

# Programme Outcomes, Programme Specific Outcomes and Course Outcomes For PG Programmes

**Programme Name:** *M.Sc. in Chemistry*

**Number of Semesters:** *Four*



Enlightenment to Perfection

Department of Chemistry  
University of North Bengal  
West Bengal, INDIA

## Programme Outcomes

- Advanced knowledge in chemical sciences
- Use of advanced spectroscopic tools in chemical science
- Advanced functional materials, its characterization and applications
- Knowledge in biophysics, bioorganic and bioinorganic chemistry
- Designing of targeted molecules and its synthesis followed by characterization.
- Catalysis and its direct industrial applications

## Programme Specific Outcomes

- Hand-on training in organic/inorganic/advanced functional materials synthesis and their characterization
- Hand on training of computational chemistry
- Extraction and identification of natural products and derivatization.
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## Course Outcomes

SEMESTER—I		
Course Code	Course Name	Course Outcomes
ORG-T/01	Organic Chemistry	<p><u>Knowledge acquired:</u></p> <ul style="list-style-type: none"><li>• Aromaticity, Principles of Stereochemistry, Carbon-Carbon Single and Double Bond Formation and Spectroscopy UV, IR, <math>^1\text{H}</math> and <math>^{13}\text{C}</math> NMR and their application in identification of organic molecule</li></ul> <p><u>Skill gained and competency developed:</u></p> <ul style="list-style-type: none"><li>• Revisit and clearing basic knowledge of organic chemistry specifically the stereochemistry and organic reactions towards the formation of C-C bond.</li><li>• Introduction of various modern spectroscopy and utilization the same towards the identification of unknown organic molecules.</li></ul>
ING-T/01	Inorganic Chemistry	<p><u>Knowledge acquired and Competency gained:</u></p> <ul style="list-style-type: none"><li>• Fundamental understanding of elemental chemistry specially late 3d metals and f-block elements</li><li>• Provide adequate knowledge of synthesis, structures, chemical bonding and properties of organometallic compounds</li><li>• Conceptual study on standard reduction potentials and their diagrammatic representations with electrochemical theories of corrosion and kinetics including details of cyclic voltammetry</li></ul>
PHY-T/01	Physical Chemistry	<p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"><li>• Basic postulates and theorems of quantum mechanics, interpretation of wave function, Heisenberg's equation of motion, particle in a box problem, linear harmonic oscillator, Ladder operators, angular</li></ul>

		<p>momentum problem, rigid rotor, hydrogen atom problem and its implications</p> <ul style="list-style-type: none"> <li>• About the variational method, Eckart's theorem, application of the variational method, Huckel Method, and its treatment in various stimuli, perturbation theory, and its applications.;</li> <li>• Brief knowledge about laws of thermodynamics and Nernst heat theorem, mathematical and thermodynamic probability, entropy and probability, the free energy of a mixture.</li> </ul> <p>Skills gained:</p> <ul style="list-style-type: none"> <li>• Applying the knowledge of quantum mechanics in various systems.</li> <li>• Introduction and application of various quantum mechanical methods in various stimuli.</li> <li>• Ability to relate the concept between quantum mechanics and thermodynamics.</li> </ul> <p>Competency developed:</p> <ul style="list-style-type: none"> <li>• Applying the concept of quantum mechanics and wave function to molecules.</li> <li>• Applying the knowledge of various quantum mechanical methods to determine the different molecular properties.</li> </ul> <p>Built the concept of the relation between thermodynamics and quantum mechanics.</p>
PHY-T/02	Physical Chemistry	<p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>• About the macromolecules, polymeric science.</li> <li>• Determination of molecular mass, number, and mass average molecular mass, molecular mass by various methods.</li> <li>• Understanding the kinetics of fast reactions and the development of many theories and techniques to understand the kinetics of chemical reactions.</li> <li>• Role of catalysis in chemicals reactions</li> <li>• Fundamental of nano-science.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>• Concept of macromolecules, polymer and its necessity in day to day life</li> <li>• About the kinetics of fast reaction and techniques to study the chemicals reaction.</li> <li>• Role of catalysis and necessity catalysis.</li> <li>• Requirement of nanotechnology</li> </ul> <p><u>Competency developed:</u></p> <ul style="list-style-type: none"> <li>• Built knowledge about polymeric science and its usefulness in modern life.</li> <li>• Techniques and methods for the study of chemicals reactions.</li> </ul> <p>Role of nanoscience in modern life.</p>
ORG/ING /PHY-P/01	Chemistry Practical	<ul style="list-style-type: none"> <li>• Systematic identification of unknown organic molecules based on known reactions and revalidation the same with spectroscopy.</li> <li>• Qualitative approach for the detection of less common metals – Be, Mo, W, Ti, Zr, Th, V, U, Ce and other acidic and basic radicals.</li> </ul> <p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>• Applying the theoretical knowledge to various chemical phenomena and reactions taught in the present semester.</li> <li>• Methods for the determination of molecular properties.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>• Application of theoretical concept to practical knowledge</li> <li>• Study the kinetics of different chemical reactions and molecular properties by various techniques.</li> </ul>

		<u>Competency developed:</u> <ul style="list-style-type: none"> <li>Built knowledge of how to apply the theoretical concept of different theories for the study the kinetics and molecular properties.</li> </ul>
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SEMESTER—II		
Course Code	Course Name	Course Outcomes
ORG-T/02	Organic Chemistry	<u>Knowledge acquired:</u> <ul style="list-style-type: none"> <li>Radical reaction, detection of radical pathways, common organic named reactions, advanced reagents and their applications in chemo, regio and stereo-selective transformations</li> </ul> <u>Skill gained and competency developed:</u> <ul style="list-style-type: none"> <li>Concept and in-depth knowledge on radical reaction and the use of advanced reagents in organic synthesis to cope up with their applications in the subsequent semester.</li> </ul>
ING-T/02	Inorganic Chemistry	<u>Knowledge acquired and Competency gained:</u> <ul style="list-style-type: none"> <li>In-depth knowledge on the advancement of organometallic compounds and their applications.</li> <li>Understanding and conceptualization of theory and applications of the reaction mechanisms of octahedral metal complexes</li> <li>Fundamentals of magnetochemistry</li> <li>Details study on Acid-Base Chemistry and Non-aqueous solvent system</li> </ul>
ING-T/03	Inorganic Chemistry	<u>Knowledge acquired and Competency gained:</u> <ul style="list-style-type: none"> <li>Preliminary to Advance course on Nuclear Chemistry</li> <li>Evaluation of reaction mechanisms of square planar metal complexes in terms of Trans effect, nucleophilicity parameter, etc.</li> <li>Details study on metal carbonyls and halide clusters, compounds with metal-metal multiple bonds.</li> <li>Understating of Magnetochemistry-A modern approach</li> <li>Comprehensive knowledge on the importance of Isopoly and heteropoly acids and their salts.</li> </ul>
PHY-T/03	Inorganic Chemistry	<u>Knowledge gained:</u> <ul style="list-style-type: none"> <li>About the computational chemistry, data analysis, coding, and decoding involving simple formulae in chemistry.</li> <li>Fundamental of group theory and symmetry</li> <li>Colloidal and solid-state chemistry</li> </ul> <u>Skills gained:</u> <ul style="list-style-type: none"> <li>Application computational knowledge for data analysis, coding, and decoding for the study of the kinetics of the chemical reaction and molecular phenomena</li> <li>To visualize the molecule by group theoretical approach and its symmetrical analysis.</li> <li>Structural nature of molecules in their solid-state.</li> </ul> <u>Competency developed:</u> <ul style="list-style-type: none"> <li>Implication of Computational knowledge to data analysis</li> <li>To know the solid-state structural nature of molecules</li> </ul>

		<ul style="list-style-type: none"> <li>Group theoretical knowledge to visualize the molecule and spectroscopic selection rules.</li> </ul>
ORG/ING/P HY- P/02	Chemistry Practical	<p><u>Skills developed:</u></p> <ul style="list-style-type: none"> <li>Synthesis of organic compounds and their purification and structural determination.</li> <li>Hand-on training on quantitative analysis: Separation and estimation of two metal ions from minerals, alloys or solutions.</li> </ul> <p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>Practical Knowledge to study the kinetics of various chemical reactions</li> <li>Methods for the determination of molecular properties.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>The implication of the theoretical concept to practical knowledge</li> <li>Study the different chemical reactions and molecular properties by various techniques.</li> </ul> <p><u>Competency developed:</u></p> <ul style="list-style-type: none"> <li>Built knowledge of how to apply the theoretical concept and computational skill for the study of the different physical and chemicals properties.</li> </ul>
SEMESTER—III		
Course Code	Course Name	Course Outcomes
ORG-T/03	Organic Chemistry	<p><u>Knowledge acquired:</u></p> <ul style="list-style-type: none"> <li>Advanced stereochemistry, asymmetric catalysis, enantiomeric and diastereomeric excess; enantio-discrimination, resolution-optical and kinetic, Nitrogen (N), Oxygen (O), Sulfur (S) containing Heterocycles and Organo-catalysis</li> </ul> <p><u>Skill gained and competency developed:</u></p> <ul style="list-style-type: none"> <li>Initiation of newer and advanced asymmetric synthesis</li> <li>Chemistry and applications of heterocycles in the modern era</li> <li>Development of skill towards the designing of target molecules.</li> </ul>
ORG-T/04	Organic Chemistry	<p><u>Knowledge acquired:</u></p> <ul style="list-style-type: none"> <li>Organic photochemistry, Basic principles, Jablonski diagram, isomerization, remote functionalization, extrusion reaction, pericyclic reaction, electrocyclic reactions, cycloadditions, sigmatropic rearrangements, carbene addition, cheletropic reactions and the chemistry of Terpenoids (sesqui-, di- and tri-terpenoids), carbohydrates</li> </ul> <p><u>Skill gained and competency developed:</u></p> <ul style="list-style-type: none"> <li>Introduction to photochemistry and utilization of photon as a source of energy in organic transformations.</li> <li>Basic information and importance of natural resources</li> </ul>
ING-T/04	Inorganic Chemistry	<p><u>Knowledge acquired and Competency gained:</u></p> <ul style="list-style-type: none"> <li>Vision of Analytical chemistry from statistical approach</li> <li>Concept and study on Group theory</li> <li>Introduction of Medicinal chemistry and application</li> <li>Advance study on Higher borans and related compounds</li> </ul>

		<ul style="list-style-type: none"> <li>• Introduction of Green Chemistry</li> </ul>
PHY-T/04	Physical Chemistry	<p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>• About the fundamental of molecular spectroscopy including EPR, Mossbauer, and NMR and its implication to the determination of molecular structure.</li> <li>• Fundamental of Statistical thermodynamics</li> <li>• Nature ions in solution, electrode-solution interface, and electrochemical processes.</li> <li>• Knowledge about biomolecules and physical properties.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>• Application of spectroscopic knowledge for structural identification and molecular properties.</li> <li>• About the law of different distribution law, partition function, and implication of partition function in various thermodynamical parameters.</li> <li>• Ion-solvent interaction and electrochemical phenomena.</li> <li>• About the biophysics</li> </ul> <p><u>Competency developed:</u></p> <ul style="list-style-type: none"> <li>• Developed knowledge about the light-matter interaction, identification of molecular structure and molecular properties</li> <li>• Correlation of thermodynamical knowledge to quantum mechanics</li> <li>• Ionic equilibrium, electrostatics.</li> <li>• Knowledge about Biophysics</li> </ul>
ORG/ING/P HY- P/03	Chemistry Practical	<p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>• Applying the theoretical idea to various chemical phenomena and kinetics of reactions whatever taught the current semester.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>• Application of theoretical concept to practical knowledge</li> <li>• Study the different kinetics of the different chemical reactions and molecular properties by various techniques.</li> </ul> <p><u>Competency developed:</u></p> <ul style="list-style-type: none"> <li>• Built knowledge of how to apply the theoretical concept of different theories for the study the kinetics and molecular properties.</li> </ul>
SEMESTER—IV		
Course Code	Course Name	Course Outcomes
ORG-T/05 ORG-T/06 ORG-T/07 ORG-T/08	Organic Chemistry	<p><u>Knowledge acquired:</u></p> <ul style="list-style-type: none"> <li>• Principle, Preparations, Properties and application of organometallic compounds of transition elements – Cu, Pd, Ni, Fe, Co, Rh, Ru, Cr and Ti in organic synthesis. Cross coupling, hydroformylation and hydrogenation reaction.</li> <li>• Green Chemistry – overview, Set of principles of green chemistry, Green synthetic methods, Organic synthesis in green solvents.</li> <li>• Structure determination of Vitamin A, B, C, D, E and K and their biological impact.</li> <li>• General accepts of Medicinal Chemistry, Drug action at enzymes, Drug action at receptors, Lead compound discovery strategies, QSAR, Antibacterial agents,</li> <li>• Bio-organic chemistry: Chemistry of cofactors and their biological</li> </ul>

		<p>function, mechanism, biosynthesis of nucleotides, folic acids; replication, transcription, protein biosynthesis.</p> <ul style="list-style-type: none"> <li>• Alkaloids (pyridine and quinolone based) structure determination and chemistry, Flavonoids</li> <li>• Retrosynthesis, Disconnection, Synthons, Linear and convergent synthesis</li> <li>• <b>Advanced spectroscopy (DEPT, 1H- <sup>1</sup>H COSY, HETCOR, TOCSY, NOESY) and their application in structural determination</b></li> <li>• Chemistry of Organosulphur, Organophosphorus, Organosilicon, Organoboron compounds.</li> </ul> <p><u>Skill gained and competency developed:</u></p> <ul style="list-style-type: none"> <li>• Merging the concept of organic and inorganic chemistry and their direct industrial application.</li> <li>• Advancement of green approach to reduced environmental pollution out of the conventional industrial activities.</li> <li>• Basic knowledge about biomolecules and their importance, application as well as mechanistic approach in relation to the conventional pathways</li> <li>• Systematic identification and their derivatization towards specific application in medicinal field.</li> <li>• Research and development of reaction methods with the knowledge so far gained in the previous section.</li> <li>• Theoretical characterization of unknown organic complex molecules using modern spectroscopic techniques.</li> </ul>
ING-T/05 ING -T/06 ING -T/07 ING -T/08	Inorganic Chemistry	<p><b>ING-T/05</b>  <u>Knowledge acquired and Competency gained:</u></p> <ul style="list-style-type: none"> <li>• Understand of bonding and properties of alkyls and aryls of transition metals.</li> <li>• A comprehensive study of Chemical bonding-Theory and Applications</li> <li>• Inorganic Photochemistry in modern chemical science: Principles, properties and solar energy conversion/storage.</li> <li>• Structure and morphology of crystalline solid state in chemistry</li> <li>• Study of analytical techniques in advance sciences</li> </ul> <p><b>ING-T/06</b>  <u>Knowledge acquired and Competency gained:</u></p> <ul style="list-style-type: none"> <li>• Analytical chemistry for molecular characterization</li> <li>• Application of Chemical bonding for origin of colour</li> <li>• Bioinorganic chemistry- A fundamental study on bioelements, biological basic processes in living world and molecule of heredity</li> <li>• General principles, crystal defects and non-stoichiometry, colourcentre in Solid state chemistry</li> <li>• Study of organometallic catalysts and Fluxional organometallic compounds.</li> </ul> <p><b>ING-T/07</b>  <u>Knowledge acquired and Competency gained:</u></p> <ul style="list-style-type: none"> <li>• Application of Group theory</li> <li>• Bioinorganic chemistry: Electron transfer processes,</li> </ul>

		<p>metalloenzymes, metabolism and Energetic in biology</p> <ul style="list-style-type: none"> <li>• Characterization of Inorganic compounds by vibrational, rotational spectroscopy, ESR, Mössbauer.</li> <li>• Molecular spectroscopy: Theory and applications</li> <li>• Discussion on the chemistry of Super Heavy elements</li> </ul> <p><b>ING-T/08</b></p> <p><u>Knowledge acquired and Competency gained:</u></p> <ul style="list-style-type: none"> <li>• Characterization of Inorganic compounds by NMR, ORD/CD, EXAFS, ESCA (XPS &amp; UPS)</li> <li>• In-depth knowledge on Crystal morphology &amp; X-Ray crystallography</li> <li>• Inorganic supramolecular chemistry : Introduction and design of new functional materials</li> <li>• A details discussion on the chemistry of non-transition elements</li> <li>• Chemistry of Nano-materials and Advance Functional Materials: Introduction, strategy and applications</li> </ul>
PHY-T/05 PHY-T/ 06 PHY -T/07 PHY -T/08	Physical Chemistry	<p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>• Knowledge about advanced quantum chemistry and chemical binding.</li> <li>• Non-equilibrium processes and their thermodynamics.</li> <li>• Advanced statistical thermodynamics</li> <li>• Knowledge about the advanced polymer chemistry</li> <li>• Advanced functional materials, their synthesis, and characterization</li> <li>• Knowledge about photophysics and advanced spectroscopy.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>• Quantum mechanical approach towards chemicals binding</li> <li>• Non-equilibrium thermodynamics</li> <li>• Advanced materials and their characterization</li> <li>• About the various photophysical processes</li> </ul> <p><u>Competency developed:</u></p> <ul style="list-style-type: none"> <li>• Quantum mechanical approach towards chemical binding</li> <li>• About the non-equilibrium processes</li> <li>• Advanced functional materials and polymer</li> <li>• Photophysics of molecules to materials.</li> </ul>
ORG-P/04	Organic Chemistry Practical	<ul style="list-style-type: none"> <li>• Development of practical skill towards the purification using column chromatography and identification of organic molecules with the help of spectroscopy.</li> </ul>
ING-P/04	Inorganic Chemistry Practical	<p><u>Skills developed:</u></p> <ul style="list-style-type: none"> <li>• Skill development on the Synthesis, strategy and their physico-chemical characterization of inorganic compounds/complexes</li> </ul>
PHY-P/04	Physical Chemistry Practical	<p><u>Knowledge gained:</u></p> <ul style="list-style-type: none"> <li>• Application of computer for the study of different physical properties of molecules and their spectroscopic features,</li> <li>• Determination of different parameters of self-assemblies.</li> <li>• Spectroscopic investigations of molecules to materials.</li> </ul> <p><u>Skills gained:</u></p> <ul style="list-style-type: none"> <li>• About the computational chemistry.</li> <li>• Characterization of self-assemblies.</li> <li>• Usefulness spectroscopy.</li> </ul> <p><u>Competency developed:</u></p> <ul style="list-style-type: none"> <li>• Use of computer in chemistry</li> <li>• Knowledge of self-assemblies</li> </ul>

		<ul style="list-style-type: none"> <li>• Study of molecules and materials by spectroscopy.</li> </ul>
ORG/ING/ PHY – PD/05	Project - Dissertation	<ul style="list-style-type: none"> <li>• Hand on experience to prepare targeted molecules set for specific application and orient young mind in advanced research work.</li> </ul>