

MASTER OF SCIENCE IN CHEMISTRY

(01 Yr)

(Framework for 2026-27 Batch)

M.Sc. Chemistry

Syllabus

Curriculum Framework as per National Education Policy

(NEP)-2020



CENTRAL UNIVERSITY OF KARNATAKA

Department of Chemistry

School of Chemical Sciences

Central University of Karnataka

JUNE 2025

**Department of Chemistry
School of Chemical Sciences
Central University of Karnataka, Kalaburagi**

VISION

To be one of the well-recognized Departments of Chemistry for higher learning in India and the world in terms of producing skilled and employable chemists, researchers, teachers and entrepreneurs who are go-getters in meeting the challenges in chemistry and society.

MISSION

- MS1:** To impart quality education at undergraduate, postgraduate and doctoral levels through the well-designed curriculum to meet the demands of academia, research laboratories and industry.
- MS2:** To provide the state-of-art research facilities to carry out pioneering research in the cutting-edge areas of Chemistry.
- MS3:** To become a hub for human resource development and sponsored research projects with funding from national and global agencies.
- MS4:** To associate with national and international reputed institutions for academic excellence and collaborative research.

Name of the Academic Program: M.Sc. in Chemistry

Program Learning Outcomes (PLOs)

After the completion of the M.Sc. Chemistry program, the student will be able to:

- PLO-1:** Demonstrate comprehensive knowledge and skills in different areas of Chemistry, viz; Organic, Inorganic, Physical, Analytical and Materials Chemistry
- PLO-2:** Apply knowledge and experimental skills to synthesize and analyze chemicals/materials of immediate need for the society and relevance to chemical and allied industries
- PLO-3:** Develop eco-friendly protocols/procedures for chemical processes in the industry.
- PLO-4:** Critically evaluate practices, rules, and theories based on empirical evidence, by following the scientific approach to knowledge development in Chemistry.
- PLO-5:** Demonstrate effective communication skills both orally and in writing using appropriate media in all the aspects related to Chemistry and one's profession

- PLO-6:** Demonstrate a sense of inquiry and ability to define problems; use research methods, analyze, interpret and draw conclusions from data; plan, execute and report the results of an experiment or investigation in intra/interdisciplinary areas of chemistry.
- PLO-7:** Apply the knowledge of chemistry associated with critical thinking to achieve sustainable solutions for energy and environment and other problems in day-today life.
- PLO-8:** Demonstrate ability to work effectively with diverse teams, facilitate cooperative effort as a member or leader of a team to achieve the deliverables of any project
- PLO-9:** Demonstrate the capability to use computational tools, software, and databases relevant to different fields of Chemistry
- PLO-10:** Demonstrate the ability to identify ethical issues related to one's work, avoid unethical behaviour such as committing plagiarism, not adhering to intellectual property rights and adopt objective and truthful actions in all aspects of work.
- PLO-11:** Demonstrate knowledge of the values of multiple cultures and a global perspective effectively engage in a multicultural society for employment or further studies
- PLO-12:** Demonstrate the ability of self-learning and lifelong-learning using ICT and Open Education Resources

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Curriculum and Credit Framework for One Year Post Graduate Program
M.Sc. in Chemistry

Semester	Theory Course	Project	Total Credits
I	4+4	12	20
II	-	20	20
			40

Course Structure for Each Semester

Semester-I

No. of credits = 20

SEMESTER-I							
S.No.	Category of Course	Course Code	Course Title	Hours			Credits
				L	T	P	
1	Major	PCHTC10100	Green Chemistry	3	1	0	4+4= 8
	Any 2 Electives*	PCHTC10101	Medicinal Chemistry	3	1		
		PCHTC10102	Electrochemistry				
		PCHTC10103	Polymer Chemistry				
		PCHTC10104	Environmental Chemistry				
		PCHTC10105	Advanced Material Chemistry				
		PCHTC10106	Advanced Analytical Chemistry				
		PCHTC10107	Nuclear & Radiation Chemistry				
		PCHTC10108	Organic spectroscopy				
		PCHTC10109	Heterocyclic chemistry				
		PCHTC10110	Biochemistry				
		PCHTC10111	Organometallics and Bioinorganic chemistry				
		PCHTC10112	Introduction to Nanochemistry & applications				
		PCHTC10113	Advanced Organic Chemistry				
	(Or)						
			NPTEL course	6	2	0	8
2	Major	PCHRC10100	RESEARCH PROJECT-I	0	0	24	12
Total				6	2	24	20

*Student has to select the course other than that selected in B. Sc (Hons. Or Research) program.

Semester-II

No. of credits = 20

SEMESTER-II							
S.No.	Category of Course	Course Code	Course Title	Hours			Credits
				L	T	P	
2	Major	PCHRC20101	RESEARCH PROJECT-II	0	0	40	20
Total				0	0	40	20

Syllabus of Courses

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10100	Major	Green Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Apply the principals of green chemistry to organic synthesis.

CLO-2: Apply the green synthetic protocols.

CLO-3: Design of chemical reactions using the principle.

CLO-4: Apply green chemistry in combinatorial chemistry and biomimetic catalyst

Detailed Syllabus:**Unit-1:**

Basic introduction and explaining goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry, Twelve principles of Green Chemistry with their explanations and examples. Designing a Green Synthesis using these principles (Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions). **(15 hr)**

Unit-2:

1. Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis).
2. Microwave assisted reactions in water: (Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylation reaction).
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) **(15 hr)**

Unit-3:

1. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments.
2. Designing of Environmentally safe marine antifoulant.
3. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
4. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of Trans-Fats and Oils **(15 hr)**

Unit-4: Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development. **(15 hr)**

Recommended Books/References:

1. Ahluwalia, V.K., Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers, 2005.
2. Anastas, P.T. & Warner, J.K, *Green Chemistry- Theory and Practical*, Oxford University Press, 1998.
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker, 2001.
4. Cann, M.C. and Connely, M.E. *Real-World cases in Green Chemistry*, ACS, 2000.
5. Ryan, M.A. and Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, 2002.
6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, Second Edition, 2010.

Semester-I: Medicinal Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10101	Major	Medicinal Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Understand the Biological activity parameters and drug metabolism.

CLO-2: Biophysical and chemical properties of enzymes, hormones, vitamins

CLO-3: Drug metabolism

CLO-4: Conceptualization of rational drug design

Detailed Syllabus:

Unit-1: Bio-physicochemical properties

Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as K_i , K_d , LD50, EC50, IC50, CC50, ADMET properties **(10 hr)**

Unit-2: Structural properties of drugs and target understanding

Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with

bond length, bond angle and dihedral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereochemically pure drug and racemates, Examples such as catecholamines, etc. Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples. (20 hr)

Unit-3: Concept of rational drug design

Structure activity relationship, Drug-receptor understanding, Molecular modelling, Structure based drug design. QSAR. (12 hr)

Unit-4: Medicinal Chemistry of Therapeutic Agent

Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, Cholinergic Drugs, Diuretics, Cardiovascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents. Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. (18 hr)

Recommended books/References:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale
2. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (2008), Kluwer publication.
3. Remington: The Science and Practice of Pharmacy Vol 1, Ed. 19 by Joseph Price Remington, Alfonso R. Gennaro. (1995), MACK Publishing.
4. Burgers Medicinal Chemistry by Manfred E. Wolff, Alfred Burger
5. Burgers Medicinal Chemistry and Drug Discovery by Abraham D. J., Lewis F. L., Burger A., vol.5, 6th Edn., 2003, Hoboken N.J.Wiley,
6. The Organic Chemistry of Drug Design and Drug Action by Silverman R. B., 2nd Edn., Academic Press. 2012.

Semester-I: Electro Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10102	Major	Electro Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Apply the concepts of electrochemistry in problem solving.

CLO-2: Design of chemical cells and predicting their functions.

CLO-2: Analyse the samples based the electroanalytical methods.

CLO-4: Apply the concepts of electrochemistry in measurement of magnetism.

Detailed Syllabus:

Unit-1:

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts. **(20 hr)**

Unit-2

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb₂O₃ electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). **(20 hr)**

Unit-3: Electroanalytical methods

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values. **(10 hr)**

Unit-4: Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation. **(10 hr)**

Recommended books/reference books

1. Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa, 2004.
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP, 2009.
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi, 2006.
5. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall, 2012.
6. Rogers, D. W. Concise Physical Chemistry Wiley, 2010.
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc., 2005.

Semester-I: Polymer Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10103	Major	Polymer Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Learn about different mechanism of polymer material formation.

CLO-2: Understand the Molecular weight and structure property relationship

CLO-3: Apply the polymerization procedures for various applications.

CLO-4: Analysing the polymers by spectroscopic methods.

Detailed Syllabus:

Unit-1: Introduction

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process. **(10 hr)**

Unit-2: Polymeric Structure and Property Relationship

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. **(20 hr)**

Unit-3: Polymerization Chemistry

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Ziegler-Natta, Metallocene and others. **(15 hr)**

Unit-4: Characterization of Polymers

Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers. **(15 hr)**

Recommended books/References:

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987.
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. J.R.Fried, Polymer Science and Technology, PHI publication, 2005.
7. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York,1962.

Semester-I: Environmental Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10104	Major	Environmental Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Learn about aspects of atmosphere.

CLO-2: Understand the effect of various chemicals on environment

CLO-3: Analyse the water samples by different means.

CLO-4: Implement the eco-friendly activities in day-to-day life.

Detailed Syllabus:

Unit-1: Environment

Composition of atmosphere, temperature variation of earth atmospheric system (temperature vs. altitude curve), biogeochemical cycles of C, N, P, S and O system. **(15 hr)**

Unit-2: Hydrosphere: Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determination fluoride, chromium and arsenic, residual chlorine and chlorine demand, purification and treatment of municipal water and waste water. **(15 hr)**

Unit-3: Atmosphere

Chemical composition of atmosphere – particle, ions, and radicals in their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, and O and their effect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution and control. **(15 hr)**

Unit-4: Aquatic chemistry

Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity, hardness) and its determination, Industrial, municipal water treatment processes, Waste water treatment procedure (primary, secondary and tertiary), Solid waste treatment. Soil pollution and Noise pollution. **(15 hr)**

Recommended Books/References:

1. De.A.K.Environmental Chemistry, Wiley Eastern Ltd, 1990.
2. Miller T.G.Jr., Environmental Science, Wadsworth publishing House, Meerut Odum.E.P.1971.
3. Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co., Philadelphia
4. S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis publisher
5. Environmental chemistry, Sharma and Kaur, 2016, Krishna publishers
6. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.

7. Environmental chemistry, C. Baird, M. Cann, 5th Edn, 2012, W.H.Freeman publication.
- 9 G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Edition) Narosa (2009).
10. Principles of instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing (London)
- 11 Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern (1995)

Semester-I: Advanced Materials Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10105	Major	Advanced Materials Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Apply the principle of solid state in solving crystal structure.

CLO-2: Learn synthesis of different nanomaterials.

CLO-3: Apply synthetic techniques in polymer synthesis.

CLO-4: Solve the structure by instrumentation methods such as X-ray crystallography, SEM, TEM etc....

Detailed Syllabus:

Unit-1: Crystal structure of solids

Synthesis of Inorganic solids; solid state, solution phase and vapor phase synthesis; precipitation, hydrothermal, sol-gel, surfactant based synthesis. Growth of single crystals. Crystal structure determination by X-ray diffraction, d-spacing formula, symmetrically absent reflections, Multiplicities, Scattering of X-rays by an atom and a crystal. Single crystal and powder diffraction. Electron and neutron diffraction. Concept of reciprocal lattice. Electron microscopy techniques. (20 hr)

Unit-2: Nanomaterial fundamentals

Synthesis: Bottom-up vs. Top-down Methods. Solution phase synthetic methods. Role of surfactant in shape and size control of nanomaterials. Synthesis of nanowires and nanotubes by CVD and MOCVD method.

Nanomaterials Characterization: XRD of nanomaterials, Electron microscopy (SEM, TEM, HRTEM and EDX) of nanomaterials, Scanning probe microscopy. Nanomaterial properties

and applications: Magnetic properties of nanoparticles; superparamagnetism, ferromagnetism in antiferromagnetic nanoparticles and single domain to multidomain transition. magnetic nanoparticles as MRI contrast agents. (20 hr)

Unit-3: Frontier areas of polymer science and technology

Conducting polymers: basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers.

Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycaprolactone, poly(vinyl alcohol), polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells. (12 hr)

Unit-4: Fibers and Rubbers:

Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.

Rubber: Compounding and elastomeric properties, vulcanization, reinforcement. (8 hr)

Recommended books/References:

1. Zhen Guo and Li Tan, *Fundamentals and Applications of Nanomaterials*.2009, Artech House, London Publication.
2. Physical methods for chemistry: R. S. Drago, 1992, Saunders college publication.
3. Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International (P) Ltd., 2015.
4. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
5. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
6. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int.Publication, 2019.

Semester-I: Advanced Analytical Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10106	Major	Advanced Analytical Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Learn the statistical methods in chemical analysis.

CLO-2: Apply the polarography in qualitative and quantitative analysis.

CLO-3: Analyse the samples by AAS, TGA/DTA and chromatography.

CLO-4: Analyse fuels and drugs.

Detailed Syllabus:

Unit-1: Statistical methods in chemical analysis

Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method). **(20 hr)**

Unit-2: Polarography

Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications. **(10 hr)**

Unit-3: Atomic spectroscopy and thermal analysis

Atomic absorption spectroscopy: theory and application (with some examples)

Thermal analysis: Theory, methodology, instruments and applications of thermogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC). **(10 hr)**

Unit-4: Chromatography

Principles of chromatography, paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC. **(10 hr)**

Unit-5: Analysis of fuel and drugs

Fuel analysis: Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point.

Drug analysis: Classification of drugs, Analysis of some standard drug using various chromatographic techniques. **(10 hr)**

Recommended books/references:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
2. Willard, H.H. *et al.: Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA, 1988.

3. Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*
6. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elsevier Harwood John Wiley 1979.
7. Ditts, R.V. *Analytical Chemistry; Methods of separation*, van Nostrand, 1974.
8. Khopkar, S. M., *Basic Concepts of Analytical Chemistry*, New Age (Second edition) 1998

Semester-I: Nuclear and Radiation Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10107	Major	Nuclear and Radiation Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Solve problems in nuclear chemistry.

CLO-2: Learn concepts of radiation chemistry.

CLO-3: Learn the concepts of accelerators and detectors in nuclear chemistry.

CLO-4: Understand about the radiation chemistry

CLO-5: Apply the radiation safety measurements.

Detailed Syllabus:

Unit-1:

Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay (Radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half-life, mean life period), units of radioactivity, Transient and secular equilibria, Carbon dating and its usefulness.

Nuclear reactions: Bethe notation, types of nuclear reactions (n, p, α , d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission: the process, fragments, mass distribution, and fission energy. **(20 hr)**

Unit-2:

Measurement of radioactivity, idea about accelerator and detectors, Van de Graaaf and linear accelerators, synchrotrons, Geiger-Muller detector, Scintillation detectors, Type of nuclear reactions, Nuclear fission, Nuclear fusion, Nuclear reactor: classification of reactors, the natural uranium reactor, breeder reactor. Nuclear fusion and stellar energy. **(15 hr)**

Unit-3:

Radiation chemistry: Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, unit of radiation chemical yield (G-value), radiation dosimetry (Fricke's dosimeter), units of radiation energy (Rad, Gray, Rontgen, RBE, Rcm, Sievert). **(10 hr)**

Unit-4:

Nuclear pollution and Radiological safety: Interaction of radiation with matter, Radiolysis of water, Radiation dosimetry. Radioactive isotopes and their applications, Isotopic dilution analysis, Neutron activation analysis, disposal of nuclear waste, nuclear disaster and its management (nuclear accidents and holocaust – discussion about case studies). **(15 hr)**

Recommended Books/references:

1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley Interscience
2. Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall,
3. Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
4. A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
5. Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
6. Arnikaar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition.

Semester-I: Organic Spectroscopy

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10108	Major	Organic Spectroscopy	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Solve problems in nuclear chemistry.

CLO-2: Learn concepts of radiation chemistry.

CLO-3: Learn the concepts of accelerators and detectors in nuclear chemistry.

CLO-4: Understand about the radiation chemistry

CLO-5: Apply the radiation safety measurements.

Detailed Syllabus:

Unit-1: Introduction to spectroscopic techniques: Application of UV – Visible and IR spectroscopy to organic structure elucidation. Electromagnetic spectrum, absorption of energy by organic compounds; Effect of solvent on UV spectrum, red shift & blue shift, Woodward – Fisher rules and theoretical λ max calculations; IR spectrometer instrument & basic principles, Organic functional group identification through IR spectroscopy. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on $>C=O$ stretching absorptions).

(15 Hrs)

Unit-2: Application of NMR Spectroscopy. Basic principles. Introduction to NMR techniques. CW and FT NMR techniques. ^1H NMR Spectral parameters – intensity, chemical shift, multiplicity, coupling constant. Analysis of first order and second - order spectra. Structure determination of organic compounds by ^1H NMR spectra.

(15 Hrs)

Unit-3: Multinuclear ^1H NMR & ^{13}C NMR: Proton coupled, off resonance decoupled, proton noise decoupled ^{13}C NMR spectra. Assignment of chemical shifts, additivity effect, characteristic chemical shifts of common organic compounds and functional groups, DEPT & SEFT spectra. 2D NMR techniques $^1H - ^1H$ COSY, $^1H - ^{13}C$ COSY – HMBC, and NOESY.

(15 Hrs)

Unit-4: Application of mass spectrometry: Basic principles, mass analyzers, ionization methods: EI, PI, CI, FAB, MALDI, ES. Liquid chromatography and mass spectrometry, types of ions and fragmentations, even electron rule, nitrogen rule, isotope abundance, McLafferty rearrangement.

Organic structure elucidation, techniques of ion production, ion and daughter ions, molecular ion and isotope abundance. Nitrogen rule energetics of fragmentation, metastable ions, common fragmentation pathways, fragmentation pattern of common chemical classes. Illustrative examples from macromolecules and supramolecules.

(15 Hrs)

Recommended Books/References:

1. R. M. Silverstein and F. X. Webster, Spectrometric identification of organic compounds, 6thEdn, Wiley.
2. W. Kemp, Organic Spectroscopy, 3rdEdn., MacMillan, 1994.

3. Pavia, Lampman and Kriz, Introduction to Spectroscopy, 3rdEdn., Brooks/Cole.
4. D. H. Williams and Ian Fleming, Spectroscopic methods in organic chemistry, Tata McGraw Hill, 1998.
5. W. Kemp, Introduction to multinuclear NMR.
6. P. S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New age international, 2004.
- 7.

Semester-I: Heterocyclic Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10109	Major	Heterocyclic Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Learn different types of heterocyclic molecules.

CLO-2: Utilize of heterocycles in medicines.

CLO-3: Apply the synthetic protocols in the design of various heterocyclic molecules.

CLO-4: Apply the chemistry of fused heterocycles for various applications.

Detailed Syllabus:

Unit-1: Three-membered heterocycles

Three-membered rings with one heteroatom: Chemistry of oxiranes, aziridines and episulphides - synthetic approaches and reactivities.

Three-membered heterocycles with two heteroatoms: oxaziranes, diaziridines and diazirines - synthetic approaches and reactivities. **(15 hr)**

Unit-2: Four-membered heterocycles

oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products: synthesis of Peniciline and cephalosporine. **(15 hr)**

Unit-3: Five-membered aromatic heterocycles

1. With one heteroatom: furans, pyrroles and thiophenes - general synthetic approaches, properties and reactivities.

2. With two heteroatoms: oxazoles, isoxazoles, imidazoles, thiazoles, pyrazoles and isothiazoles - general synthetic approaches and reactivities.

3. With three and four heteroatoms: triazoles and tetrazoles - synthetic approaches, properties and reactivity. (20 hr)

Unit-4: Condensed five-membered Heterocycles:

Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry of Indoles. (10 hr)

Recommended Books/references:

1. Heterocyclic Chemistry, J.A. Joule, K. Mills, Wiley, 2010.
2. The Essence of heterocyclic Chemistry, A. R. Parikh, H. Parikh, R. Khunt, New Age Int. Publication,
3. Principles of Modern Heterocyclic Chemistry, L. A. Paquette, W. A. Benjamin, New York, 1968.
4. Heterocyclic Chemistry, J.A. Joule and G. F. Smith, van Nostrand, London, 1978.
5. Comprehensive Heterocyclic Chemistry. The structure, reactions, synthesis and use of Heterocyclic compounds, (Ed. A.R. Katritzky and C. W. Rees),. Vol 1-8, Pergamon Press, 1984.
6. Handbook of Heterocyclic Chemistry, A. R. Katritzky, Pergamon Press, 1985.
7. Van der plas, H. C. Ring transformations of Heterocycles, Vols 1 and 2, Academic Press, 1974.

Semester-I: Biochemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10110	Major	Biochemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Understand the importance of biochemistry.

CLO-2: Learn about chemistry proteins, enzymes, lipids, DNA and RNA

CLO-3: Apply biocatalysis in green chemistry and chemical industry

CLO-4: Apply the biochemistry concepts in gene therapy.

Detailed Syllabus:

Unit-1: Carbohydrates:

Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. (12 hr)

Unit-2: Proteins:

Classification, biological importance; Primary, secondary and tertiary structures of proteins: α -helix and β -pleated sheets, Denaturation of proteins. **(12 hr)**

Unit-3: Enzymes:

Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Biocatalysis in Green Chemistry” and Chemical Industry **(12 hr)**

Unit-4: Lipids:

Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. **(12 hr)**

Unit-5: Structure of DNA/RNA:

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. **(12 hr)**

Recommended Books/References:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VI the Edition. W.H. Freeman and Co.
2. Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) principles of Biochemistry. IV Edition. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill

Semester-I: Organometallics and Bioinorganic Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10111	Major	Organometallics and Bioinorganic Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Learn structure and bonding aspects of metal carbonyl, alkyls and sandwich complexes.

CLO-2: Apply organometallic chemistry to catalytic applications.

CLO-3: Solve the problems based on 18 e⁻ rule, back bonding.

CLO-4: Design the complexes/organometallic compounds for biological applications

Detailed Syllabus:

Unit-1:

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies). EAN rule as applied to carbonyls. (15 hr)

Unit-2:

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds. (15 hr)

Unit-3:

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. (15 hr)

Unit 4:

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Mg^{2+} ions: Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones), chelate therapy, metals in diagnosis and medicine, metal complexes for anti-cancer and other therapies. (15 hr)

Recommended books/reference books

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company, 1994.

2. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
3. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997
4. B. D. Gupta, A. J Elias, Basic Organometallic chemistry, 2nd Edn, University Press, 2013.

Semester-I: Introduction to Nanochemistry and Applications

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10112	Major	Introduction to Nanochemistry and Applications	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Understand the types of nanomaterials.

CLO-2: Learn about properties of nanomaterials

CLO-3: Apply synthetic methods in nanomaterial synthesis.

CLO-4: Characterize the nanomaterials by various techniques.

Detailed Syllabus:

Unit-I: Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot); Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.

(15 hr)

Unit-II: Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties.

(15 hr)

Unit-III: Synthesis of Nanomaterials: Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

(15 hr)

Unit-IV: Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of

use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed). (15 hr)

Recommended Books/References books:

- 1.C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
- 2.G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London, 2004
- 3.R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
- 4.Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley Interscience, 2003.
5. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

Semester-I: Advanced Organic Chemistry

Credits: 04

Code	Type	Title	Credits	Hours	L	T	P
PCHTC10113	Major	Advanced Organic Chemistry	4	4	3	1	0

Course Learning Outcomes (CLOs)

After completion of this course successfully, the students will be able to.....

CLO-1: Apply the basic oxidation and reduction reactions on organic molecules.

CLO-2: Apply reagents in the stereoselective reactions using mild reagents.

CLO-3: Plan to synthesize molecules using popularly named reactions.

CLO-4: Categorize the pericyclic reactions and construct various cyclic molecules.

CLO-5: Apply oxidations, reductions, photochemical reactions in the organic synthesis.

Detailed Syllabus:

UNIT-I: Advanced Stereochemistry:

Relationship between elements of symmetry and chirality. Optical activity in the absence of chiral centre: Axial and planar chirality and helicity. Topicity: Enantiotopic and diastereotopic atoms, ligands and faces. Conformational analysis of cyclic compounds: cyclohexane, mono-substituted cyclohexanes; disubstituted cyclohexanes. Decalins. Principles of asymmetric synthesis, Enantioselectivity and diastereoselectivity. Stereospecific and stereoselective reactions. Chiral auxiliaries. Biomolecule chirality (20 Hrs)

UNIT-II: Named Reactions, Rearrangements & Reagents in organic synthesis:

Dicyclohexyl Carbodiimide (DCC), Gilman's reagent, DDQ, Prevost Hydroxylation, Phase transfer catalysts, Phosphorous and Sulphur ylides, Lawson reagents, IBX, Tebbe reagent. Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Neber, Beckmann, Hofmann, Curtius, Schmidt rearrangements, Mukaiyama aldol reaction, Mitsunobu reaction, Shapiro reaction, Vilsmeier-Haack reaction, Baylis-Hillman reaction, Biginelli reaction. **(20 Hrs)**

UNIT-III: Pericyclic reactions-I

Thermal and photochemical pericyclic reactions, Conrotation and disrotation; Electrocyclic closure and opening in $4n$ and $4n+2$ systems. Woodward-Hoffmann selection rules for electrocyclic reactions. Explanation for the mechanism of electrocyclic reactions and examples. **(10 Hrs)**

UNIT-IV: Pericyclic reactions-II

Cycloaddition reactions: Suprafacial and antarafacial interactions. $\pi^2 + \pi^2$ and $\pi^4 + \pi^2$ cycloadditions. Diels-Alder reaction, Woodward-Hoffmann selection rules for cycloaddition reactions and examples. Mechanism by orbital symmetry correlation diagrams, Fukui Frontier Molecular Orbital (FMO) theory. Endo-exo selectivity in Diels-Alder reaction and regioselectivity; Sigmatropic reactions: mechanism of sigmatropic reactions, Cope and Claisen rearrangements. **(10 Hrs)**

Reference books:

1. Carey B. F. A., Sundberg R.J., (2007). *Advanced Organic Chemistry Part A and Part B*, Springer, 5th edition.
2. Jie Jack Li, (2009). *Name Reactions: A collection of Detailed Reaction Mechanism*, Publisher: Springer-verlag.
3. McMurry J., *Organic Chemistry*, Asian Book Pvt. Ltd, 8th edition, New Delhi.
4. Smith, M. B., March J., (Latest Ed.) *March's Advanced Organic Chemistry*, John Wiley and Sons, 6th edition, New York.
5. Clayden, J.; Greeves, N.; Warren, S., (2012) *Organic Chemistry*, Oxford University press, 2nd edition.
6. Sankaraman, S. (2005). *Pericyclic reactions: Reactions, Applications and Theory*, Wiley-VCH.
7. Kurti, L., Czako, B. (2005). *Strategic Applications of Named Reactions in Organic Synthesis*, Elsevier Publications.

Semester-I: Research Project-I**Credits: 12**

Code	Type	Title	Credits	Hours	L	T	P
PCHRC10100	Research Project/ Dissertation	Research Project	12	24	0	0	24

Detailed Syllabus:

Individual faculty members will float a stipulated number of projects. Students have to consult respective faculty members and select projects. More than one student can work under a single project based on the nature of the project. Guide allotment for the MSc project will be based on choice cum merit.

Once guide allotment (either single or more than one guide) is declared, the student has to submit a research proposal either individually or one member from the group. Students will be periodically assessed for their project work by the individual faculty member or group of faculty members and 40% internal marks will be credited for this continuous assessment.

The final submission of the research project i.e. small thesis, presentation, and comprehensive viva carries 60% marks.

Note:

1. Student should submit 3 copies of the final research project copy in hard binding format with all declarations and signatures.
2. For referencing any ACS journal pattern should be followed.

Semester-II: Research Project-II

Credits: 20

Code	Type	Title	Credits	Hours	L	T	P
PCHRC20100	Major	Research Project/Dissertation	20	40	0	0	40

Detailed Syllabus:

Individual faculty members will float a stipulated number of projects. Students have to consult respective faculty members and select projects. More than one student can work under a single project based on the nature of the project. Guide allotment for the MSc project will be based on choice cum merit.

Once guide allotment (either single or more than one guide) is declared, the student has to submit a research proposal either individually or one member from the group. Students will be periodically assessed for their project work by the individual faculty member or group of faculty members and 40% internal marks will be credited for this continuous assessment.

The final submission of the research project i.e. small thesis, presentation, and comprehensive viva carries 60% marks.

Note:

1. Student should submit 3 copies of the final research project copy in hard binding format with all declarations and signatures.
2. For referencing any ACS journal pattern should be followed.