Darrang College (Autonomous), Tezpur-784001

Syllabus for FYUGP

B.Sc. Chemistry (Major)

Skill Enhancement Courses (SEC)

Prerequisites:

- For Major in Chemistry a student must pass in Chemistry and Mathematics at XII level.

Approved by :

Board of Studies meeting held on 31th July, 2025

&

Academic Council vide Resolution no. 04, dated- 12/08/2025

FOUR-YEARUNDERGRADUATE PROGRAMME (FYUGP) IN CHEMISTRY, Darrang College (Autonomous)

Introduction:

The Chemistry syllabus at Darrang College (Autonomous) has been designed in alignment with the transformative vision of the **National Education Policy (NEP) 2020**, which emphasizes a holistic, multidisciplinary, and flexible education system rooted in Indian values and committed to nurturing globally competent individuals.

This syllabus aims to provide students with a strong foundation in the principles and applications of Chemistry, while also fostering scientific temper, critical thinking, creativity, and problem-solving abilities. It embraces the spirit of NEP 2020 by offering **multiple entry and exit options**, **skill-based learning**, **interdisciplinary integration**, and **continuous formative assessment**.

The curriculum is structured to support a learner-centric approach that balances core concepts, laboratory experience, environmental and ethical awareness, and the development of communication and research skills. Through this, students will not only gain knowledge in the chemical sciences but also be empowered to apply it responsibly in real-world contexts, contributing to sustainable development and societal progress.

Darrang College (Autonomous) reaffirms its commitment to academic excellence, innovation, and nation-building, preparing graduates to meet the scientific and technological challenges of the 21st century.

The Four-Year Undergraduate Programme (FYUGP) in Chemistry is designed to nurture a deep and holistic understanding of the chemical sciences, while promoting interdisciplinary learning, research aptitude, and employability. The programme aspires to prepare students for academic, industrial, and societal roles by fostering foundational knowledge, technical skills, and ethical awareness.

Aims of Four Year Under-Graduate Programme (FYUGP) in Chemistry:

The primary aims of the FYUGP in Chemistry are:

1. **To provide a strong foundation in chemical principles and their applications** in diverse areas such as organic, inorganic, physical, analytical, and environmental chemistry.

2. **To develop critical thinking, scientific reasoning, and analytical skills** that enable students to approach scientific problems methodically and creatively.
3. **To promote experiential learning through practical laboratory work, fieldwork, and research projects**, encouraging innovation, curiosity, and hands-on skills.
4. **To foster interdisciplinary learning and flexibility**, in accordance with NEP 2020, allowing students to explore connections between chemistry and fields such as biology, physics, environmental science, materials science, and computational studies.
5. **To enhance communication skills and ethical understanding**, ensuring that students can effectively disseminate scientific knowledge and apply it responsibly for societal and environmental well-being.
6. **To prepare students for diverse career paths**, including higher studies, research, teaching, industry, entrepreneurship, and public service, by integrating skill development and value-added courses.
7. **To cultivate a lifelong learning mindset and a spirit of inquiry**, aligned with the vision of building competent, compassionate, and self-reliant individuals for national and global development.

By fulfilling these aims, the FYUGP in Chemistry at Darrang College seeks to create graduates who are not only knowledgeable chemists but also responsible citizens and capable contributors to sustainable and inclusive growth.

Programme Outcome (PO) of (FYUGP) in Chemistry:

- **PO1: Fundamental Knowledge:** Demonstrate a solid understanding of the core areas of chemistry-organic, inorganic, physical, analytical, and interdisciplinary branches integrated with emerging fields like environmental chemistry, green chemistry, and materials science.
- **PO2: Scientific Thinking and Problem Solving:** Apply chemical knowledge and scientific methods to analyse, interpret, and solve real-world problems in laboratory and practical settings.
- **PO3: Laboratory and Technical Skills:** Acquire hands-on experience with classical and modern laboratory techniques, instrumentation, safety protocols, and data analysis relevant to chemical research and industry.

- **PO4: Research and Innovation:** Develop the ability to design and carry out experiments or research projects independently or collaboratively, fostering innovation, creativity, and inquiry-based learning.
- **PO5: Communication and Teamwork:** Communicate scientific ideas and research findings effectively through oral, written, and digital media, and work collaboratively in diverse teams.
- **PO6: Ethical and Environmental Responsibility:** Understand and practice ethical behaviour in scientific research and industry, while being sensitive to the environmental and societal impact of chemical substances and processes.
- **PO7: Interdisciplinary and Multidisciplinary Learning:** Integrate chemical knowledge with other disciplines such as physics, biology, mathematics, environmental science, and computational tools to address complex scientific questions.
- **PO8: Career Readiness and Lifelong Learning:** Be prepared for higher education, competitive examinations, professional roles in industry and research, or entrepreneurship, with an aptitude for continuous learning and upskilling.
- **PO9: Digital and Technological Proficiency:** Utilize information and communication technologies (ICT), computational tools, and digital resources for data handling, simulations, presentations, and scientific communication.
- **PO10: National Development and Global Citizenship:** Act as responsible citizens contributing to national development goals, sustainability, and global scientific progress, in alignment with the values promoted by NEP 2020.

Teaching Learning Process:

The programme allows using of varied pedagogical methods and techniques both within the classroom and in laboratories.

- Lecture
- Tutorial
- PowerPoint presentation
- Project Work/Dissertation
- Seminars/workshops/conferences
- Industry Visits/Field Visits

Teaching Learning Tools:

- White/Green/Black Board
- LCD projectors/Monitor
- Smart Board
- Model Demonstration
- Learning through lab experiments
- Industry and field visits

Assessment:

- Home assignment
- Project/Industry/Filed Visit Report
- Seminar Presentation
- In semester/Sessional examinations (Theory and Practical)
- End Semester examinations (Theory and Practical)

FYUGP in Chemistry
Detailed Syllabus of Skill Enhancement Course (1st Semester)

Title of the Course	**Basic Analytical Chemistry**
Paper Code	**CHE-SEC-01013**
Total Credits	**3 (Theory: 02, Practical: 01)**
Distribution of Marks	**30 (End Semester Theory) + 25 (End Semester Practical) + 20 (Internal) [Sessional Exam: 10 marks, Home Assignment: 3 marks, Class Test: 4 marks, Attendance: 3 marks]**
Course Outcomes	By the end of this course/module, students will be able to: • **CO 1:** Explain the basic principles and techniques of chemical analysis. • **CO 2:** Design and perform microscale and semi-microscale experiments, and accurately record experimental observations. • **CO 3:** Interpret and analyze experimental data using appropriate scientific methodology. • CO 4: Develop problem-solving skills through troubleshooting of experimental errors and optimizing analytical methods. • **CO 5:** Evaluate the impact of analytical chemistry in real-world applications such as environmental monitoring, food testing, pharmaceuticals, and industrial quality control. • **CO 6:** Exhibit readiness to pursue research or employment in analytical laboratories and quality assurance sectors.
No. of Required Classes	**30 (Theory) + 30 (Practical)**
Details of Course Designer	1. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry
Text Book/ Reference Book	1. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall. 2. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall. 3. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers. 4. Skoog & Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.

Semester-1 (Theory Credit: 02)					
Unit	**Content**	**L**	**T**	**P**	**Total Hours**
Unit I: Analysis of soil	Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators, Forensic Applications of Chemical Indicators: The Case of Phenolphthalein in Trap Investigations, Estimation of	**4**	**2**	**-**	**6**

	Macro (N, P, K, Ca, Mg, S) and Micronutrients (Fe, Mn, Zn, Cu) in Soil Samples				
Unit II: Analysis of water	Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods, principles, relevance, and methods for determination of Dissolved Oxygen (DO)	**3**	**1**	**-**	**4**
Unit III: Analysis of food products	Nutritional value of foods, idea about food processing and food preservations and adulteration. Typical adulterants in common foods and their detection, health hazards, Analysis of preservatives and colouring matter	**4**	**2**	**-**	**6**
Unit IV: Chromatography	Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. Comparison of paint samples by TLC method.	**4**	**1**	**-**	**5**
Unit V: Ion-exchange	Column, ion-exchange chromatography etc., Determination of ion exchange capacity of anion / cation exchange resin	**3**	**1**	**-**	**4**
Unit VI: Analysis of cosmetics	Major and minor constituents cosmetics and their functions, Analysis of deodorants and antiperspirants, Chemical Analysis of Cosmetic Products, Major and Minor Constituents (Al, Zn, boric acid, chloride, sulphate)	**3**	**2**	**-**	**5**
Semester-1 (Practical Credit: 01)					
Unit	**Content**	**L**	**T**	**P**	**Total Hours**
Laboratory Course I	1. Determination of pH of soil samples. 2. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. 3. Determination of pH, acidity and alkalinity of a water sample. 4. Determination of dissolved oxygen (DO) of a water sample. 5. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. 6. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). 7. Separation of a mixture of organic compounds by Thin Layer Chromatography Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.	**-**	**-**	**30**	**30**

FYUGP in Chemistry
Detailed Syllabus of Skill Enhancement Course (2nd Semester)

Title of the Course	**Green Chemistry**
Paper Code	**CHE-SEC-02013**
Total Credits	**3 (Theory: 02, Practical: 01)**
Distribution of Marks	**30 (End Semester Theory) + 25 (End Semester Practical) + 20 (Internal) [Sessional Exam: 10 marks, Home Assignment: 3 marks, Class Test: 4 marks, Attendance: 3 marks]**
Course Outcomes	By the end of this course/module, students will be able to: • **CO 1:** Explain the 12 principles of green chemistry and their significance in reducing environmental impact. • **CO 2:** Analyze traditional organic reactions and suggest greener alternatives using safer reagents and solvents. • **CO 3:** Design environmentally benign synthetic pathways for selected organic compounds. • **CO 4:** Demonstrate practical knowledge of green chemistry, lab techniques, including the use of renewable feedstocks and catalytic systems. • **CO 5:** Identify and explain the economic and environmental benefits of using green chemistry in industrial processes. • **CO 6:** Interpret case studies from the pharmaceutical and chemical industries where green chemistry has been successfully implemented. • **CO 7:** Communicate the importance of green chemistry practices to promote sustainable development and responsible innovation. • **CO 8:** Prepare for careers in the chemical, pharmaceutical, or environmental sectors with a foundation in green chemistry principles.
No. of Required Classes	**30 (Theory) + 30 (Practical)**
Details of Course Designer	1. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry
Text Book/ Reference Book	1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005). 2. 2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998). 3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001). 4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000). 5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

Semester-2 (Theory Credit: 02)					
Unit	**Content**	**L**	**T**	**P**	**Total Hours**
Unit I: Introduction to Green Chemistry	What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.	**2**	**1**	**-**	**3**
Unit II: Principles of Green Chemistry and Designing a Chemical synthesis	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); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.	**7**	**4**	**-**	**11**
Unit III: Examples of Green Synthesis/ Reactions	Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, citral, ibuprofen, paracetamol, furfural. 2. Microwave assisted reactions in water: Oxidation of toluene, alcohols. Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Diels-Alder Reaction. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, benzimidazoles. 3. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.	**8**	**3**	**-**	**11**
Unit IV: Future Trends in Green Chemistry	Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Solventless reactions; Green chemistry in sustainable development	**3**	**2**	**-**	**5**

Semester-2 (Practical Credit: 01)					
Unit	**Content**	**L**	**T**	**P**	**Total Hours**
Laboratory Course II	**1. Safer starting materials** The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch. (i) Effect of concentration on clock reaction (ii) Effect of temperature on clock reaction. **2. Using renewable resources** Preparation of biodiesel from vegetable oil. **3. Avoiding waste: Principle of atom economy** Benzil-Benzilic acid rearrangemnet by two methods can be studied: I. Benzil $\xrightarrow[\text{Ethanol}]{\text{50\% KOH solution}}$ Benzilic acid II. Benzil $\xrightarrow[\text{No solvent, 100}^{o}\text{C, 20 min}]{\text{Solid NaOH or KOH}}$ Benzilic acid **4. Use of enzymes as catalysts** Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide **5. Alternative Green solvents** Diels Alder reaction in water: Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.	**-**	**-**	**30**	**30**