DEPARTMENT OF CHEMISTRY

GOVERNMENT COLLEGE CHITTUR, PALAKKAD – 678104

RE-ACCREDITED BY NAAC WITH A+ GRADE

AFFILIATED TO UNIVERSITY OF CALICUT, KERALA

SUMMER INTERNSHIP PROGRAMME 2026

Organic Synthesis, Separation Techniques, Spectroscopic Analysis and ICT Tools for Molecular Design and Data Analysis

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The Department of Chemistry at Government College Chittur offers a 60-hour skill-oriented internship programme for undergraduate students to strengthen their practical knowledge and laboratory skills in chemistry. The programme is designed to complement classroom learning by providing hands-on training in essential experimental techniques, analytical methods, and modern computational tools used in chemical sciences.

Through a combination of laboratory exercises and digital learning modules, students gain exposure to contemporary scientific practices and develop competence in data analysis, instrumental techniques, and laboratory methodologies. The internship aims to enhance scientific aptitude, analytical thinking, problem-solving abilities, and technical proficiency, thereby preparing students for higher education.

Objectives

- To provide comprehensive hands-on training in green organic synthesis techniques, including mechanochemical synthesis, ultrasound-assisted synthesis, and nanomaterial synthesis, with emphasis on reaction setup, monitoring reaction progress, product isolation, purification, and characterization of synthesized compounds.
- To develop proficiency in compound characterization through systematic understanding and interpretation of spectroscopic techniques such as UV-Visible and IR spectroscopy.
- To equip students with essential skills in chemical structure drawing and molecular modelling using modern digital tools for accurate scientific representation.
- To introduce scientific data analysis, molecular modelling, structure visualization, and graphical representation using specialized software such as ChemDraw,

Avogadro, and Origin for the effective interpretation and presentation of experimental results.
- To enhance research aptitude, critical thinking, problem-solving ability, and overall laboratory confidence for advanced academic and research pursuits.

Eligibility

- Students pursuing II Semester and IV Semester Under graduation
- Must have a Chemistry background

Certification

- Participants will be awarded an Internship Completion Certificate by the Department of Chemistry, Government College Chittur upon successful completion.

Learning Outcomes

Upon successful completion of the internship programme, students will be able to:

1. Apply green and sustainable approaches for the synthesis of organic compounds using mechanochemical and ultrasound-assisted techniques.
2. Perform nanoparticle synthesis and understand the principles involved in the preparation of nanomaterials.
3. Employ chromatographic techniques such as Thin Layer Chromatography (TLC) and Column Chromatography for reaction monitoring, separation and purification of chemical compounds.
4. Record, analyze, and interpret UV–Visible and Infrared (IR) spectra for the characterization of chemical substances.
5. Utilize ChemDraw software to draw, edit, and represent chemical structures, reaction schemes, and molecular information in standard scientific formats.
6. Generate and interpret basic spectral simulations, molecular properties, and structure–property relationships using ChemDraw.

7. Construct, visualize, and manipulate two-dimensional and three-dimensional molecular structures using Avogadro software.

8. Demonstrate proficiency in using Origin software for scientific data processing, graphical visualization, spectral analysis, and preparation of publication-quality figures.
9. Analyze spectroscopic and diffraction data, including UV–Visible, FT-IR, Raman, and XRD datasets, using Origin software tools.

Module	Unit		Hours
Module I **Organic Synthesis (12 Hours)**	**Unit 1** Mechanochemical Synthesis	• Introduction to the principles of mechanochemistry and green organic synthesis. • Solvent-free synthesis of Schiff bases using grinding techniques.	**4 Hours**
	Unit 2 Ultrasound-Assisted Synthesis	• Diels–Alder cycloaddition reactions using ultrasonication techniques.	**4 Hours**
	Unit 3 Nanoparticle Synthesis	• Green Synthesis of Ag Nanoparticle	**4 Hours**
Module II **Separation Techniques (8 Hours)**	**Unit 4** Thin Layer Chromatography (TLC) Techniques	• Preparation of TLC plates • Preparation of samples and sample spotting • Selection of suitable mobile phase • Development of TLC plates • Visualization of chromatograms using UV chamber • Calculation of R_f values • Monitoring reaction progress using TLC • Assessment of compound purity using TLC • Comparison of R_f values for identification of compounds	**3 Hours**
	Unit 4 Column Chromatography	• Selection of suitable stationary phase and solvent system (eluent) • Preparation and packing of the chromatographic column	**3 Hours**

		• Preparation and loading of the crude sample onto the column • Elution of compounds using an appropriate solvent or solvent mixture • Collection of eluate fractions • Monitoring of fractions using Thin Layer Chromatography (TLC) • Isolation and recovery of the purified compound	
	Unit 5 Soxhlet Extraction	• Introduction to the principles and applications of Soxhlet extraction • Assembly of the Soxhlet extraction apparatus • Selection of suitable extraction solvents based on the solubility and polarity of the mixture components • Loading of sample into the extraction thimble • Working of the Soxhlet extraction system • Recovery of extract and removal of solvent using distillation	**2 Hours**
Module III **Spectroscopic Analysis (10 Hours)**	**Unit 6** UV–Visible Spectroscopy	• Introduction to UV–Visible spectroscopy • Preparation of samples for **UV–Visible** analysis • Operation of **UV–Visible** spectrophotometer • Recording UV–Vis spectrum	**2 Hours**
	Unit 7 Infrared(IR) Spectroscopy	• Introduction to Infrared (IR) spectroscopy • Preparation of samples for IR analysis and operation of IR spectrophotometer • Recording IR spectra of compounds • Identification of characteristic functional group absorption bands.	**2 Hours**

	Unit 8 Spectral interpretation	• Interpretation of UV–Vis and IR spectra • Correlation of structure with spectral data • Confirmation of product formation using spectral data	**6 Hours**
Module IV **Molecular Modeling - ChemDraw Molecule structure drawing tool (6 Hours)**	**Unit 9** Fundamentals and Basic Features	• Introduction to ChemDraw • User interface: Toolbars, Drawing canvas, Menus and panels, • Basic drawing tools: Bonds (single, double, triple), Rings and templates, Atom labeling, • Structure clean-up (geometry correction), • Creating and editing chemical structures, • Drawing chemical equations and reaction diagrams, • Export options: SVG, PDF, Image formats	**2 Hours**
	Unit 10 Structure Representation and Conversion	• Customization of structures: Bonds, angles and geometry; Charges and radicals, Labels and annotations, • Chemical name to structure conversion, • Structure to IUPAC name conversion,	**2 Hours**
	Unit 11 Spectral Simulation and Analysis	• NMR spectrum simulation: ^{1}H NMR, ^{13}C NMR, • Mass spectrum simulation, • Molecular weight determination, • Property prediction tools, • Correlation between structure and spectral data, • Basic interpretation of spectral outputs.	**2 Hours**
Module V **Avogadro software for Molecular**	**Unit 12** Introduction to Avogadro software	• Installation • User interface: Menu bar, Toolbars, Display window • File handling: Open, save, export files	**2 Hours**

Modeling (8 Hours)	**Unit 13** Building Molecular Structures	• Drawing organic and inorganic molecules • Adding atoms and bonds • Adjusting bond order (single, double, triple) • Editing structures (delete, modify atoms, change atom types) • Using templates and fragments • Building complex molecules	**2 Hours**
	Unit 14 3D Visualization and Editing	• Molecular visualization (ball and stick, space-filling) • Rotating and zooming structures • Measuring bond length, bond angle, dihedral angle • Structure manipulation (translation and rotation) • Display settings and customization	**2 Hours**
	Unit 15 Geometry Optimization and Calculations	• Concept of molecular geometry optimization • Energy minimization • Optimization tools in Avogadro • Basic molecular properties (energy, stability)	**2 Hours**
Module VI **Data Analysis and Visualization with Origin (16 Hours)**	**Unit 16** Introduction to Origin Software and Graphical Data Visualization	• Overview of the Origin software interface, including worksheets, workbooks, and graph windows. • Importing and managing data from Excel, CSV, and TXT files. • Organizing data using columns, labels, units, and project management tools. • Basic data editing, formatting, and manipulation for scientific analysis. • Creating line, scatter, and bar plots for data visualization. • Generating multi-curve and overlay graphs for comparative analysis. • Customizing graph axes, scales, ticks, labels, legends, and annotations.	**2 Hour**

		• Using graph templates and saving styles for consistent and publication-ready figures.	
	Unit 17 Spectral Data Processing and Analysis Using Origin	• Application of smoothing, filtering, and baseline correction techniques to improve data quality. • Detection, identification, and characterization of spectral peaks in analytical datasets. • Data interpolation and extrapolation for enhanced interpretation and prediction of results. • Peak fitting using Gaussian and Lorentzian models, including peak area and height calculations. • Interpretation of UV–Vis and IR spectra and export of publication-quality figures in TIFF, PNG, and EPS formats.	**2 Hour**
	Unit 18 Spectroscopic and Diffraction Data Analysis Using Origin Software	• Introduction to Origin software for scientific data analysis • Importing and organizing spectroscopic and diffraction data • FT-IR spectral analysis: peak identification and functional group interpretation • UV-Visible spectral analysis: absorption maxima (λ_{max}), electronic transitions, and band-gap estimation • Raman spectral analysis: vibrational mode assignment and peak interpretation • XRD data analysis: peak indexing, d-spacing calculation, crystallinity assessment, and crystallite size determination • Baseline correction, smoothing, and peak fitting techniques • Comparative analysis of spectra and diffraction patterns	**4 Hours**

		• Graph preparation and data visualization using Origin	
	Unit 19 Report Preparation & Integration	• Export graphs to Word • Figure captions and labeling • Preparing publication-quality figures • Combining graphs with chemical structures and tables • Report Preparation	**8 Hours**

Module	**Learning Outcomes**
Module I **Organic Synthesis**	1. Explain the principles of mechanochemistry and green organic synthesis and their importance in sustainable chemistry. 2. Perform solvent-free synthesis of Schiff bases using grinding techniques and evaluate the advantages of mechanochemical methods. 3. Conduct Diels–Alder cycloaddition reactions using ultrasonication and understand the role of ultrasound in enhancing reaction efficiency. 4. Synthesize silver nanoparticles through green synthesis methods using environmentally friendly reducing and stabilizing agents. 5. Characterize and compare the products obtained from green synthetic approaches and assess their environmental benefits over conventional methods. 6. Apply green chemistry principles to design safer, sustainable, and eco-friendly chemical processes.
Module II	1. Demonstrate proficiency in Thin Layer Chromatography (TLC) for sample analysis, reaction monitoring, purity

Separation Techniques	assessment, and compound identification through Rf value determination. 2. Apply column chromatography techniques for the separation, purification, isolation, and recovery of chemical compounds from crude mixtures. 3. Select appropriate stationary phases, mobile phases, and solvent systems based on the chemical properties of target compounds. 4. Perform Soxhlet extraction by assembling the apparatus, selecting suitable solvents, and carrying out efficient extraction of compounds from solid samples. 5. Integrate extraction, separation, and purification techniques for the isolation and characterization of chemical substances in laboratory practice.
Module III **Spectroscopic Analysis**	1. Explain the principles and applications of UV–Visible and Infrared (IR) spectroscopy in chemical analysis. 2. Prepare samples and operate UV–Visible and IR spectrophotometers for the acquisition of spectral data. 3. Record and interpret UV–Vis and IR spectra, including the identification of characteristic functional group absorption bands. 4. Correlate spectral features with molecular structure to obtain structural information about chemical compounds. 5. Utilize spectroscopic data to confirm product formation and support compound characterization.
Module IV **Molecular Modeling - ChemDraw Molecule structure drawing tool**	1. Develop a comprehensive understanding of the ChemDraw interface, tools, and workflow for efficient chemical drawing 2. Gain proficiency in drawing, editing, and optimizing chemical structures including organic, inorganic, and complex molecules 3. Acquire the ability to construct clear chemical equations, reaction mechanisms, and schematic diagrams 4. Demonstrate skills in customizing structures with correct geometry, bond angles, charges, and annotations 5. Attain competence in converting chemical names to structures and generating IUPAC names

	6. Develop the ability to simulate and interpret basic spectral data (^{1}H NMR, ^{13}C NMR, mass spectra) and correlate with structures 7. Create publication-quality scientific illustrations and export them in suitable formats for academic and research use
Module V **Avogadro software for Molecular Modeling**	1. Demonstrate proficiency in using Avogadro software for creating, editing, and managing organic and inorganic molecular structures. 2. Visualize and manipulate molecular models in three dimensions using various display formats and structural transformation tools. 3. Measure and analyze molecular parameters, including bond lengths, bond angles, and dihedral angles, to understand molecular geometry. 4. Apply geometry optimization and energy minimization techniques to obtain stable molecular conformations using computational tools. 5. Evaluate fundamental molecular properties, including energy and stability, and utilize computational modelling for molecular structure analysis and prediction.
Module VI **Data Analysis and Visualization with Origin**	1. Demonstrate proficiency in using Origin software for importing, organizing, managing, and processing scientific data from diverse sources. 2. Create, customize, and optimize graphical representations, including multi-curve plots and publication-quality figures, for effective scientific communication. 3. Apply advanced data processing techniques such as smoothing, filtering, baseline correction, peak detection, interpolation, extrapolation, and peak fitting for analytical data interpretation. 4. Analyze and interpret spectroscopic and diffraction data, including FT-IR, UV–Visible, Raman, and XRD datasets, to extract meaningful structural and material information. 5. Perform comparative analysis of spectra and diffraction patterns and integrate graphical outputs with chemical structures, tables, and annotations for comprehensive data presentation. 6. Prepare professional scientific reports, thesis figures, and research publication materials by exporting, formatting, and presenting data according to academic and journal standards

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