



Ph.D. Course Work Syllabus – 2026

**Department of Chemistry
University of Kalyani**

Course Work Structure¹

Paper 801A-CW-CHEM: Research Methodology (A)

Quantitative Method, Computer Application, Training, Field work etc.

Marks: 30+10+10 = 50

Term end examination + Internal Assessment + Viva = 50

Credits: 02

Paper 801B-CW-CHEM: Research and Publication Ethics (B)

Research integrity, Publication ethics, Research misconduct and Predatory Publications, Citation databases, Open access publications, Research Metrics and Plagiarism Tools

Marks: 30+10+10 = 50

Term end examination + Internal Assessment + Viva = 50

Credits: 02

Paper 802 CW-CHEM: Research Methodology (B)

Review of published research, Documentation/submission of reports on review work and presentation

Marks: 60+20+20 = 100

(Report+ Presentation+ Viva Voce Exam) =100

Credits: 04

Paper 803 CW-CHEM: Advanced Level Course on Subject (A)

Subject-specific components

Paper 804 CW: Advanced Level Course on Marks: 60+20+20 = 100

Term end examination + Internal Assessment + Viva = 100

Credits: 04

Paper 804 CW-CHEM: Advanced Level Course on Subject (B)

Trans-disciplinary components

Marks: 60+20+20 = 100

Term end examination + Internal Assessment + Viva = 100

Credits: 04

¹ University regulations for admission, registration, coursework, examination and award of Ph.D. degree-2025, University of Kalyani

Paper 803 CW-CHEM: Advanced Level Course on Subject (A)

Subject: Physical Chemistry

Course: 803 CW-CHEM-P1

Course Title: Commonly used Fluorescence Techniques

Credit: 2

Course Content:

Introduction to Fluorescence Spectroscopy - Basic Theory, Instrumentation - Steady State, Time-resolved and Fluorescence Microscopy / Confocal Microscopy, Some Applications

Subject: Physical Chemistry

Course: 803 CW-CHEM-P2

Course Title: Applications of symmetry and group theory

Credit: 2

Course Content:

Hybridization in σ - and π -bonding network, IR-Raman activity in vibrational spectroscopy, electronic transitions, molecular orbitals.

Subject: Physical Chemistry

Course: 803 CW-CHEM-P3

Course Title: Techniques for Material Characterization

Credit: 2

Course Content:

Gel Permeation Chromatography, Gas Chromatography, Liquid Chromatography, MALDI Analysis, X-ray Diffraction, Thermal Analysis, Differential Scanning Calorimetry (DSC)

Subject: Physical Chemistry

Course: 803 CW-CHEM-P4

Course Title: Chromatography Techniques for Polymer Characterization

Credit: 2

Course Content:

Gel Permeation Chromatography, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography, Crystallization and Crystallinity of polymers

Subject: Organic Chemistry

Course: 803 CW-CHEM-O1

Course Title: Modern methods in Organic Synthesis: Modern reagents in C-C, C-X (X = heteroatom)

Credit: 2

Course content:

bond formation reactions, Modern reagents for halogenation, formylation, epoxidation, dihydroxylation. Chemo-selective reagents, C-H activation reaction, green techniques in organic synthesis, microwave assisted reaction

Subject: Organic Chemistry

Course: 803 CW-CHEM-O2

Course Title: Stereochemistry

Credit:2

Course content:Stereochemistry

Chiral elements, pro-stereoisomerism, electronic and steric factors in conformational analysis, stereoheterotopic ligands and spectroscopy.

Subject: Inorganic Chemistry

Course:803 CW-CHEM-I1

Course Title:Organometallic Compound

Credit:2

Course Content:

Organotransition metal chemistry: Nature of metal-carbon bonding, classification of organometallic compounds, Fluxional organometallic compounds, Homogeneous catalytic hydrogenation, Ziegler-Natta polymerization of olefins, catalytic reactions involving CO (hydroformylation, oxo insertion etc.), Wacker oxidation, Monsanto acetic acid synthesis.

Subject: Inorganic Chemistry

Course:803 CW-CHEM-I2

Course Title:Electron transfer reaction/ Bioinorganic chemistry

Credit:2

Course Content:

Outer sphere and inner sphere electron transfer reaction, Principles of coordination chemistry related to bioinorganic chemistry, Essential and trace metal ions in biological systems, Porphyrin and related ligands, ATP as energy source, oxidative phosphorylation and phosphorylation of glucose.

Subject: Analytical Chemistry

Course:803 CW-CHEM-A1

Course Title: Thermal Methods of Analysis

Credit:2

Course Content:

Principles, instrumentation and applications of Thermogravimetric analysis (TGA), derivative of thermogravimetry (DTG), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Various factors affecting the thermal methods. Problem solving research-based compounds.

Subject: Analytical Chemistry

Course:803 CW-CHEM-A2

Course Title: X-ray Crystallography

Credit:2

Course Content:

Brief introduction of different scattering, Bragg's law, Laue's equations, Fourier analysis, reciprocal lattice, Friedel's law, Ewald's synthesis, systematic absences, twinning. Determination of space group symmetry from diffraction pattern. Structure solution and refinement. Fourier transform and inverse Fourier transform. Patterson method, direct methods. Charge flipping,

phase problem, least-squares refinement, Rietveld refinement, Fourier maps. Diffraction by periodic and aperiodic (modulated and composite) crystals.

Paper 804 CW-CHEM: Advanced Level Course on Subject (B)
Trans-disciplinary components

Subject: Physical Chemistry

Course: 804 CW-CHEM-TP1

Course Title: Advanced microscopic techniques

Credit: 2

Course Content:

Working principle, instrumentation and applications. Electron microscopy (SEM and TEM), atomic force microscopy (AFM), scanning tunneling microscopy (STM), fluorescence microscopy.

Subject: Physical Chemistry

Course: 804 CW-CHEM-TP2

Course Title: Interfacial Chemistry

Credit: 2

Course Content:

Nature of Surfaces, Micelles, Micellisation, Reverse micelles, properties, related factor, Thermodynamics of micellar systems uses and applications.

Subject: Physical Chemistry

Course: 804 CW-CHEM-TP3

Course Title: Techniques for Polymer Characterization

Credit: 2

Course Content:

Glass transition temperature of Polymers, X-ray Diffraction, Thermal Analysis, Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), MALDI-TOF Mass Spectroscopy

Subject: Physical Chemistry

Course: 804 CW-CHEM-TO1

Course Title: Structure elucidation of Organic Compounds

Credit: 2

Course Content:

Basic concepts on structure elucidation, ^1H , ^{13}C NMR, DEPT, 2D NMR, UV-Vis, FTIR and mass analysis to determine the unknown structures.

Subject: Inorganic Chemistry

Course: 804 CW-CHEM-TI1

Course Title: Metal Complexes/oxides in Homogeneous and Heterogeneous Catalysis

Credit: 2

Course Content:

Catalyst—definition and types, physical background, activation energy, collision theory, principles of catalytic reaction—format and action, surface adsorption and desorption, strength of adsorption, specificity, poisoning, catalytic converter, auto catalysis, enzyme— 'lock and key' model, green chemistry—atom economy, important homogeneous catalytic reactions—key reactions steps.

Case study—detail investigation on

- (i) Oxide-supported methyltrioxorhenium: An olefin metathesis catalyst
- (ii) Environmentally beneficial catalysts

Subject: Analytical Chemistry

Course:804 CW-CHEM-TA1

Course Title: Electroanalytical Techniques

Credit:2

Course Content:

Aspects of various electroanalytical methods, Electrochemical cells, interfaces, and the electric double layer, electrode kinetics, migration, convection currents. Polarography & Voltammetry: linear sweep voltammetry, cyclic voltammetry, staircase voltammetry, pulse voltammetry, Cathodic stripping voltammetry, Anodic stripping voltammetry. Instrumentation and applications of voltammetry, Electrochemical Water Splitting.

Subject: Analytical Chemistry

Course:804 CW-CHEM-TA2

Course Title: Advanced Pharmaceutical Chemistry

Credit:2

Course Content:

Primary aspects of pharmaceutical drugs, including their definition, classification, and behaviour within the body (pharmacokinetics/pharmacogenomics), structure-based drug design, structure-activity relationships, pharmaceutical analysis and quality control, drug metabolism and its broad-spectrum pathways, principles and instrumental methods for the analysis of some pharmaceutical drugs.