## M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01CACH51** | Title of the Course | **Inorganic Chemistry – I** |
|---|---|---|---|
| Total Credits of the Course | 4 | Hours per Week | 4 |

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| Course Objectives | ➢ To clarify the concept of crystal field theory (CFT), ligand field theory (LFT) and molecular orbital theory (MOT).<br>➢ To review the basic concepts of electronic states of transition metal complexes. The learners should be able to apply theories of chemical bonding, electronic structure and magnetic properties of coordination complexes to identify the occurrence, active site structure and functions of some transition metal ions.<br>➢ To develop an understanding of calculation of Dq, B and ß parameters<br>➢ To develop the concept related to organometallic chemistry. |

| **Course Content** | | |
|---|---|---|
| **Unit** | **Description** | **Weightage** |
| **1.** | **Chemistry of Transition Elements – I**<br>Concept of crystal field theory (CFT), ligand field theory (LFT) and molecular orbital theory (MOT), splitting of d-orbitals in various stereochemistry, Jahn Teller effect: tetragonal distortion in octahedral complexes; spectrochemical series, nephelauxetic series, Electronic states and term symbols; term symbols for diatomic molecule, microstates; derivation of terms for closed subshell; derivation of terms for p2 and d2 configurations. | 25% |
| **2.** | **Chemistry of Transition Elements – II**<br>Correlation diagrams; Orgel diagram; Tanabe-Sugano diagram; selection rule; determination of Dq and electronic parameters; Interpretation of electronic spectra of 3d metal complexes. | 25% |
| **3.** | **Organometallic compounds**<br>Introduction, classifications and general characteristics of organometallic compounds, Organometallic compounds of main group elements; organometallic compounds of transition metals–σ-bonded and Π-bonded organometallics, Catalytic processes involving transition metal organometallic compounds as homogeneous catalysts hydrogenation, hydroformylation, oxidation, isomerization, | 25% |

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|---|---|---|
| | dimerization and polymerization of alkenes and alkenes metathesis, Catalytic applications of main group organometallic compounds | |
| **4.** | **Reaction Mechanism**<br>The nature of substitution reaction, Theoretical approach to substitution mechanism, Nucleophilic reactivity, Nature of central atom, Kinetic application of crystal field theory, Replacement of coordinated metal, Acid analysis, Molecular rearrangement complexes, Reactions of geometrical and optical isomers, Outer sphere electron transfer reactions, Inner sphere electron transfer reactions, Two electron transfer. | 25% |

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| Teaching-Learning Methodology | ➢ We make extensive use of chalk and board.<br>➢ ICT tools such as multimedia projector, smart board, etc. are also used for better explanation of scientific concepts.<br>➢ Detail lecture notes and other reference materials are also provided to the students as and when required from departmental library resources. |

| Evaluation Pattern | | |
|---|---|---|
| Sr. No. | Details of the Evaluation | Weightage |
| 1. | Internal Written Examination (As per CBCS R.6.8.3) | 15% |
| 2. | Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3) | 15% |
| 3. | University Examination | 70% |

Course Outcomes: Having completed this course, the learner will be able to

- Understand the concept of Crystal field theory (CFT) and Ligand field theory (LFT).
- Understand the splitting of d-orbitals in various stereochemistry.
- Determine the term symbols and derivation of terms for f2 configurations.
- Explain correlation diagrams for octahedral and tetrahedral stereochemistry and Tanabe Sugano diagram for octahedral and tetrahedral stereochemistry
- Understand the Charge Transfer transition.
- Understand the concept of Molecular orbital theory for the octahedral and tetrahedral complexes.

References

**Reference Books**


- Electronic Absorption Spectroscopy and Related Techniques, D. N. Sathyanarayana, University Press, 1st Ed. (2001).
- Advanced Inorganic Chemistry, Cotton, Wilkinson, Murillo and Bochmann, Wiley & Sons, 6th ed. (2007).
- Mechanism of Inorganic Reactions, F. Basolo, R. G. Persons, Wiley Pub. 2nd ed. (1967).
- Reaction Mechanism of Coordination Compounds, C. H. Langford, H. B. Gray (1966).
- Fundamental Principles of Inorganic Chemistry, D. Banerjea, Sultan Chand & Sons, 3rd ed. (1993).
- Organometallic Chemistry, R.C. Mehrotra, Anirudh Singh, New Age International (P) Limited Publishers, 2nd ed. (2000).


**Books for further Reading**


- Introduction to Ligand Fields, B.N. Figgis, John Wiley & Sons, 1st ed. (1966).
- Modern Aspects of Inorganic Chemistry, Emeleus and Sharpe, Routledge & Kagan Paul Plc. 4th ed. (1973).
- Inorganic Chemistry, C. E. Housecroft, Alan G. Sharpe, Pearson Publication 4th ed. (2012).
- Inorganic Chemistry, James E. Huheey, Eilen A. Keiter, Richard L. Keiter, Harper Collins, Pearson Publication, 4th ed. (2006).
- Inorganic Chemistry, Shriver, Atkins, Oxford Press, 5th ed. (2009).
- Inorganic Chemistry, James E. huheey, Ellen A. Keiter, Richard L. Keiter, Pearson, 4th ed. (2006).
- Organometallic Compounds, Vol.1 & 2, G. E. Coates, M.L.H. Green, K. Wade, Metheun & Co. Ltd. London EC4, 3rd ed. (1967).
- Organometallic Compounds, G.E. Coates, John Wiley


**On-line resources to be used if available as reference material**

- On-line Resources
- www.nptel.ac.in
- www.swayam.gov.in
- www.epgp.inflibnet.ac.in (e-PG pathshala)
- www.ndl.iitkgp.ac.in (National Digital Library)

# M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01CACH52** | Title of the Course | **Organic Chemistry – I** |
|---|---|---|---|
| Total Credits of the Course | 4 | Hours per Week | 4 |

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| Course Objectives | ➢ To understand the concepts of Stereochemistry, chirality, topicity, prostereoisomerism, stereoselective, and stereospecific reactions.<br>➢ To clarify the concept of reaction mechanism and various methods for identification of mechanism.<br>➢ To understand the role of reactive intermediates in molecular rearrangements.<br>➢ To learn addition, elimination, substitution reactions. |

| **Course Content** | | |
|---|---|---|
| **Unit** | **Description** | **Weightage** |
| **1.** | **Stereochemistry**<br>Optical and geometrical isomerism, Optical activity, chirality and symmetry, Determination of chirality, Different molecular projections and their interconversions, Absolute and relative configuration, Elements of Chirality, Methods of determining configuration, Cahn-Ingold-Prelog system for R/S nomenclature, Optical purity and Enantiomeric excess, Molecules with two (or more) chiral centres and total possible stereoisomers, Compounds containing chiral atom other than carbon, Stereoisomerism in cyclic structures, Prochirality and prostereoisomerism, Homotopic and heterotopic ligands and faces, Stereospecific and stereo-selective reactions. | 25% |
| **2.** | **Reaction mechanism and various methods of determining mechanism**<br>Types of mechanism and reaction, Transition states and intermediates, Thermodynamic and kinetic requirements for reaction, thermodynamic and kinetic control, Hammond Postulate, Microscopic Reversibility, Importance of mechanism and methods of determining mechanisms, Determining reaction mechanism through identification of products, Determining reaction mechanism through identification of intermediates, Determining reaction mechanism through isotopic labeling, Determining reaction mechanism through kinetic isotope effects, Determining reaction mechanism through stereochemical evidences, Determining reaction mechanism through cross-over | 25% |

| | | |
|---|---|---|
| | experiment. | |
| **3.** | **Reactive intermediates**<br>Carbocations (carbonium ions and carbenium ions), Structure, geometry and generation of carbocations, Carbocation stability and fate of carbocations, Reactions involving non-classical carbocations, Structure, geometry and generation of carbanions, Stability and reactions of carbanions, Chiral carbanions and tautomerism in carbanions, Structure and generation of free radicals, Stability and reactions of free radicals, Structure, geometry and generation of carbenes, Reactions of carbenes, Structure, reactivity and generation of nitrenes, Reactions of nitrenes, Structure, reactivity, generation and reactions of arynes. | 25% |
| **4.** | **Addition, Elimination and Substitution reactions**<br>Addition reactions- orientation, reactivity and mechanism, Markovnikov and anti-Markovnikov addition reactions, Addition reactions (hydro-halo, hydro-hydroxy, and hydro-alkoxy), Addition reactions (dihydro, dihydroxy, dihalo and ozonolysis), Elimination mechanism and orientation, E1-E2-E1cB mechanistic spectrum, Effect of Substrate Structure, attacking base, leaving group and medium on elimination reaction, Pyrolytic Eliminations, Aliphatic substitution, $S_E2$, $S_E1$ and $S_Ei$ Mechanism, $S_N1$, $S_N2$, $S_Ni$ mechanism, Neighboring-Group mechanism, Aromatic Substitution, $S_NAr$, $S_N1$ Mechanism, Orientation and reactivity in mono-substituted benzene rings, Orientation in benzene rings with more than one substituent, Ipso substitution | 25% |

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| Teaching-Learning Methodology | ➢ We make extensive use of chalk and board.<br>➢ ICT tools such as multimedia projector, smart board, etc. are also used for better explanation of scientific concepts.<br>➢ Detail lecture notes and other reference materials are also provided to the students as and when required from departmental library resources. |

| Evaluation Pattern | | |
|---|---|---|
| Sr. No. | Details of the Evaluation | Weightage |
| 1. | Internal Written Examination (As per CBCS R.6.8.3) | 15% |
| 2. | Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3) | 15% |
| 3. | University Examination | 70% |

Course Outcomes: Having completed this course, the learner will be able to

- Detect chirality in molecular structure using symmetry
- Recognize the relationship between enantiomeric and diastereomeric structures
- Understand the concept of topicity and prostereoisomerism
- Appreciate the difference between stereoselective and stereospecific reactions
- Manipulate the probable reaction mechanism for chemical transformation
- Employ various name reactions for their useful applications
- Learn the differences between elimination, addition reactions and substitution reactions
- Identify the stereochemical consequences during chemical reactions.
- Practice various techniques for determination of reaction mechanism

References

**Reference Books**


- Advanced Organic Chemistry, Part-A: Structure and Mechanisms, F.A. Carey, R. J. Sundberg, Kluwer Academic/ Plenum Publishers, Springer, 5th ed. (2008).
- Text book of Organic Chemistry Vol. I & II, I. L. Finar, Pearson Education India, 6th ed. (2002).
- Organic Chemistry, R. T. Morrison, R. N. Boyd, Pearson Pub., 7th ed. (2010).
- Advanced Organic Chemistry: Reaction Mechanism and Structure, Jerrry March, John Wiley, 4th ed. (2006).
- J. Clayden, N. Greeves, and S. Warren, Organic Chemistry 2nd Ed. Oxford publication.
- Organic Reactions, Stereochemistry and Mechanism: P.S. Kalsi New Age publication.
- Modern Methods of Organic Synthesis: W. Carruthers Cambridge press.
- Organic Reaction Mechanism: V. K. Ahluwalia and R. K. Parashar Narosa publication.


**On-line resources to be used if available as reference material**

- On-line Resources
- www.nptel.ac.in
- www.swayam.gov.in
- www.epgp.inflibnet.ac.in (e-PG pathshala)
- www.ndl.iitkgp.ac.in (National Digital Library)

# M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01CACH53** | Title of the Course | **Physical Chemistry - I** |
|---|---|---|---|
| Total Credits of the Course | 4 | Hours per Week | 4 |

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| Course Objectives | ➢ The concepts of chemical thermodynamics, and Statistical Thermodynamics Phase Equilibria and Chemical Equilibria, electrochemistry and surface sciences will be expanded to aid in quantification and understanding of several concepts in physical chemistry that have already been studied at UG level.<br>➢ The course contents aim at developing principles, theoretical back ground and further applications of chemical thermodynamics, Statistical Thermodynamics, electrochemistry and surface sciences. |

| **Course Content** | | |
|---|---|---|
| **Unit** | **Description** | **Weightage** |
| **1.** | **Chemical Thermodynamics**<br>Introduction, revision of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Extensive and intensive properties, Gibbs-Duham equation and its application to study the partial molar quantities and their significance. Maxwell relations, thermodynamic equation of state, variation of chemical potential with temperature and pressure. | 25% |
| **2.** | **Statistical Thermodynamics**<br>Limitation of classical thermodynamics, statistical thermodynamics, Energy states and energy levels, macrostate and microstate, thermodynamic probability, the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions, Molecular partition function and their significance, thermodynamics properties in terms of partition function, Rotational, translational, vibrational and electronic partition function, the statistical interpretation of entropy, Sackur-Tetrode equation, comparison of distribution function for indistiguishble particles. | 25% |
| **3.** | **Phase Equilibria and Chemical Equilibria**<br>Elementary description of phase transitions, phase equilibria and phase rule, One-component, two components and three components | 25% |

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|---|---|---|
| | system. Thermodynamics of ideal and non-ideal gases and solutions. | |
| **4.** | **Electrochemistry**<br><br>Electrochemistry of solutions, Debye-Huckel theory of inter-ionic attraction, atmosphere, time of relaxation, relaxation and electro-phoretic effects, Debye-Huckel-Onsagar equation and its validity for dilute solution and at appreciable concentrated solutions. Activity coefficients: forms of activity coefficients and their interrelationship. Debye-Huckel limiting law for osmotic and activity coefficients of dilute electrolyte solutions and its application to concentrated solutions. Debye-Huckel-Bronsted equations, quantitative and qualitative verification of Debye-Huckel limiting law, Industrial applications of Electrochemistry. | 25% |

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| Teaching-Learning Methodology | ➢ We make extensive use of chalk and board.<br>➢ ICT tools such as multimedia projector, smart board, etc. are also used for better explanation of scientific concepts.<br>➢ Detail lecture notes and other reference materials are also provided to the students as and when required from departmental library resources. |

| Evaluation Pattern | | |
|---|---|---|
| Sr. No. | Details of the Evaluation | Weightage |
| 1. | Internal Written Examination (As per CBCS R.6.8.3) | 15% |
| 2. | Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3) | 15% |
| 3. | University Examination | 70% |

Course Outcomes: Having completed this course, the learner will be able to

- Analyze, determine and correlate concepts of laws of thermodynamics, free energy, chemical potential and entropies, partial molar properties, ideal and non-ideal systems.
- Understand the concept of Phase Equilibria and Chemical Equilibria.
- Recognize the electrochemistry principles for understanding the solution properties and Behavior Identify and distinguish the ideal and non-ideal systems in terms of excess functions, activity and activity coefficient of electrolytic solutions in terms of Debye-Huckel.

References

**Reference Books**


- Thermodynamics for Chemists, S. Glasstone, D. Van Nostrand Publication, 13th printed. (1964).
- Elements of Statistical Thermodynamics, L. K. Nash, Addison Wesley, 2nd ed. (1968).
- Elements of Statistical Thermodynamics, M. C. Gupta, New Age International Limited 2nd ed. (1990).
- Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith, Oxford University Press, 7th ed. (2017).
- Physical Chemistry, Ira N. Levine, Tata McGraw Hill Publishing House, 6th ed. (2011).
- Modern Electrochemistry – Vol. I & II, J. O. M. Bockris, A. K. N. Reddy, Plenum Press, Springer publication, 2nd ed. (2018).
- An Introduction to Electrochemistry, S. Glasstone, Maurice Press, 1st ed. (2007).
- Electrolytic Solutions, R. A. Robinson, R. H. Strokes, Dover Publication, 2nd ed. Revised edition (2002).


**Books for further reading**


- Thermodynamics of A Core Course, R. C. Srivastava, S. K. Saha, A. K. Jain, Prentice hall Learning Ltd. 3rd ed. (2007).
- An Introduction to Statistical Thermodynamics, T. L. Hill, Addison – Wesley, 2nd Printing (1960).
- Statistical Mechanics, Donald A. McQuarrie, Viva student ed., (2011).
- An Introduction to thermodynamics, Kinetic theory of Gases and Statistical
- Mechanics, F. W. Sears and Slinger, Addition Wesley, 3rd ed. (1975).
- Principal of Physical Chemistry, B. R. Puri, L. R. Sharma, M. S. Pathania, V. P. D. Publisher, 47th ed. (2017).


**On-line resources to be used if available as reference material**

- On-line Resources
- www.nptel.ac.in
- www.swayam.gov.in
- www.epgp.inflibnet.ac.in (e-PG pathshala)
- www.ndl.iitkgp.ac.in (National Digital Library)

## M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01CACH54** | Title of the Course | **Practical** |
|---|---|---|---|
| Total Credits of the Course | 4 | Hours per Week | 16 |

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|---|---|
| Course Objectives | ➢ Describe how to design experiments, execute experiments, and investigate and infer the observations yielded.<br>➢ The students are trained to handle the experimental set up including standardization.<br>➢ Synthesis and quantitative analysis of organic and inorganic compounds.<br>➢ Quantification of metal ions using different titrations.<br>➢ Identification and separation of radicals present in inorganic mixture.<br>➢ Estimation of organic functional group/molecules by titrimetric methods. |

| **Course Content** | | |
|---|---|---|
| **Unit** | **Description** | **Weightage** |
| | **Inorganic Chemistry**<br>**Quantitative Analysis:**<br>Direct Titration ($Cu^{+2}$, $Ni^{+2}$, $Ca^{+2}$, $Mg^{+2}$ and $Fe^{+3}$)<br>Indirect Titration of Calcium<br>By Back Titration and Replacement titration<br>**Synthesis of metal complexes, double salts and estimation by gravimetry.**<br>➢ Chrome alum $K_2SO_4$, $Cr_2(SO_4)_3.24\ H_2O$<br>➢ Ferrous ammonium sulphate $FeSO_4(NH_4)_2SO_4.6H_2O$<br>➢ Tris ethylene diamine Ni(II) sulphate<br>➢ Tetrammine Cu(II) sulphate<br>➢ Sodium trioxalato ferrate trihydrate<br>➢ Potassium trioxalatochromate (III)<br>➢ Hexa-ammine nickel (II) chloride<br>➢ Hexa-ammine cobalt (III) chloride | 100% |

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| | **Organic Chemistry**<br>➢ Separation and identification of the two component mixtures using Chemical and physical methods.<br>➢ Estimation of unsaturation, ester, acids, reducing sugars, phenols, amines, ketones.<br>➢ Study on acid catalyzed synthesis reactions: Reaction of acetone with glycerol to synthesize acetal in presence of an acid catalyst.<br>➢ Study on base catalyzed synthesis reactions: Knoevenagel condensation of benzaldehyde with cyclohexanone. | |

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| Teaching-Learning Methodology | ➢ Experimental setup and instrumental analysis demonstration at laboratory.<br>➢ Learner perform the same under the observation of supervisor. |

| Evaluation Pattern | | |
|---|---|---|
| Sr. No. | Details of the Evaluation | Weightage |
| 1. | Internal practical Examination (As per CBCS R.6.8.3) | 30% |
| 2. | University Examination | 70% |

Course Outcomes: Having completed this course, the learner will be able to

- Determine the percentage of metal ion using complexometric titration, replacement titration and back titration.
- Perform different types of chemical reactions and synthesized various organic compounds.
- Monitor reaction progress by TLC

References

**Reference Books**

- Qualitative Chemical semimicroanalysis, V. N. Alexeyev, Mir Publishers Moscow, 1st thus ed. (1975).
- Vogel's Qualitative Inorganic Analysis, G. Svehla, Orent Longman, 6th ed. (1979).

- Vogel's Textbook of Quantitative Chemical Analysis, G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, ELBS Publication, 5th ed. (1996) Chapter 2, 3, 11.
- A Textbook of Practical Organic Chemistry, A. I. Vogel, Longman, 5th ed. (2010).
- Elementary Practical Organic Chemistry – Part 3: Quantitative Organic Analysis, A. I. Vogel, Longman, pearson edu., 2nd ed. (2010).
- Practical Organic Chemistry, F. G. Mann, B. C. Saunders, Longman. Pearson, 4th ed. (2009).
- Laboratory Manual of Organic Chemistry, B. B. Dey, M.V.Sitaraman, Allied Publication, 1st ed. (1957).

**On-line resources to be used if available as reference material**

- On-line Resources: From time to time there are many Online resources, including web sites, databases, e-books, bibliographies and platforms that offer educational videos, lectures on a range of topics can be suggested or displayed to the students.
- Major Web Sites used for Laboratory Activities like the Interactive Lab Primer; the Laboratory Safety Institute (LSI); Virtual Chemistry

# M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01CACH55** | Title of the Course | **Practical** |
|---|---|---|---|
| Total Credits of the Course | 4 | Hours per Week | 16 |

| | |
|---|---|
| Course Objectives | ➢ Describe how to design experiments, execute experiments, and investigate and infer the observations yielded.<br>➢ The students are trained to handle the experimental set up including standardization.<br>➢ To describe the various aspects of physical and analytical chemistry. |

| **Course Content** | | |
|---|---|---|
| **Unit** | **Description** | **Weightage** |
| | **Physical and Analytical Chemistry**<br>➢ Determination of normality, amount of chloride/bromide/iodide using potentiometry.<br>➢ Determination of solubility and solubility product of silver halides.<br>➢ Determination the composition of a mixture of acetic acid and Hydrochloric acid by conductometric titration.<br>➢ Determination of CMC of anionic surfactant by conductometry.<br>➢ Determination of mixture of acids and relative strength of weak acids using conductometry.<br>➢ Investigate the molecular composition of a ferric-salicylate complex by Job's method.<br>➢ To determine the rate constant of the saponification of ethyl acetate at different temperatures and calculate the energy of activation of the reaction.<br>➢ To study the variation of refractive index with composition of mixtures of glycol and water.<br>➢ To find out the amount of Borax in given solution by titrating it against hydrochloric acid pH metrically.<br>➢ Kinetics of inversion of cane sugar in presence of strong acid. | 100% |

| | | |
|---|---|---|
| | ➢ Investigation of the reaction between acetone and iodine.<br>➢ Determination of partial molar volume by intercept method, density measurements. | |

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|---|---|
| Teaching-Learning Methodology | ➢ Experimental and instrumental analysis demonstration at laboratory.<br>➢ Learner perform the same under the observation of supervisor. |

Evaluation Pattern

| Sr. No. | Details of the Evaluation | Weightage |
|---|---|---|
| 1. | Internal Practical Examination (As per CBCS R.6.8.3) | 30% |
| 2. | University Examination | 70% |

Course Outcomes: Having completed this course, the learner will be able to

- To study the Critical micelle concentrations (CMC) and surface active parameters of surfactant by surface tension method
- Student gained during theory teaching to the practical aspects such as monitoring rate of saponification, rate of muta-rotation of sugar, quantitative determination using spectrophotometry and refractometer. The students are trained to handle the experimental set up including standardization.
- Students learn how to use various instruments.

References

**Reference Books**


- Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, R. M. W. Rickett, Pergamon Press, Oxford. (2nd revised and enlarged ed.) (2013)
- Findlay's Practical Physical Chemistry, B. P. Levitt, Longman Group Limited, 9th Edition.
- A Laboratory Manual of Experiments in Physical Chemistry, D. Brennan, C. F. H. Tipper, McGraw-Hill Publishing Company Ltd., London. 1st ed. (1967)
- Advanced Physico-Chemical Experiments: A Textbook of Practical Physical Chemistry and Calculations. J. Rose, Sir Isaac Pitman & Sons Ltd., London. 1st ed. (1964)

- Experimental Physical Chemistry, R. C. Das, B. Behera, Tata McGraw-Hill Publishing Company Ltd., New Delhi. 1st ed. (1983)

**On-line resources to be used if available as reference material**

- On-line Resources: From time to time there are many Online resources, including web sites, databases, e-books, bibliographies and platforms that offer educational videos, lectures on a range of topics can be suggested or displayed to the students.
- Major Web Sites used for Laboratory Activities like the Interactive Lab Primer; the Laboratory Safety Institute (LSI); Virtual Chemistry

# M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01EACH51** | Title of the Course | **Analytical Chemistry** |
|---|---|---|---|
| Total Credits of the Course | 4 | Hours per Week | 4 |

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|---|---|
| Course Objectives | ➢ This course gives an introduction to analytical chemistry and an overview of important analytical methods.<br>➢ To Highlight the importance of various spectroscopic methods |

| **Course Content** | | |
|---|---|---|
| **Unit** | **Description** | **Weightage** |
| **1.** | **Errors and Treatment of Analytical Chemistry**<br><br>Terms used in evaluation of Analytical data, Errors, Determinant, constant and interminate, Distribution of random errors, Average derivation and standard derivation, Variance and confidence limit, Significance figures and computation rules, Least square method., Methods of sampling: sample size, Techniques of sampling of gases, fluid, solids and particulates. | 25% |
| **2.** | **UV-Visible and Infra-red (IR) Visible Spectroscopy**<br><br>Introduction of Spectroscopy, region of electromagnetic radiations, Interactions of radiation with matter, rotational, vibrational, electronic energy levels, types of spectroscopy methods.<br>**UV-Vis:** Introduction, Beer-Lambert's law, instrumentation, fundamental of electronic transitions, chromophores and auxochromes, Woodward-Fieser rules, Effect of conjugation.<br>**IR Spectroscopy:** Introduction, Principle of IR spectroscopy, Instrumentation, fundamental modes of vibrations, types of vibrations, condition for IR absorption, selection rules, condition for IR absorption. | 25% |
| **3.** | **Nuclear Magnetic Resonance (NMR)**<br><br>Introduction, principles, magnetic and nonmagnetic nuclei, precessional motion, Larmor frequency, absorption of radio frequency, instrumentation, Shielding and de-shielding effects, chemical shift, Origin of Chemical shift and spin-spin coupling, Fourier Transform technique, Pulse sequence, relaxation processes, peak area and proton ratio, anisotropic effect, spin-spin coupling, coupling constant, | 25% |

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|---|---|---|
| | applications to simple structural problems, Nuclear Overhauser effect with examples. | |
| **4.** | **Mass Spectroscopy**<br>General principle and theory, Methods of ionization, different detectors, time of flight, Importance of HRMS, Rules of fragmentation, Recognition of the molecular ion peak, Mclafferty rearrangements, metastable ionson peaks, the nitrogen rule, Application of Mass spectrometer in structure elucidation and molecular weight determination. | 25% |

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|---|---|
| Teaching-Learning Methodology | ➢ We make extensive use of chalk and board.<br>➢ ICT tools such as multimedia projector, smart board, etc. are also used for better explanation of scientific concepts.<br>➢ Detail lecture notes and other reference materials are also provided to the students as and when required from departmental library resources. |

| Evaluation Pattern | | |
|---|---|---|
| Sr. No. | Details of the Evaluation | Weightage |
| 1. | Internal Written Examination (As per CBCS R.6.8.3) | 15% |
| 2. | Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3) | 15% |
| 3. | University Examination | 70% |

| Course Outcomes: Having completed this course, the learner will be able to |
|---|
| ➢ Understand the analytical chemistry importance in different fields of chemistry<br>➢ Students have an idea about various spectroscopic analysis methods. |

References

**Reference Books**


- Instrumental Methods of Analysis, Willard, Merrit, Dean and Settle, CBS Publishers & Distributors, 7th ed. (2004).
- Spectroscopic Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler, John Wiley & Sons, 2nd ed. (1967).
- Spectroscopic Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw Hills, 6th ed. (2004).
- Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, Thomson Brookes/Cole, 9th ed. (2013).
- Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks/Cole publisher, 4th ed. (2009).
- Fundamentals of Molecular Spectroscopy, C. N. Banwell, E. M. McCash, Tata McGraw Hill publishing, 4th ed. (2017).


**Books for further reading**


- Applications of Spectroscopic Techniques in Organic Chemistry, P. S. Kalsi, New Age Publication, 6th ed. (2014).
- Instrumental Methods of Chemical Analysis, V. K. Ahluwalia, ANE Books Publication, 1st ed. (2015).
- Spectroscopy, B. K. Sharma, GOEL Publishing House (2015).
- Atomic and Molecular Spectroscopy, Mool Chand Gupta, New Age International Publishers, 1st ed. (2001).
- Molecular Spectroscopy, J. D. Graybeal, McGraw Hill, Revised subsequent ed. (1993).
- Modern Spectroscopy, J. M. Hollas, John Wiley & Sons, 4th ed. (2003).


**On-line resources to be used if available as reference material**

- On-line Resources
- www.nptel.ac.in
- www.swayam.gov.in
- www.epgp.inflibnet.ac.in (e-PG pathshala)
- www.ndl.iitkgp.ac.in (National Digital Library)

# M.Sc. Applied Chemistry

Semester - I

| Course Code | **PT01EACH52** | Title of the Course | **Environmental Chemistry** |
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| Total Credits of the Course | 4 | Hours per Week | 4 |

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| Course Objectives | ➢ To clarify the link between environment and chemistry<br>➢ To give the highlights of various harmful activities of chemistry which resulted into the various pollutions.<br>➢ To impart the knowledge about the soil and waste management.<br>➢ To introduce the various techniques for environmental chemical analysis. |

| **Course Content** | | |
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| **Unit** | **Description** | **Weightage** |
| **1.** | **Introduction to Environmental Chemistry**<br>Introduction, Concepts and scope of study, useful terms, Environmental composition, nomenclature of some useful Terms, and ecology. Hydrosphere: Water resources, Physical and Chemical properties of water, sea water model, microbiological processes, organic and inorganic matters in water. Lithosphere: Concentric layers of earth, Physical and Chemical weathering processes, composition of soil, Nitrogen cycle and NPK in soil. Atmosphere: Composition & structure of atmosphere, particles, ions, radicals and chemical reactions in atmosphere. Biosphere: Definition, ecosystem and natural cycles | 25% |
| **2.** | **Air and Water pollution**<br>**Air Pollution:** Source and impact of air pollutants, classification of pollutants, environmental indicators. Sources and effect of air pollutants, pollution by SMOK, FOG, SMOG, PAN, PAH, greenhouse effect, acid rain, ozone depletion, EL Nino phenomena. Analysis of air pollution.<br>**Water pollution:** Definition, types of waters pollutants, Environmental toxicology and toxic elements & pesticides in water, Impact on enzymes, Biochemical effect of pesticides. Water and waste water analysis; collection of sample, Determinations of water quality parameters: Alkalinity, acidity, TDS, TH, D.O., BOD, COD, Chlorides, sulphate, nitrate and nitrite etc. | 25% |

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| **3.** | **Soil pollution and waste management**<br><br>Soil pollution and Waste management: Introduction to soil pollution; waste and pollutants in soil. Waste Management: Classification of wastes, overview of waste management program, methodologies, techniques available and new approaches, Green Chemistry: Basic Principle and its need, tools for green synthesis, Elementary ideas about Green process, green reagent, solvent, catalyst, atom economy. | 25% |
| **4.** | **Methods for Environmental Chemical Analysis**<br><br>Environmental chemical analysis methods Monitoring techniques in water and gas analysis: sampling, total solids, alkalinity and acidity, chlorides and sulfate, hardness, D.O., BOD, COD, nitrate and nitrite, analysis of pollutants in water, analysis of fuel gas, analysis of gaseous pollutants in air, Karl-Fisher reagent and its use, Instrumental techniques: atomic absorption spectrometry, X-ray fluorescence, gas chromatography etc. | 25% |

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| Teaching-Learning Methodology | ➢ We make extensive use of chalk and board.<br>➢ ICT tools such as multimedia projector, smart board, etc. are also used for better explanation of scientific concepts.<br>➢ Detail lecture notes and other reference materials are also provided to the students as and when required from departmental library resources. |

| Evaluation Pattern | | |
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| Sr. No. | Details of the Evaluation | Weightage |
| 1. | Internal Written Examination (As per CBCS R.6.8.3) | 15% |
| 2. | Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3) | 15% |
| 3. | University Examination | 70% |

| Course Outcomes: Having completed this course, the learner will be able to |
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| ➢ Identify alternative green chemistry for environment with the help of their knowledge.<br>➢ Learners know the various pollutions and their effects on environment. |

- Learners get ideas about soil and waste management.
- Learners also know the different analysis techniques related to environmental chemistry.

References

**Reference Books**


- Environmental Chemistry, J. W. Moore, E. A. Moore, Academic Press. Inc. Latest ed. (2012).
- Environmental Chemistry, A. K. De, New Age International Publishers, 7th ed. (2007).
- Principles of Environmental Science: Inquiry and Applications, William Publicaton.
- Cunningham, Mary A. Cunningham. McGraw Hill Publishing Company Ltd., 8th ed. (2016).
- Environmental Chemistry, S.K. Banerji, Prantice Hall of India Pvt. Ltd., 2nd ed. (2005).
- Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH, 1st ed. (2013).
- Methods and Reagents for green synthesis: An introduction, Pietro Tundo, Alvise Perosa, F. Zecchin, Wiley, 1st ed. (2007).
- A Text Book on Experiments and Calculations-Engineering Chemistry, S. Chand & Co. Ltd. 1st ed. (1984).


**On-line resources to be used if available as reference material**

- On-line Resources
- www.nptel.ac.in
- www.swayam.gov.in
- www.epgp.inflibnet.ac.in (e-PG pathshala)
- www.ndl.iitkgp.ac.in (National Digital Library)