29

# B.Sc. I Year Chemistry Syllabus

## CBCS Annual Pattern
## From Academic Year 2021-2022

Paper I

| Part A Introduction | | | | |
|---|---|---|---|---|
| **Program- CERTIFICATE** | | **Class-B.Sc.** | **Year- First** | **Session: 2021-2022** |
| **Subject - Chemistry** | | | | |
| | Course Code | S1-CHEM1T | | |
| | Course Title | **Fundamentals of Chemistry( Paper I)** | | |
| | Course Type | Core Course | | |
| | Pre-requisite (if any) | To study this course our students must have had the subject Chemistry in class +2 or equivalent. | | |
| | Course Learning Outcomes (CLO) | By the end of this course students will learn the following aspects of Chemistry:<br>1. Ancient Indian chemical techniques.<br>2. Various theories and principles applied to reveal atomic structure.<br>3. Significance of quantum numbers.<br>4. Concept of periodic properties of elements.<br>5. Theories related to chemical bonding.<br>6. Acid-base concept, ph, buffer.<br>7. Factors responsible for reactivity of organic molecules.<br>8. Basics and mechanism of chemical kinetics.<br>9. Properties of electrolytes. | | |
| | Credit Value | 4 | | |
| | Total Marks | Maximum Marks: CCE-25, University Exam (UE)- 75 | Minimum Passing Marks: 33 | |

| Part B- Content of the course | | |
|---|---|---|
| **Total No. of Lectures-Tutorials-Practical (In hours per week): L-T-P:60-0-30** | | |
| **Unit** | **Topic** | **No. of lectures** |
| 1 | **(a)**Chemical techniques in ancient India: General Introduction<br>**(b)** Contribution of ancient Indian scientists in chemistry e.g. metallurgy, dyes, pigments, cosmetics, Ayurveda, Charak Sanhita.<br><br>**Atomic Structure:**<br><br>(i) Review of Bohr's theory and its limitations. Atomic spectrum of Hydrogen. Dual nature of particles and waves, de Broglie's equation, Heisenberg's | **2+4** |

16.10.2021

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| | ionic character.<br><br>*Valence shell electron pair repulsion theory (VSEPR) theory:* Assumptions, need of theory, application of theory to explain geometries or shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements such as: $NH_3$, $H_2O$, $SF_4$, $ClF_3$, $PCl_5$, $SF_6$, $ClF_5$, $XeF_4$.<br><br>**Molecular orbital (MO) concept of bonding**<br>The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach)<br>Rules for the LCAO method, bonding and antibonding MOs. Characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals.<br>MO diagrams of homonuclear diatomic molecules: $H_2$, $Li_2$, $Be_2$, $B_2$, $C_2$, $N_2$, $O_2$, $F_2$, and their ions.<br>Molecular orbitals of heteronuclear diatomic molecules: CO, NO, CN, HF.<br>**Bond parameters:**<br>Definition and factors affecting - bond orders, bond lengths, bond angles.<br>***Keywords/Tags*** *:Ionic Bonding, Covalent Bonding, Hybridization, VSEPR Theory, LCAO, MO Diagrams, Bond Parameters* | |
| **4** | **Acid-Base concept**<br><br>Arrhenius concept, Bronsted-Lowry's concept, conjugate acids and bases, relative strength of acids, Lewis concept.pH, buffer solutions.Acid-base neutralisation curves, Handerson equation.<br><br>Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.<br><br>Indicator, choice of indicators.<br><br>***Keywords/Tags*** *: Acid-Base Concept, Bronsted-Lowry's Concept, Conjugate Acids And Bases, pH, Buffer Solution, Indicator.* | **4** |
| **5** | **(a) Fundamentals of Organic Chemistry**<br>Structure, shape and reactivity of organic molecules:<br>Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.<br>Cleavage of Bonds: Homolysis and Heterolysis.<br>Reactive Intermediates: Carbocations, Carbanions and free radicals.<br>Nucleophiles and electrophiles.<br>**(b) Stereochemistry of Organic compounds:**<br>Concept of isomerism.<br>**Geometrical isomerism**:<br>Determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. | **12** |

16.10.2021

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| | **Optical isomerism:**<br>Elements of symmetry, molecular chirality, enantiomers& their properties, stereogeniccentre, optical activity of enantiomers. Concept of chirality (up to two carbon atoms): chiral and achiral molecules with two stereogeniccentres, diastereomers, threo and erythroisomers, meso isomer, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.<br>**Conformations and Conformational analysis**<br>Conformationsof ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations.<br>***Keywords/Tags*** *:Electronic Displacements, Nucleophiles, Electrophiles, Isomerism, Molecular Chirality, Enantiomers, Sequence Rules, Conformation* | |
| **6** | **Chemical Kinetics:**<br><br>Rate of reaction, Definition and difference of order and molecularity. Derivation of rate constants for first, second, third and zero order reactions and examples. Derivation for half-life period. Methods to determine the order of reactions. Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy.<br><br>**Ionic Equilibria:**<br><br>Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Solubility and solubility product of sparingly soluble salts – applications of solubility product.<br><br>***Keywords/Tags****: Order Of Reaction, Molecularity Of Reaction, Arrhenius Equation, Activation Energy, Electrolytes, Salt Hydrolysis, Solubility Product.* | **12** |

## Part C -Learning resources

**Text Books, Reference Books, Other Resources**

**Text Books:**


1. Lee, J.D., Concise Inorganic Chemistry, ELBS, 1991.
2. Khera, H.C., Gurtu, J.N., Singh, J., Chemistry For B.Sc. Ist Year, Pragati prakashan.
3. Bariyar, A. & Goyal, S., B.Sc. Chemistry Combined, **(In** Hindi) Krishna Educational Publishers Year: 2019.
4. Puri, B. R., Pathania, M.S., Sharma, L. R., Principles of Physical Chemistry. Vishal Publishing Co. 2020.
5. Gurtu, J. N.,Gurtu A., Advanced Physical Chemistry, Pragati Prakashan, Meerut. ISBN: 9789386633347, 9386633345; Edition: IV, 2017
6. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
7. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.


16.10.2021

8. Kalsi, P. S., Stereochemistry Conformation and Mechanism, New Age International, 2005.
9. Finar, I.L., Organic Chemistry (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N., Organic Chemistry, Pearson, 2010.
11. Clayden, J., Greeves, N., Warren, S.,Wothers, P., Organic Chemistry, Oxford University Press, 2nd Edition, 2012.
12. Atkins' Physical Chemistry, 10th Edition, Oxford University Press, 2014

**Reference Books:**

**Reference Books:**

1. Prakash, S., Founders of Sciences in Ancient India, published by The Research Institute of Ancient Scientific Studies, New Delhi. 1965 (OCoLC)594302452.
2. Acharya Prafulla Chandra Ray - A Collection of Writings, Volume IIIA : A History of Hindu Chemistry (Volume-I), Editor : Prof. Anil Bhattacharyya, Publisher : University of Calcutta. . Online information: https://www.caluniv.ac.in/news/APCR%20Publication/acharya-prafulla.html
3. Chemistry in India, in Traditions & Practices of India, Textbook for Class XI, Module 2, Central Board of Secondary Education.
4. Subbarayappa, B.V.,Chemistry and Chemical Techniques in India, Centre for Studies in Civilizations, 2004, ISBN 818758601X.
5. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K., Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Education India, 2006.
6. Douglas, B.E., McDaniel, D.H. & Alexander, J.J., Concepts and Models in InorganicChemistry, John Wiley & Sons, 1994.
7. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, JohnWiley & Sons, 12th Edition, 2016.
8. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
9. Sykes, P., A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
10. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill (2007)

Suggested equivalent online courses:

**(all URLs accessed in May 2021)**

- MOOC: https://alison.com/course/fundamentals-of-chemistry
- NPTEL: https://nptel.ac.in/courses/104/106/104106119/ ; https://nptel.ac.in/courses/104/101/104101121/
- MIT: https://ocw.mit.edu/courses/chemistry/5-12-organic-chemistry-i-spring-2005/syllabus/

**Web sources**

**(all URLs accessed in May 2021)**

https://www.sydney.edu.au/science/chemistry/~george/1108/ShapesOfMolecules.pdf

16.10.2021

https://artsandculture.google.com/exhibit/rasashala-ancient-indian-alchemical-lab-national-council-of-science-museums/KwJCaP1RF0y-KQ?hl=en

http://sanskrit.uohyd.ac.in/events-new/Ancient-Indian-chemistry.pdf

https://insa.nic.in/writereaddata/UpLoadedFiles/IJHS/Vol01_1_1_PRay.pdf

https://asi.nic.in/Ancient_India/Ancient_India_Volume_9/article_8.pdf

https://ddceutkal.ac.in/Syllabus/MA_history/paper_23.pdf

https://vvm.org.in/study_material/ENG%20-%20Indian%20Contributions%20to%20Science.pdf

https://www.pgurus.com/chemistry-in-ancient-india/

https://en.wikipedia.org/wiki/History_of_chemistry

| | Part D-Assessment and Evaluation | |
|---|---|---|
| | **Suggested Continuous Evaluation Methods:** Continuous Internal Evaluation Shall be Based on Allotted Assignment and Class Tests. The marks shall be as follows: | **marks** |
| | **Assessment and presentation of assignment** | **04** |
| | **Class Test-I (Objective Questions)** | **04** |
| | **Class Test-II (Descriptive Questions)** | **04** |
| | **Class Test-I (Objective Questions)** | **04** |
| | **Class Test-II (Descriptive Questions)** | **04** |
| | Overall performance throughout the Year (includes Attendance, Behaviour, Discipline, Participation in Different Activities) | **05** |
| | Total | **25** |

| Elaboration: Assessment Theory | | | |
|---|---|---|---|
| **External Assessment** | | | |
| **Theory Paper** | Section A | 3 Very short question (50 words each) | 03 X 03=09 |
| | Section B | 4 short question (200 words each) | 04X 09=36 |
| | Section C | 4 Long question (500 words each) | 02X 15=30 |
| | **Total** | | **75** |
| **Grand Total** | | | **100** |

16.10.21

# B.Sc. I Year Chemistry Syllabus

## CBCS Annual Pattern
## From Academic Year 2021-2022

Paper II

| Part A Introduction | | | | |
|---|---|---|---|---|
| **Program- CERTIFICATE** | | **Class- B.Sc.** | **Year- First** | **Session: 2021-2022** |
| **Subject - Chemistry** | | | | |
| | Course Code | S1-CHEM2T | | |
| | Course Title | **Analytical Chemistry (Paper II)** | | |
| | Course Type | Core Course | | |
| | Pre-requisite (if any) | To study this course students must have had the subject Chemistry in class +2 or equivalent. | | |
| | Course Learning Outcomes (CLO) | By the end of this course students will learn the following aspects of Chemistry:<br>1. Basic concepts of Mathematics for Chemists.<br>2. Fundamentals of analytical chemistry and steps involved in analysis.<br>3. Basic knowledge of Computer for chemists.<br>4. Basic Concepts of Chemical equilibrium.<br>5. Principles of Chromatography and chromatographic techniques.<br>6. Various techniques of Spectroscopic Analysis. | | |
| | Credit Value | 4 | | |
| | Total Marks | Maximum Marks: CCE-25, University Exam (UE)- 75 | Minimum Passing Marks: 33 | |

16.10.2021

## Part B- Content of the course

**Total No. of Lectures-Tutorials-Practical (In hours per week):**

**L-T-P:** 90-0-30

| Unit | Topic | No. of lectures |
|---|---|---|
| 1 | **Mathematics for Chemists**<br>Straight line equation, Logarithmic relations, curve sketching, linear graphs & calculation of slopes. Differentiation, differentiation of functions like $k_x, e^x, x^n$, sinx, logx, maxima & minima,partial differentiation. Integration of some useful relevant functions.<br>***Keywords/Tags:*** *Linear graphs, Logarithmic Relation, Differentiation, Integration* | 10 |
| 2 | **Basic Analytical Chemistry:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures, statistical terms: mean, mean deviation, median, standard deviation, Numerical Problems.<br><br>**Calculations used in Analytical Chemistry**<br>**Some Important units of measurements-** SI Units, distinction between mass and weight, mole, milli mole and Numerical Problems.<br>**Solution and their concentrations**-Concept of Molarity, molality and normality. Expressing the concentration in parts per million (ppm), parts per billion (ppb), Numerical Problems.<br>**Chemical Stoichiometry**- Empirical and Molecular Formulas, Stoichiometric Calculations, Numerical Problems.<br>***Keywords/Tags:*** *Accuracy, Precision, SI units, Units of Concentration, Chemical stoichiometry.* | 10 |
| 3 | **Computer for Chemists**<br>Introduction to computer, Introduction to operating systems like -DOS, Windows, Linux and Ubuntu.<br>**Use of computer programs**<br>Running of standard programs & packages such as MS-word, MS-excel, PowerPoint, Execution of linear regression x-y Plot. Use of softwares for drawing structures and molecular formulae.<br>***Keywords/Tags:*** *Operating Systems, MS-word, MS-excel, PowerPoint.* | 10 |
| 4 | **Chemical Equilibrium:** Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium. Temperature dependence of equilibrium constant; Van't Hoff reaction isochore, Van't Hoff reaction isotherm. Le-Chatelier's principle and its applications.<br>***Keywords/Tags:*** *Chemical Equilibrium, Equilibrium constant, Free Energy, Chemical Potential* | 10 |
| 5 | **Chromatography**<br>Introduction, Principle and Classification. Mechanism of separation: adsorption, partition & ion-exchange.<br>Development of chromatograms: frontal, elution and displacement methods. | 10 |

16.10.2024

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| | Paper Chromatography (ascending, descending and circular), Thin Layer Chromatography (TLC) and Column Chromatography (CC), Gas Chromatography (GC) and High Pressure Liquid Chromatography (HPLC), types of column and column selection, applications, limitations.<br>**Principle and Applications of :**<br>• Flash chromatography,<br>• Ion-exchange chromatography and<br>• Chiral chromatography.<br>***Keywords/Tags*** *Chromatogram, Ion Exchange, Column Selection, Adsorption* | |
| 6 | **Spectral techniques of analysis**<br>**Basics of absorption spectroscopy**: Electromagnetic radiation, Spectral range.Absorbance, Absorptivity, Molar Absorptivity, Fundamental Laws of Absorption, Lambert-Beer Law and its limitations.<br>Constitution & working of photometer, spectrometer, colorimeter.<br>**Ultraviolet (UV) absorption spectroscopy-**<br>Presentation and analysis of UV spectra, Types of electronic transitions, Effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, Hyperchromic and hypochromic shifts. UV spectra of conjugated polyenes and enones.<br>**Infra-red (IR) absorption spectroscopy-**<br>Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, Measurement of IR spectrum, finger print region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds.<br>***Keywords/Tags*** *: Hypsochromic, Hypochromic, Absorption, Spectrum* | **10** |

## Part C -Learning resources

Text Books, Reference Books, Other Resources

**Text Books**


1. Gaur, S., Computer for Chemists, Neel Kamal Prakashan, 2017
2. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009
3. Kaur H, Analytical Chemistry, PragatiPrakashan (2008)
4. Gupta, Alka L.,Analytical Chemistry, PragatiPrakashan (2020)
5. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
6. Kaur H, Instrumental Methods of Chemical Analysis, PragatiPrakashan, 2018
7. Sharma B.K., Chromatography, Krishna Prakashan, 2019.
8. Sharma Y.R., Elementary Organic Spectroscopy, S Chand, 2013
9. Singh, DR, Saxena, G., Singh, B., Inorganic Chemicals, Shivlal Aggarwal & Company, Agra
10. Srivastava, S. S., Gehlot, A. S., Chemistry, Ratan Prakashan Temple, Indore
11. Soni, PL, Organic Chemistry, Sultan Chand and Sons, Delhi


16.10.2024

12. Singh, R.K. P., Modern Chemistry, Sahitya Bhavan, Agra
13. Agnihotri, PK, Sahu, D
14. P., Pillai, A., Sahu, M., Yugbodh Chemistry, Yugbodh Publications, Raipur

Reference Books:

1. Mitra Surbhi, Handbook of Computer Science & IT, Arihant, 2018
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007)
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill (2007)
5. Atkins' Physical Chemistry, 10th Edition, Oxford University Press, 2014
6. Gurtu J.N, Gurtu A., Advanced Physical Chemistry, PragatiPrakashan, Meerut. ISBN: 9789386633347, 9386633345; Edition: IV, 2017
7. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
8. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
9. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
10. Banwell, Molecular Spectroscopy, 2017.
11. Silverstien Robert, Spectrometric Identification of Organic Compounds, Wiley, 2014
12. Dyer J.R., Applications of Absorption Spectroscopy of Organic Compounds, 2009.

Suggested equivalent online courses:

MOOC : https://www.edx.org/course/basic-analytical-chemistry

NPTEL: https://nptel.ac.in/courses/104/105/104105084/

**Web sources**

1. http://www.freebookcentre.net/Chemistry/Analytical-Chemistry-Books.html
2. https://www.springer.com/journal/216

| | Part D-Assessment and Evaluation | |
|---|---|---|
| | **Suggested Continuous Evaluation Methods:** Continuous Internal Evalution Shall be Based on Allotted Assignment and Class Tests.The marks shall be as follows: | **Marks** |
| | **Assessment and presentation of assignment** | **04** |
| | **Class Test-I (Objective Questions)** | **04** |
| | **Class Test-II (Descriptive Questions)** | **04** |
| | **Class Test-I (Objective Questions)** | **04** |
| | **Class Test-II (Descriptive Questions)** | **04** |
| | Overall performance throughout the Year (includes Attendance Behaviour Discipline Participation in Different Activities) | **05** |
| | Total | 25 |

| Elaboration: AssessmentTheory | |
|---|---|
| **External Assessment** | |
| Theory Paper | 75 |
| Grand Total | **100** |

16.10.2024