adulterants, preparation of lactose free milk.	10

III	Food as Medicine: Immunity boosters, alkalising diet, haemoglobin booster, food for strong muscles and bones. Detox diet, food for gut health, food for flawless skin and healthy hair, anti-inflammatory foods, food for strengthening nerves.	10
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References:

1. SrilakshmiB(2017): Nutrition Science, 6th Multicolour Ed. New Age International (P) Ltd.
2. RodayS(2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
3. Mann J and Truswells(2017) : Essentials of Human Nutrition, 5th Ed. Oxford University Press.
4. Sadasivan S and ManikamK(2007): Biochemical Methods, 3rd Ed. New Age International (P) Ltd.
5. GopalanC , Rama Sastri BV and Balasubramanian SC(2016): Nutritive value of Indian Foods, Indian Council of Medical Research.
6. Potter NN and Hotchkiss JH(1999): Food science, 5th Ed , Spinger.
7. Kitchen Chemistry by Ted Lister Heston Blumenthal
8. Damodran, S., Parkin, K.L and Fennema, D.R. (2007). Fennema's Food Chemistry. 4th edition. CRC Press
9. Mann J and Truswell S(2017) : Essentials of Human Nutrition, 5th Ed. Oxford University Press
10. Handbook of Food and Nutrition- Dr. M. Swaminathan, Bangalore Press
11. Guthrie, H.A. (1983). Introductory nutrition. 5th Edition. Mosby, St. Louis.
12. Mudambi, S.R and Rajgopal, M.V. (2001). Fundamentals of Foods and Nutrition. 4th Edition. New Age International Publishers.
13. Willson, D. (1999). Evan Principles of Nutrition. 4th Edition. John Willey & Sons: New York

S Y. B. Sc. Semester III		
CHE-230	Industrial Skills for Chemists-I (VSC)	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	List the types of chemical industries and their various departments	1
CO2	Understand the importance of necessary skills required in become a chemical industrialist	2
CO3	Construct a flowchart of the products that are manufactured in chemical industries and its significance	3
CO4	Develop product purchases from vendors as per guidelines and legalities	4
CO5	Categorize the type of skills as prerequisites for proper documentation of activities in Chemical industries	5
CO6	Discuss a plan for establishing a small scale industrial unit	6

Unit	Content	No. of hours
I	<p>Introduction to various chemical industries:</p> <p>Types of industries: Material Science- Petrochemicals, Cement and Glass, Polymer, Paints and Pigments, Plastic, Textile, Electroplating, Cosmetics and Perfumes, Nanotechnology. Lifesciences- Agrochemicals, Biopharmaceutical, Biotechnology, Food Industry, Nutraceutical Geochemistry- Ecology and Environment</p>	10
II	<p>Skills for Industrial Chemists:</p> <p>Requirements to become an industrial chemist: Technical knowledge, and Skills.Recent trends in technology, communication and Interpersonal skills,Problem-solving, Analytical and Critical thinking, Teamwork and Management, Leadership and Project Planning Legal and regulatory knowledge, Multitasking, Laboratory safety (MSDS), Marketing skills, Data analysis. Chemical waste management.</p>	10
III	<p>Chemical Industry Management:</p> <p>Collecting quotations from vendors, preparing comparative charts of quotations, issuing purchase orders, developing vendor relationships, creating clear chemical storage procedures, Stock and Inventory Control-Arranging stock, locating and referencing, shelf arrangement of stock, order books, inventory. Files and Records-Filing Systems- Classification of files, filing methods, filing system for equipment and chemicals, filing of printed and written material, preparation of lab manuals. Records system: Stock records, recording stock (used and misused), record of use of listed poisons, record of use of alcohol, record of breakages, information about equipment serial numbers, record maintenance, miscellaneous records.Industrial visits, surveys and report writing.</p>	10

References:

1. Business Chemistry by Jens Leker, Carsten Gelhard, Stephan von Delft Released February 2018
Publisher(s): Wiley ISBN: 9781118858493
2. <https://edu.rsc.org/resources/business-skills-and-commercial-awareness-for-chemists/4012640.article>
3. <https://edu.rsc.org/resources/business-skills-for-chemists/952.article>

4. <https://www.educationcorner.com/chemistry-study-skills-guide/>
5. <https://www.degruyter.com/document/doi/10.1515/ci-2021-0302/html?lang=en>

S Y. B. Sc. Semester III		
CHE-240	Basic Laboratory Skills (SEC-III)	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define fundamental terms in analytical chemistry.	1
CO2	Understand calibration and sampling methods for quantitative analysis.	2
CO3	Apply analytical methods for sampling, titrations, separations and interpret the results for chemical analysis.	3
CO4	Prepare solutions of different concentrations for different estimations.	4
CO5	Communicate chemical knowledge effectively through written reports, oral presentations	5
CO6		6

Unit	Content	No. of hours
I	<p>Laboratory Reagents and Solvents:</p> <p>Reagents: Classification of reagents according to their action; (i) acids (ii) bases (iii) salts (iv) complexing agents (v) oxidizing and reducing agents (vi) precipitating agents (vii) chelating agents. Each type to be explained with at least one suitable example. Primary and secondary standards: Definition, characteristics, uses examples for different types of reactions.</p> <p>Solvents: Solute, Solvent & Solution, classification of solvents (i) Protic and aprotic (ii) Acidic, basic amphiprotic and neutral (iii) Aqueous and non-aqueous (iv) Polar and nonpolar. Each type is to be explained with at least one example.</p>	5
II	<p>Solution Preparation:</p> <p>Solutions, components of a solution, types of solution, solubility, concentration terms - percentage, ppm, ppb, g/L, molarity, normality, molality, calculation of masses and volumes for preparation of solutions and their practical approach.</p>	13
III	<p>Common Laboratory Techniques:</p> <p>Refluxing: Apparatus with interchangeable ground glass joints (Quick fit), Filtration: Techniques and filter media, filter paper, simple filtration, Recrystallization: Choice of solvent and precautions with flammable solvents, Distillation: recovery of solvents through partial distillation, distillation under reduced pressure, and determination of boiling point.</p>	12

References:

1. Fundamentals of Analytical Chemistry; Skoog, West, Holler and Crouch 9th edition; Mary Finch. (2014).
2. Principles of Instrumental Methods of Analysis; Skoog, Holler and Nieman, 5 th edition, Saunders College Publishing, International Limited (1999).
3. Analytical Chemistry; Gary D Christian; 6th edition; John Wiley and Sons (2010).
4. Modern Analytical Chemistry; David Harvey; McGraw Hill Higher education publishers, (2000).
5. Analytical Chemistry Principles; John H Kennedy, 2nd edition, Published by Cengage Delmar Learning India Pvt (2011).
6. Vogel's Textbook of quantitative chemical analysis; 6th edition, Pearson Education Limited, (2007).

1. Vogel, Arthur I: A Textbook of Quantitative Inorganic Analysis (Rev. by GH Jeffery and others) 5th Ed. The English Language Book Society of Longman
2. Willard, Hobert H. et. al: Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. New York- John Willy, 2004.
4. Harris, Daniel C, Quantitative Chemical Analysis, 3 rd Edition, W.H. Freeman and Company, New York, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry New Age, International Publisher, 2009.
6. Koogs, West and Holler, Fundamentals of Analytical Chemistry, 6th Edition, Sauders College Publishing, New York. 1991.

Suggestive digital Platforms web links:

1. <http://chemcollective.org/vlabs>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <https://wp.labster.com/Chemistry-virtual-labs/>
4. https://www.youtube.com/watch?v=O_nyEj_hZzg
5. https://www.youtube.com/watch?v=gR_3Z_02mi0
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7. [https://chem.libretexts.org/Bookshelves/General_Chemistry/Book%3A_Chem1_\(Lower\)/08%3A_Solutions/8.01%3A_Solutions_and_their_Concentrations](https://chem.libretexts.org/Bookshelves/General_Chemistry/Book%3A_Chem1_(Lower)/08%3A_Solutions/8.01%3A_Solutions_and_their_Concentrations)
8. <https://www.ncbi.nlm.nih.gov/books/NBK55884/>
9. <https://www.lehman.edu/administration/environmental-health-safety/documents/chemical-storage.pdf>
10. <https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/acs-secondary-safety-guidelines.pdf>
11. <http://www.srsvidyamahapitha.org/images/uploads/Laboratory%20Equipments.pdf>
12. <https://studiousguy.com/list-of-Chemistry-laboratory-apparatus-and-their-uses/>
13. <https://chem.hbcse.tifr.res.in/wp-content/uploads/2019/10/vogels-textbook-of-quantitative-chemical-analysis-5th-edition.pdf>
14. <https://www.youtube.com/watch?v=dLUdhFlxZfo>
15. <https://chemicalsafety.com/chemical-inventory-management-software/>
16. <https://www.youtube.com/watch?v=D7rnlaR8Arc>

S. Y. B. Sc. Semester IV		
CHE-251	Organic and Inorganic Chemistry - I (Major-Theory)	Credits: 4 Hours: 60
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's cognitive level
CO1	Describe basic concepts of chemistry. reaction mechanisms of organic chemistry. Identify the reagents, types of organic compounds and their nomenclature. Describe definitions of acids and bases, fundamental concepts	1

	related to periodic properties of elements.	
CO2	Explain the mechanisms of organic reactions. Predict the products and sensitivity of reagents in organic reactions. Understanding the increase or decrease trends in periodic properties of elements, understanding the inorganic isomerism.	2
CO3	Apply basic concepts to classify organic compounds, explain their transformations and write the reaction sequence, Apply the concept of valence bond theory for formation of complexes.	3
CO4	Analyze the chemical reactions and their significance. Differentiate between reaction intermediates involved in organic synthesis. Arrange the acids and bases according to their strength, justify the magnetic nature of complexes on the basis of theories,	4
CO5	Justify the given condition for organic reactions and determine the organic structure. Predicts the different types of isomerism in inorganic complexes,	6
CO6	Understand the reaction mechanism and rearrangement .predict the hybridisation in inorganic complexes.	2

Unit	Content	No. of hours
I	Reaction Mechanism Introduction to reaction intermediates: carbocation, carbanion, carbene, nitrene and free radicals. Reaction mechanism of Aliphatic nucleophilic substitution (S_N1 , S_N2 and S_Ni reactions) and Elimination ($E1$, $E2$ and $E1cB$, Saytzeff and Hofmann elimination) reactions and factors affecting their rate of reaction. $E2$ -elimination reactions in substituted cyclohexane (cis and trans 1-bromo-2-methylcyclohexane). Competitive studies between substitution and elimination reactions.	10
II	Chemistry of Heterocyclic Compounds with One Hetero Atom Classification and nomenclature, Structures, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis of: Furan (Paal-Knorr synthesis), Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis and Hantzsch synthesis), Thiophene (Paal-Knorr synthesis), Pyridine (Hantzsch synthesis). Reactions and mechanism of substitution reactions: Nitration, Sulphonation, Acylation and Catalytic reduction.	8
III	Reagents in Organic Synthesis Reducing agents: Catalytic hydrogenation (homogeneous and heterogeneous), $NaBH_4$, $LiAlH_4$, Sn/HCl , NH_2NH_2/OH . Oxidizing agents: $KMnO_4$, $K_2Cr_2O_7$, PCC, OsO_4 , MnO_2 and SeO_2 .	6
IV	Name Reactions and Rearrangements (with mechanism) Name reactions: Aldol reaction, Cannizzaro reaction, Knoevenagel reaction, Reformatsky reaction, Wittig reaction. Suzuki reaction, Ugi Reaction. Rearrangements: Pinacol-Pinacolone, Beckmann and Baeyer Villiger oxidation, Hofmann bromamide degradation.	6

V	<p>Acids, Bases and Solvents</p> <p>Different theories of acids bases: Arrhenius theory, Bronsted- Lowry concept, solvated proton, conjugate acid base pairs, relative strength of acids and bases - trends of hydracids and oxyacids, Pauling's rules, levelling and differentiating solvents, Lewis acid-base concept, classification of Lewis acids and bases and their relative strength, Lux-Flood theory, Properties of solvents.</p>	8
VI	<p>Chemistry of 13-18 groups Elements</p> <p>Position of elements in the periodic table, electronic configuration, trends in properties like atomic size, ionization potential, electro-negativity, electron affinity, relative stability of different oxidation states, Inert pair effect.</p> <p>Properties, Bonding and applications of Diborane, boric acid, borazine, borax, carbon allotropes, silicones, silicates, silane, phosphazene, S-N compounds, oxyacids of sulphur, interhalogen compounds, pseudohalogens.</p> <p>Bonding and molecular structure of Xenon compounds - XeF₂, XeF₄, XeF₆, XeO₃, XeOF₆, XeOF₄.</p>	10
VII	<p>Coordination Chemistry</p> <p>Werner's theory, primary and secondary valency, valence bond theory (inner and outer orbital complexes), electroneutrality principle, back bonding, Sidgwick's theory, EAN Rule, Basic terms and IUPAC Nomenclature of coordination compounds (excluding the polynuclear ones), Isomerism, Types of Isomers (Structural isomerism and Stereoisomerism).</p>	8
VIII	<p>Chemistry of d-Block Elements</p> <p>Position of d-block in the periodic table, General group trends with special reference to electronic configuration, size of atoms and ions, variable oxidation states, catalytic properties, complex formation ability, colour, magnetic properties.</p>	4

References:

1. Organic Chemistry by Paula Bruice Pearson Higher Education 7th edition.
2. Organic Chemistry by Clayden, Greeves, Oxford press.
3. Reactions, rearrangements and reagents - S N Sanyal.
4. Heterocyclic Chemistry by Joule and Keith Mills, Wiley-Blackwell 4th edition
5. Organic Chemistry - 7th Ed. Morrison, Boyd & Bhattacharjee Pearson Education, 2011
6. Heterocyclic Chemistry 5th Ed. John A. Joule and Keith Mills, Wiley-Blackwell 2010
7. Reactions, rearrangements and reagents - S N Sanyal
8. Concise Inorganic Chemistry by J. D. Lee - 5th edition.
9. Coordination Chemistry 2009 D. Banerjee.
10. Donald A. Tarr, Gary Miessler Inorganic Chemistry 3rd Edition, Pearson, 2013.
11. Inorganic Chemistry D.F. Shiver & P.W. Atkins- C. H. Longford ELBS - 2nd edition.
12. Basic Inorganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley Eastern Ltd 1992.
13. Concept and Model of Inorganic by Douglas Mc Daniels - 3rd edition.
14. Chemistry by Raymond Chang - 5th edition.

15. Inorganic Chemistry by A. G. Sharpe - 3rd edition.
16. Fundamental Chemistry by A. K. De - 3rd edition.
17. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu.
18. Text book of Inorganic Chemistry, P. L. Soni.

S Y. B. Sc. Semester IV		
CHE-250	Chemistry Practical- IV (Major- Practical)	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify the type of organic compounds and Inorganic compounds.. Define terms and principles of the basic principles of qualitative Organic and inorganic analysis.	1
CO2	Understand the procedure of the experiments. Carry out and examine the given experiment by using different techniques.	2
CO3	Analyze the experimental yield, physical constant, and compare the observations with standard values. Calculate and describe the results of the experiment.	3
CO4	Interpret the major findings and draw an outline of the experiment.	4
CO5	Record the major findings and draw a conclusion/ result at the end of each experiment.	5
CO6	Plan the procedure according to the experimental conditions and summarize the experiment.	6

Unit	Title of the Experiment	No. of Hours
I	<p>Organic Chemistry Practicals:</p> <p>A] Qualitative analysis of unknown binary organic compounds. Solid-Solid mixtures only (Including elemental test)</p> <p>B] Drawing of Organic structures and reactions on Chemdraw chemistry software</p> <p>C] Organic Preparation. (Any one) (Including Crystallization, MP, TLC)</p> <p>6. Preparation of benzoic acid and benzyl alcohol from benzaldehyde</p> <p>7. Preparation of phthalimide from phthalic anhydride,</p> <p>8. Preparation of Aspirin from Salicylic acid,</p> <p>9. Preparation of Glucosazone from D-glucose,</p> <p>10. Preparation of 2:4- DNP derivative of aldehyde or ketone.</p>	30

II	<p>Inorganic Chemistry Practicals:</p> <p>(c) Semi-micro inorganic qualitative analysis of binary mixture containing two cations and two anions.</p> <p>(d) Synthesis of Nickel/ Copper coordination complexes and determine Lambda Max with the help of UV- visible spectrophotometer</p>	30
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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.

S.Y.B.Sc. Semester IV		
CHE-261	Physical and Analytical Chemistry (Minor-Theory)	Credits: 2 Hours: 30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the fundamental concepts of properties, equations, laws and principles related to liquids, solutions , chemical kinetics and chemical analysis.	1
CO2	Interpret the relation between intermolecular forces and their effects on properties and vapor pressure-composition, temperature-composition diagrams of ideal, non-ideal solutions. classify the chemical reaction on the basis of order. Classify and explain different qualitative and quantitative analysis methods for compounds.	2
CO3	Solve the numericals based on chemical kinetics, solutions. Apply concepts of chemistry in solving numerical and chemical properties. Apply the volumetric knowledge in commercial samples. Classify cations into groups.	3
CO4	Explain the effect of concentration, catalyst and temperature on rate constant of the reaction and intermolecular forces on viscosity , surface tension and vapour pressure. Analyse the temperature composition diagram. Perform standardisation of solution and calibrate volumetric glassware. Identify interfering anions and perform its removal.	4
CO5	Analyse, detect, separate and confirm different acidic and basic radicals, elements and functional groups in a given compound.	5
CO6	Interpret titration curves and articulate the types along with the role of indicators.	6

Unit	Content	No. of hours
I	<p>Liquids and Intermolecular Forces</p> <p>Molecular comparison of liquids, solids, and gases; intermolecular forces: dispersion forces; dipole-dipole interactions; ion-dipole forces; properties of liquids: viscosity, surface tension, vapour pressure, volatility, and temperature.</p>	5
II	<p>Solution</p> <p>The solution process at molecular level, saturated solutions and solubility, factors affecting solubility, ways of expressing concentration, Solution of liquids in liquid, Raoult's law, ideal and non-ideal solutions, Problems based on Raoult's law and Henry's law, vapor pressure–composition diagram of ideal and non-ideal solutions. Temperature composition diagram of miscible binary solutions, distillation from temperature–composition diagram, azeotropes, Theory of fractional distillation, steam distillation, and solutions of solids in liquid.</p>	8
III	<p>Chemical Kinetics</p> <p>Introduction to Chemical kinetics, molecularity and order of reaction, reaction rates, rate laws, rate constant and its significance, Integrated rate law expression and its characteristics - zero order, first order, second order equal concentration and the effect of temperature on rate and rate constant of the reaction(Arrhenius equation.)</p>	7
IV	<p>Introduction to Analytical Chemistry</p> <p>Introduction, chemical analysis, applications of chemical analysis, sampling, types of analysis, common techniques, instrumental methods, other techniques, factors affecting on choice of method.</p>	2
V	<p>Qualitative Analysis of Organic Compounds</p> <p>Types of organic compounds, characteristic tests and classifications, analysis of binary mixtures. Analysis – Detection of nitrogen, sulfur, halogen by Lassaigne's test. Purification of organic compounds- Introduction, recrystallization, distillation, sublimation.</p>	5
VI	<p>Inorganic Qualitative Analysis</p> <p>Basic principle, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals, removal of interfering anions (phosphate and borate), detection of acidic radicals.</p>	5
VII	<p>Introduction to Volumetric Analysis</p> <p>Introduction of volumetric (titrimetric) analysis, titrant, titrand, direct titration, indirect titration-back and blank titration Introduction, methods of expressing concentrations, primary and secondary standard solutions, Apparatus used and their calibration: burettes, micro burettes, volumetric pipettes, graduated</p>	3

	pipettes, volumetric flask, Classification volumetric analysis. Various indicators used in titration.	
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References:

1. The Central Science 14th Edition by Theodore L. Brown et al.
2. Principles of Physical Chemistry by Maron and Prutton, 1992.
3. Essentials of physical chemistry Bhal, Tuli and S. Chand, 2010.
4. Chemistry by John Murray & Robert C Fay.
5. J. D. Lee Concise Inorganic Chemistry: Fifth Edition, Wiley, 2008.
6. Bodie Douglas and Darl Mcdaniel Concepts and Model of Inorganic Chemistry Third Edition, Wiley, 1983.

S Y. B. Sc. Semester III		
CHE-262	Chemistry Practical - IV (Minor-Practical)	Credits: 2 Hours: 60
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the procedure, list the apparatus, chemicals and understand the objective of the experiment.	1
CO2	Carry out and examine the given experiment by using different techniques.	2
CO3	Analyze the physical properties using different methods and compare the observations with standard values. Apply computational data to explain chemical phenomenon.	3
CO4	Validate and infer the rate constant, molecular weight, critical solution temperature, solubility product etc. and conclude the results	4
CO5	examine the techniques used while performing the experiments.	5
CO6	Propose the skills and techniques to industrial applications.	6

Expt. Type	Title of the Experiment (Any 15)
Physical Chemistry Practicals	<ol style="list-style-type: none"> Determination of the critical solution temperature of the phenol water system. Determination of the molecular weight of a given organic liquid by steam distillation. Study and compare the hydrolysis of an ester using HCl and H₂SO₄ catalyst. Determination of the solubility and solubility product of sparingly soluble salts (BaSO₄/PbSO₄) by conductometry. Determination of the molecular weight of a given substance using Landsberger's method. Determination of the molecular weight of a given solute by the freezing point of naphthalene. Evaluate the order of the reaction (a=b) of KI and K₂S₂O₈. Determination of solubility of benzoic acid at different temperatures and to determine ΔH of dissolution process. Optimize structure and spectra of molecules using standard softwares of computational chemistry Study the conformational isomers of ethane or butane using standard softwares of computational chemistry. Preparation of buffer solutions of different pH using pH meter.
Analytical Chemistry Practicals	<ol style="list-style-type: none"> Determination of Ca in presence of Mg using EDTA. <ol style="list-style-type: none"> Preparation of standard 0.05N oxalic acid solution and standardization of approx 0.05N KMnO₄ solution. Determination of the strength of given H₂O₂ solution with standard 0.05N KMnO₄ solution. <ol style="list-style-type: none"> To determine the amount of Aspirin from a given tablet. To find the absolute error & relative error with reference to the mean of analysis. To find the standard deviation & relative standard deviation with reference to the mean of analysis. Estimation of Nickel/Aluminum from the given salt solution by using Eriochrome

	<p>Black-T indicator (Back titration method).</p> <p>25. To determine the amount of copper from the given solution iodometrically.</p> <p>26. a) To choose the best indicator in the titration between standard 0.05N oxalic acid solution & approx. 0.05N NaOH. b) To standardize the approx. 0.05N NaOH solution against standard 0.05N oxalic acid solution using the best indicator.</p> <p>27. To determine the amount of acetic acid in commercial vinegar by titrating with approx. 0.05N NaOH solution using selected best indicator</p> <p>28. To find out the amount of Acetone in the given solution iodometrically.</p> <p>29. Synthesis of Copper nanoparticles and its characterisation spectrophotometrically.</p> <p>30. Report of one day industrial study tour / survey</p>
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References:

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

S. Y. B. Sc. Semester IV		
CHE-270	Chemistry of Cosmetology	Credits: 2 Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's cognitive level
CO1	List names of cosmetics and their significance	1
CO2	Understand the principles and manufacturing process of various cosmetics with examples	2
CO3	Apply the knowledge of cosmetic chemistry to prepare products in small scale	3
CO4	Differentiate between the effects of various types of cosmetics	4
CO5	Plan the steps involved in preparation of cosmetics for regular use	6
CO6	Design a plan to prepare skin and hair care products for daily routine	6

Unit	Content	No. of hours
I	Cosmetics and Chemistry: History, Types of cosmetics, Comparison of chemicals used in Synthetic, semisynthetic and herbal based cosmetics. Principles and methodologies involved in manufacturing. Scope for entrepreneurship.	10
II	Skin care products Hand sanitiser, Bathing soap, Cleanser, Toner, Moisturiser, Sunscreen, Understanding of basic makeup products- Primer, concealer, foundation, compact powders, blush, highlighters, Eyeliner, kajal, mascara, Lip balm, Lipsticks.	10
III	Hair care products: Hair cleanser, conditioner, Hair mask, Hair serum, Hair dye, Hair oil Anti dandruff shampoos, Hair growth serum, Hair damage control products, Products for Dry and brittle hair, Products for oily hair. Frizzy hair care.	10

References:

1. Introduction to Cosmetic Chemistry- Dr.Kumari Ramesh
2. Cosmetic Chemistry by Florence Barrett Hill (e Book)
3. GandhaShashtra
4. Brihat Samhita
5. Charak Samhita

S. Y. B. Sc. Semester IV		
CHE-280	Basics of biomolecules and Bioanalytical Techniques (VSC)	Credits: 2 Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive skills
CO1	Recall names of biomolecules and its structures. Remember the applications of various bioanalytical techniques.	1
CO2	Classify biomolecules. Explain the in-vivo and in- vitro reactions of molecules and its significance.	2
CO3	Apply the basic principles of qualitative analysis, quantitative estimations and separation techniques to validate results in various biological samples.	3
CO4	Analyse, separate and characterise the components in unknown samples using suitable techniques.	4
CO5	Detects the type of biomolecules in isolates from various sources.	5
CO6	Design a systematic plan for qualitative analysis, quantitative estimation for biomolecules and their Isolation, separation and purification procedures.	6

Unit	Content	No. of hours
I	<p>Basics of biomolecules: Chemistry of biological molecules: Carbohydrates: Definition, classification of carbohydrates, configuration of (+) Glucose (D/L, d/l, R/S), Fischer-Haworth and chair formulae, epimers, anomers, mutarotation, Killiani-Fischer synthesis and Ruff degradation. Reaction of monosaccharide (glucose): oxidation, reduction, osazone and ester formation. Brief account of disaccharides (structure only): Sucrose, cellobiose, maltose and lactose. Polysaccharides- Starch, Cellulose. Derived sugars.</p> <p>Amino acids: Fischer projection, relative configuration, classification, structures, Zwitterion, Isoelectric point. Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis, amination of α-halo acids, Reductive Amination, Reactions of Amino acids: esterification, acetylation, peptide bond synthesis, reaction with Dansyl chloride, HNO_3 and ninhydrin test.</p> <p>Basic chemistry of Lipids, proteins, enzymes, nucleic acids, and vitamins. Chemical composition of different types of cells and its organelles Types of bonds in biomolecules. Types of chemical reactions and associated energy transformations in living cells.</p>	15
II	<p>Bioanalytical Techniques (any 10)</p> <ol style="list-style-type: none"> 1. Preparation of biological buffers and checking its pH using pH meter. 2. Acid base titration of amino acid and determination of pK, pI and buffering zones 3. Separation of amino acids by paper chromatography and calculating the Rf values. 4. Preparation of common reagents for qualitative analysis and detection of carbohydrates, amino acids and proteins in unknown samples. 5. Preparation of different types of osazones of reducing sugars and observing shapes of the crystals under microscope. 6. Isolation of carbohydrates, proteins and enzymes from any one source. 7. Quantitative estimations of carbohydrates and proteins in unknown samples using colorimeters. 8. UV Absorption spectra of proteins and nucleic acids to calculate the wavelength of maximum light absorption. 9. Separation of macro and micro molecules by dialysis, and by reverse dialysis using poly ethylene glycol. 10. Detection of DNA by Diphenylamine method and separation of DNA fragments by agarose gel electrophoresis (Demo) 11. Separation of proteins by polyacrylamide gel electrophoresis (Demo) 12. Preparation of nutrient agar medium for bacterial growth under sterilised conditions 13. Antimicrobial activity check 14. Determination of blood group 15. Determination of immunological reaction of antigen and antibody by Ouchterlony technique (Demo) 	15

	16. Study of inversion of sugars using Polarimeter.	
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References:

1. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
3. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann, London (1980).
4. Devlin, T.M., Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, 2010.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rd Ed. PHI Learning.
7. Nelson, D.L. & Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman, 2013.
8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods, D. Van Nostrand & Co., 1961.
9. Practical Biochemistry- David Plummer
10. Biochemical Methods - Sadashivam and Manikam

S. Y. B. Sc. Semester IV		
CHE-290	Chemical Analysis (SEC)	Credits: 2 Hours: 30
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's Cognitive skills
CO1	Interpret pH values in relation to the acidity or alkalinity of the samples; understand the implications for food quality and importance of protein analysis in food quality assessment.	2
CO2	Perform acid-base, redox, complexometric, potentiometric, and precipitation titrations with precision and Baudouin, Halphens, and Hexabromide to detect different oil samples.	4
CO3	Apply the principle of detecting artificial sweeteners in food and beverages	3
CO4	Understand and apply techniques for determining moisture content in food samples, quantitative chemical analysis, and Total Dissolved Solids (TDS), DO, COD, BOD. Measurement for water quality assessment, appreciating the practical applications of these analytical methods in quantitative analysis across diverse fields.	2, 3
CO5	Use appropriate equipment and methods to accurately measure and calculate moisture levels.	5
CO6	Utilize both universal indicator and pH meter for determining pH in given samples, employing methods for the detection of saccharin in beverages, and utilizing a range of instruments, including pH meters, conductivity meters, spectrophotometers, and titrimetric methods for diverse analytical applications.	6

Unit	Content	No. of hours

I	<p>Analysis of food additives:</p> <p>Types of food additives. Impact on public health. Testing of common additives seen in various commercial food products. such as additives in dairy products, honey and other sweeteners, oils and fats, grains and pulses, spices and condiments.</p>	10
II	<p>Analysis of Soil :</p> <p>Introduction to Soil analysis, Concept of masking and demasking reactions. Principles of conductometric and potentiometric titrations. Principles of colorimetry, flame photometry, and atomic absorption spectrophotometry. Radiotracer technique and its methodology. Practical preparation of standard solutions; Titrimetric analysis - acid-base, redox, complexometric, potentiometric and precipitation titrations; Use of pH meter, conductivity meter, visible, ultraviolet and infrared spectrophotometer, atomic absorption spectrophotometer, flame-photometer. Determination of Ca and Mg from given soil sample. Dissolved constituents- Major constituents- Ca, Mg, Na, K, Carbonate, bicarbonate, sulfate, Chloride and nitrate. Minor constituents- B, Si, nitrite, Sulfide and fluoride.</p>	10
III	<p>Analysis of water:</p> <p>Determination of total hardness of water, the pH, TDS, dissolved oxygen, COD, BOD, conductivity of water Sample.</p>	10

References:

1. The Food Chemistry Laboratory: A Manual for Experimental Foods, Dietetics, and Food Scientists by Connie M. Weaver and James R. Daniel, 2nd edition, CRC Press.
2. Manual Of Methods Of Analysis Of Foods (Milk And Milk Products)- Directorate General Of Health Services Ministry Of Health And Family Welfare Government Of India New Delhi, 2005, Page No:10.
3. Food Analysis, 2nd Edition. S.S. Nielsen, Aspen Publishers.
4. Food Analysis: Theory and Practice. Y. Pomeranz & C.E. Meloan, Chapman and Hall
5. Food Analysis: Principles and Techniques. D.W. Gruenwedel and J.R. Whitaker, Marcel Dekker.
6. Analytical Chemistry of Foods. C.S. James, Blackie Academic and Professional.