

Curriculum Framework
Syllabus – B.Sc. (Chemistry) 2022-23
L-5 (II Semester)

II-Semester

Level / Semester	Nature of Course	Courses Code	Course Title	MM	L	T	P	C
L-5 II Semester	Discipline Specific: Major	CHE-DSM-211	Fundamentals of Organic & Physical Chemistry (Theory)	100	4	0	0	4
	Discipline Specific: Major	CHE-DSM-212	Organic & Physical Chemistry (Practical)	100	0	0	2	2
	Discipline Specific: Major	DSM-213	Other Department	100	6	0	0	6
	Multi Discipline Major	CHE-MDM-211	Mathematical concept and Material Chemistry	100	4	0	0	4
	Multi Discipline Major	CHE-MDM-212	Chemistry (Practical)	100	0	0	2	2
	Ability Enhancement Course (AEC) (Either in I or II Sem)	CHE-AEC-111	Analysis of Applied and Industrial Products	100	2	0	0	2
	Value Enhancement Course (VEC)	VEC-211	Other Department					Qualifying
Total Credits								20
Exit with Certificate								

*Note: Student can choose either AEC or SEC in one semester

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**Bachelor of Science – B.Sc.
Disciplinary Major (DSM)
B.Sc. II Semester**

CHE-DSM-211: Fundamentals of Organic & Physical Chemistry (Theory)

Credits: 04

Time: 60 Hrs

Course learning Objectives: To educate fundamentals of organic and physical chemistry

Unit wise learning outcomes:

1. Basics of organic molecules and stereochemistry of organic molecules, Conformations, Configuration and basic nomenclature of stereoisomer.
2. Basics of Aliphatic hydrocarbons and their characteristic properties.
3. To learn about the specific character of aromaticity and to analyze different solutions by conductivity measurement.
4. To learn about the importance of phase in the field of material science.
5. Partial molar quantities and it's attributes, dilute solutions and properties of solutions

Unit I Fundamentals of Organic Chemistry:

12

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric 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. Aromaticity: Benzenoids and Hückel's rule. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

Stereochemistry:

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of asymmetry. Configuration: Geometrical and Optical isomerism; *cis-trans* & *syn-anti* with CIP Rules; E / Z notations; Enantiomerism, Diastereomerism and Meso compounds. Threo and Erythro; D / L and R / S designations.

Unit II Aliphatic Hydrocarbons: Alkanes:

12

Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes:

Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk. KMnO_4) and *trans*-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes:

Preparation: Acetylene from CaC_2 and conversion into higher alkynes by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline KMnO_4 , ozonolysis and oxidation with hot alkaline KMnO_4 .

Unit III Aromatic hydrocarbons : *Preparation* (Case benzene): from phenol, by 12
decarboxylation, from acetylene, from benzenesulphonic acid.

Reactions: (Case benzene): Electrophilic Aromatic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation). Side chain oxidation of alkyl benzenes.

Conductance: Conductivity, equivalent and molar conductivity and their

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variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit IV Phase Equilibrium:

12

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $\text{FeCl}_3\text{-H}_2\text{O}$ and Na-K only).

Unit V Solutions:

12

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction

References:

1. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
4. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
6. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand
7. R.A. Alberty, Physical Chemistry, 4th Edition, John-Wiley & Sons.
8. C.N.R Rao, University General Chemistry, 1st Edition, MacMillan India Ltd- New Delhi.
9. P.W. Atkins, J.D. Paula, Elements of Physical Chemistry, Seventh Edition, Oxford University Press.
10. G. M. Barrow, Physical Chemistry, 5th Edition, Tata McGraw Hill (2007).
11. K.L. Kapoor, A Textbook of Physical Chemistry, Vol. 3, 3rd Edition, McMillan.

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Bachelor of Science – B.Sc.

Disciplinary Major (DSM)

B.Sc. II Semester

CHE-DSM-212: Organic & Physical Chemistry (Practical)

Credit: 02

Time: 30 Hrs

Course Objective: To introduce about best practices and applications in Chemistry labs

Course learning outcome

- To understand use of chemical thermometer and its calibration.
- To check the purity of organic compounds.
- To make impurity check on the basis of melting point and inferences drawn.
- To remove the impurities from organic compounds.
- To understand concept of calorimetric experiments.
- To perform pHmetric titrations.
- To make quantitative measure of chemical compounds using gravimetry methods.

Laboratory course

Organic

- Checking the calibration of the thermometer.
- Determination of the melting points of organic compounds
- Effect of impurities on the mix melting point.
- Determination of boiling point of liquids.
- Purification of organic compounds by crystallization.

Physical

- Demonstration of calorimetric experiments.
- The solubility of salts in water at room temperature.
- pH metric titrations.

Gravimetry

- Estimation of Barium as barium sulphate.
- Estimation of metal ions using Gravimetric methods Ni as $\text{Ni}(\text{DMG})_2$.

References

1. G. Svehala and I.B. Sivankar, Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 6th Edition, (2012).
2. J. Mendham Vogel's Quantitative Chemical analysis, A.I. Vogel, Prentice Hall, 6th Ed., 2009.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012)
5. J. N. Gurtu, Amit Gurtu, Advanced Physical Chemistry Experiments, Pragati Prakashan.
6. A. M. Halpern, & G.C. McBane, Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
7. V.D. Athawale and P. Mathur, Experimental Physical Chemistry, New Age International (2001)

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**Bachelor of Science – B.Sc.
Multidisciplinary Major (MDM)
B.Sc. II Semester**

CHE-MDM-211: Mathematical concept and Material Chemistry

Credits: 04

Time: 60 Hrs

Learning Objective: To provide physico-chemical understanding of solids, liquids and gases

Learning Outcomes: After Completion of the course, the learner shall be able to understand:

1. Some mathematical concepts of Chemistry
2. Understanding basic parameters of Gaseous state chemistry.
3. Understanding basic parameters of crystalline solid, symmetry and crystal structures.
4. To prepare inorganic solids, ionic liquid and its significance.
5. To draw mechanism of polymer materials and characterization of polymers.

- Unit I Mathematical Concepts for Chemistry** 12
Logarithmic relations, curve sketching, linear graphs and calculation of slopes differentiation of function like k_x , e^x , $\sin x$, $\log x$, maxima and minima, partial differentiation and reciprocity relations. Integration of some useful/relevant, functions permutations and combinations. Factorial. Probability.
- Unit II Gaseous state chemistry** 12
Need for Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule-explanation of the terms only. Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems.
Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c , P_c and V_c from vander Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c . Amagat's mean density method or V_c . Problems on the calculation of T_c , P_c and V_c , a and b .
- Unit III Solid state chemistry** 12
Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.
- Unit IV Inorganic solids/ionic liquids** 12
Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydro-thermal method, Ion-exchange and Intercalation methods. Introduction to Solid electrolytes, inorganic liquid crystals. Ionic liquids, forces responsible for ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids. Host-guest chemistry (elementary ideas).

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Unit V

Polymer chemistry

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

References

1. Maths for Chemists, Vols 1 and 2 M. C. R. Cockett and G. Dogget, Royal Society of Chemistry, Cambridge (2003).
2. Atkins P, Overton T., Rourke J. Weller M. and Armstrong F *Shriver and Atkins. Inorganic Chemistry* Oxford University Press, Fifth Edition, 2012.
3. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley, 1974.
4. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.
5. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
6. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
7. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.

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**Bachelor of Science – B.Sc.
Multidisciplinary Major (MDM)
B.Sc. II Semester
CHE-MDM-212: Chemistry (Practical)**

Time: 30 Hrs

Credits: 02

Learning Objective: To introduce about best practices and applications in Chemistry labs

Learning Outcomes: After Completion of the course, the learner shall be able to understand:

1. To make the student understand about the use of different apparatus and how to calibrate them.
2. The student will learn to prepare different types of standard solutions. Differentiation between primary and secondary standards.
3. Quantification of analytes by volumetric analysis.
4. The student will understand the concept of density, surface tension, viscosity.
5. To understand different chemical and computational calculations.

Titrimetric Analysis

- Calibration and use of apparatus.
- Preparation of solutions of different Molarity/Normality of titrants.
- Use of primary and secondary standard solutions.
- Estimation of carbonate and hydroxide present together in mixture.
- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents
- Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution.
- Estimation of oxalic acid and sodium oxalate in a given mixture.
- Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal(diphenylamine, anthranilic acid) and external indicator.
- To determine the density of a given liquid by viscometer; R.D. bottle.
- Determine the surface tension by drop number method.
- Study the relative surface tension of a liquid with respect to water at room temperature by stalagmometer.
- Determination of viscosity of aqueous solution of solids/liquids at room temperature.
- Study the relative viscosity of a liquid with respect to water at room temperature by Ostwald's viscometer.

References

1. G. Svehala and I.B. Sivankar, Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 6th Edition, 2012.
2. J. Mendham Vogel's Quantitative Chemical analysis, A.I. Vogel, Prentice Hall, 6th Edition, 2009.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
4. B.S. Furniss, A. J. Hannaford, P.W.G. Smith,; Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson, 2012.
5. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
6. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* 8th Ed.; McGraw-Hill: New York (2003).
7. J. N. Gurtu, Amit Gurtu, Advanced Physical Chemistry Experiments, Pragati Prakashan.

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Bachelor of Science – B.Sc.
B.Sc. II Semester
Ability Enhancement Course (AEC)

CHE-AEC-211: Analysis of applied industrial products

Credits: 02

Time: 30 Hrs

Learning Objective: To provide chemical aspects of industrially important products

Unit wise Learning Outcomes:

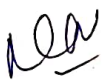
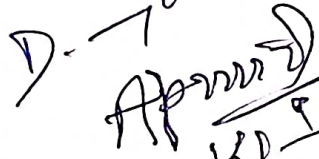
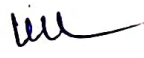
1. To understand chemical aspects and analysis of chemical products: soaps, detergents and paints.
2. To learn analytical methods in fats and oils.
3. To aware the students about the agricultural products viz. fertilizers, pesticides etc.
4. To aware the students with contribution of Indian scientists in chemical industry.
5. To learn about methods of analysis of complex materials.

Unit I	Soaps, detergents and paints Moisture and volatile matter, combined alkali, total fatty matter, free alkali, total fatty acid, sodium silicate and chlorides. Paints: Vehicle and pigments, Barium Sulphate, total lead, lead chromate, iron pigments, zinc chromate.	6
Unit II	Fats and oils: Saponification value, iodine value, acid value, ester value, bromine value, acetyl value.	6
Unit III	Fertilizers & pesticides: Fertilizers: Urea, NPK fertilizer, super phosphate, Pesticides: Analysis of DDT, BHC, endrin, Endosulfone, malathion, parathion; Concept of Green chemicals	6
Unit IV	Sugar and paper industry: Analysis of Starch, sugars, cellulose, and paper.	6
Unit V	Analysis of cement- loss on ignition, insoluble residue, total silica, sesqui oxides, lime, magnesia, ferric oxide, Inorganic & Organic Polymeric materials of Industrial Importance.	6

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References:

1. F.J. Welcher, Standard Methods of Chemical Analysis: Instrumental methods,
2. A.I. Vogel-A text book of quantitative Inorganic analysis-ELBS,
3. H.H. Willard and H.Deal- Advanced quantitative analysis- Van Nostrand Co,
4. F.D. Snell & F.M.Biffen-Commercial methods of analysis-D.B.Taraporavala& sons,
5. J.J. Elving and I.M.Kolthoff- Chemical analysis - A series of monographs on analytical chemistry and its applications -- Inter Science- Vol I to VII.,
6. G.Z. Weig - Analytical methods for pesticides,plant growth regulators and food additives - Vols I to VII,
7. Aanalytical Agricultural Chemistry by S.L.Chopra & J.S.Kanwar -- Kalyani Publishers
8. Mannual of soil, plant, water, and fertilizer analysis, R.M.Upadhyay and N.L Sharma, Kalyani Publishers

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