# NATIONAL UNIVERSITY BANGLADESH

PROVISIONAL

**Syllabus**
**Bachelor of Science (Honors) Second Year**
**Department of Chemistry**

**Effective from the Session: 2024–2025 and onwards**

**Vision of the University**

We expect that the hundredth anniversary of the National University, our commitment to "Progress for Everyone" will be evident in all areas of our operations and stakeholder engagements.

We leverage our core strength in education, research, and community engagement to address pressing global issues and foster sustainable development.

By 2042, National University aims to strengthen its positions as Bangladesh's top academic institution and rank among the world's leading universities. Our focus will be on expanding expertise building strategic partnerships, and increasing our global influence. Our services will be measured by the achievements of the individuals and communities we serve.

**Mission of the University**

To promote "Progress for Everyone" by fostering transformative education, conducting pioneering research, and encouraging meaningful collaboration with individuals, communities, and partners both in Bangladesh and around the world.

**Name of the Program:** B.Sc. (Honours) in Chemistry

Chemistry is the rudimentary branch of science that basically exists on experimental work and innovation of new knowledge. This wing of science has vast applications in wide range of social, and industrial demands. Moreover, this subject may flourish the problem-solving caliber of a person in laboratory affairs, research collaborations, production sector, quality control, quality assurance, and entrepreneurs in industrial sector. This degree provides the fundamental and modern concept in chemistry that ameliorates the capability of students to cope with the global situation.

The students can correlate their gained concepts in related fields subsuming, agricultural, biotechnology, pharmacy, material science, medicine, and so on. Chemistry discipline has launched this program with contemporary contents in chemistry having minimum **158**-credit.

These credit hours contain theory course, and enormous laboratory work in addition to industry training. This diversification may equip the students in research and career-oriented fields. Students generally get idea about basic and advanced knowledge of chemistry. So, one can easily adapt to higher study in home and abroad. At present era, the environmental safety has become a great challenge for us. The offered environmental safety related course may be salubrious for a student to protect the environment. Beside these, all branches of knowledge are interlinked with each other. Therefore, general education has also kept at a minimum level so that the graduates can conduct their research and correlate their occupations to multidisciplinary level.

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**Graduation Profile of the Program**

**Objectives:**

Students who have completed the B.Sc. (Hons) Degree will have acquired an advanced-level of education including specialist knowledge and general intellectual and life skills that prepare them for gainful employment and effective citizenship with a firm foundation for continuous learning and personal development. They will be a distinct clique with a strong sense of professionalism, desire for continuous improvement, confidence and adaptability, ability to communicate and cooperate, and a deep empathy for the needs of the wider society.

**The Chemistry graduates will be able to-**

1. Demonstrate advanced knowledge and concepts in specialized areas defined by their program.
2. Apply skills in proper methods of analysis, whether quantitative or qualitative, or both, to assemble and integrate information in ways consistent with the highest standards of their discipline.
3. Develop problem solving skills and analytical thinking skills.
4. Study contemporary research in their field of specialization and apply their research and investigations in scholarly communication, applied in oral, text, and digital formats or poster presentations.
5. Employ modern library search tools to locate and retrieve scientific information about a chemical technique, or topic relating to chemistry.
6. Evaluate equipment and processes to ensure compliance with safety and environmental regulations.
7. Engage in research-based studies at postgraduate level home and abroad.
8. Apply their broad knowledge and understanding of chemistry to serve the country as responsible citizens who are ethical and professional in action.
9. Work independently or collaboratively with members of a team in research or professional activities those results in an original contribution to knowledge.

**The Chemistry graduates will be competent to-**

- Serve as researchers, academics, consultants, managers, executives, administrators and policy planners in the Research Laboratories, Chemical Industries, Pharmaceuticals, BCS, College, School etc., in both locally and globally.
- Link in self-employment in Chemistry and allied fields.
- Engage in the teaching, learning, research, creative activities and career placement as professions of the University.

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**Vision of the Department**

The program aspires boldly explore and advance new chemical frontiers in the advanced field of chemistry that fosters research breakthroughs and teaching innovations and to excel in chemical education, research and services.

**Mission of the Department**

Mission Statement of the program (M)

| | |
|---|---|
| **M1** | To train and mentor students as responsible scientists and scientifically literate professionals, involving them in all aspects of chemistry and the global chemical enterprise. |
| **M2** | To offer quality chemistry learning experiences, conduct basic and applied research of national and international impact. |
| **M3** | To prepare competitive and professional graduates empowered with excellent technical and leadership skills, integrity, and social responsibility. |
| **M4** | To create novel and sustainable solutions to serve public interests and to address global challenges in areas such as health, energy, and environment. |
| **M5** | To build proactive partnerships with industries and offer effective training and educational and technical services to the society. |

**Program Education Objectives (PEOs):**

| | |
|---|---|
| **PEO1** | To provide students the scientific skills and chemical knowledge essential for success. |
| **PEO2** | To train students how to apply concepts they acquired and to design and perform experiments. |
| **PEO3** | To equip students with effective scientific communication skills. |
| **PEO4** | To encourage the pursuit of lifelong learning. |
| **PEO5** | To foster a commitment to ethical and social responsibilities. |
| **PEO6** | To promote the students in professional development and service. |

**PEO to Mission Statement (M) Mapping**

| Ms/PEOs | PEO1 | PEO2 | PEO3 | PEO4 | PEO5 | PEO6 |
|---|---|---|---|---|---|---|
| M1 | √ | √ | √ | √ | | |
| M2 | √ | √ | √ | √ | √ | |
| M3 | √ | √ | √ | √ | √ | |
| M4 | √ | √ | √ | √ | √ | √ |
| M5 | √ | √ | √ | √ | √ | √ |

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**Program Educational Objectives (PEOs):**

After graduation, our students will be able to:

| Objectives | Description | Domain |
|---|---|---|
| **PEO 1** | To provide knowledge in all the major branches of chemistry to understand the key concepts, principles and theories associated with life nature and society. | Fundamental |
| **PEO 2** | To provide the opportunity of conducting numerous scientific experiments with effective scientific communication skills. | Social |
| **PEO 3** | To equip the graduates with research-oriented skills including research proposal writing, research design, method validation and analyses, report writing and presentation of research outcome. | Thinking |
| **PEO 4** | To develop problem-solving, group work and communication skills so that they can operate with a high degree of autonomy. | Fundamental |
| **PEO 5** | To develop professionalism, resilience, and morality as well as to infuse an understanding of the culture, sustainability and human rights. | Personal |

**Program Learning Outcomes (PLOs):**

After successful completion of the Chemistry Graduate degree, the learner will be able to:

| | |
|---|---|
| **A. Fundamental Skills** | |
| A1 | formulate and explain the fundamental concepts in the core areas of the discipline (organic, inorganic, analytical, physical, industrial, pharmaceutical and/or biological chemistry). |
| A2 | identify and locate current, reliable and accurate sources of scientific knowledge and apply knowledge and relevant skill to solve chemistry-related problems. |
| A3 | employ critical thinking and scientific inquiry into the design, performance, interpretation and documentation of laboratory experiments at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program. |
| A4 | work effectively with others in various situations, including a laboratory setting, classroom setting, or a team research project. |
| **B. Social Skills** | |
| B1 | clearly communicate the results of the scientific work in oral, written, and electronic formats to both scientists and the public at large. |

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| | |
|---|---|
| B2 | convey ideas and information effectively to a range of audiences for a variety of purposes and contribute in a positive and collaborative manner to achieve common goals. |
| B3 | participate in career planning, club activities, societies, co-curricular activities, internships, and different social as well as workplace settings and demonstrate the ability to incorporate entrepreneurial skills within the scope of different activities. |
| **C. Thinking Skills** | |
| C1 | use critical thinking skills and scientific reasoning to evaluate arguments and address complex issues based on facts, experiments and observations. |
| C2 | demonstrate the ability to think in an integrated manner and look at problems from different perspectives. |
| C3 | design and carry out scientific experiments as well as accurately record and analyze the results of such experiments in both chemistry and allied fields of science and technology. |
| **D. Personal Skills** | |
| D1 | engage in self-guided learning. |
| D2 | appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals in contemporary environmental and global issues. |
| D3 | demonstrate discipline-specific computer skills, including use of software for word processing, spreadsheet calculations, database applications, graphing and curve fitting, data acquisition, and instrument control. |

**MAPPING PLOs WITH PEOs:**

| **Program Education Objectives (PEO)** | **Program Outcomes (PLOs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Fundamental** Domain | | | | **Social** Domain | | | **Thinking** Domain | | | **Personal** Domain | | |
| | A 1 | A 2 | A 3 | A 4 | B 1 | B 2 | B 3 | C 1 | C 2 | C 3 | D 1 | D 2 | D 3 |
| **PEO 1** | • | • | | | | • | | | | | | • | |
| **PEO 2** | • | • | | | | • | | • | • | • | | • | • |
| **PEO 3** | | • | • | | | | | • | • | • | • | | • |
| **PEO 4** | | • | • | • | • | • | • | | • | • | | • | • |
| **PEO5** | | | | • | | • | • | | • | | • | • | |

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**Mapping Courses with PLOs: Second Year**

| Course Code | PLOs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Fundamental** Domain | | | | **Social** Domain | | | **Thinking** Domain | | | **Personal** Domain | | |
| | A 1 | A 2 | A 3 | A 4 | B 1 | B 2 | B 3 | C 1 | C 2 | C 3 | D 1 | D 2 | D 3 |
| **Second Year** | | | | | | | | | | | | | |
| **8222851** | • | • | | | | • | | | | | | • | |
| **8222853** | • | • | | | | • | | • | • | • | | • | • |
| **8222855** | | • | • | | | | | • | • | • | • | | • |
| **8222856** | • | • | • | • | • | • | • | | • | • | | • | • |
| **8223757** | • | • | | • | | • | • | | • | | • | • | |
| **8223758** | • | • | | | | • | | • | | • | | • | |
| **8222757** | • | • | | • | | | • | | • | | | | • |
| **8222758** | • | • | | | | • | | • | | | • | | |
| **8221171** | • | • | | • | | | • | | | • | | | • |
| **8226601 8226602** | • | | | | | • | | • | | • | | • | |
| **8222858** | • | | • | | • | • | | • | • | | | | • |

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## Courses, Marks and Credit Distribution

| Course Code | Course Title | Marks | Credits |
|---|---|---|---|
| **8222851** | Physical Chemistry-II | 100 | 4 |
| **8222853** | Organic Chemistry | 100 | 4 |
| **8222855** | Chemistry of the Representative Elements & Its applications | 100 | 4 |
| **8222856** | Quantitative Inorganic Analysis (Practical) | 100 | 4 |
| **8223757** | Calculus II and Ordinary Differential Equations | 100 | 4 |
| **8223758** | Math Lab (Mathmatica) | 50 | 2 |
| **8222757** | Physics-III (Electricity and Modern Physics) | 100 | 4 |
| **8222758** | Physics-IV (Physics Practical) | 50 | 2 |
| **8221171** | Functional English | 100 | 4 |
| **8226601** | Applied Information and Communication Technology (Applied ICT) | 75 | 3 |
| **8226602** | Practical: Applied ICT | 25 | 1 |
| **8222858** | Viva-Voce (Chemistry) | 50 | 2 |
| | **Total =** | **900** | **38** |

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| Course Code | 8222851 | Marks: 100 | Credits: 4 | Class Durations: 28 Weeks |
|---|---|---|---|---|
| Course Title | Physical Chemistry-II | | | |

**Course Objectives:**

- To design the course for the students to impart and improve fundamental knowledge and as a support to understand the fundamental physical chemistry-II topics.
- To develop and extend student's knowledge on thermodynamics, second and third law of thermodynamics Carnot cycle, Gibb's-Helmholtz equation, thermodynamic derivation of colligative properties electrochemistry, electrolytes, conductance, electrochemical cells and cell potentials, rate of reactions and catalysis.

**Course Learning Outcomes (CLOs)**

After completing this course, students will be able to:

| | | | Mapping with PLOs |
|---|---|---|---|
| **Course Learning Outcomes (CLOs)** | **CLO1** | Explain the fundamental knowledge about the thermodynamics and its different equations, electrochemistry, different cells, rate of reactions and catalysis. | A1 |
| | **CLO2** | Discuss the transformation of energy, and the laws governing the conversion of thermal energy into mechanical, electrical, or other forms of energy. | B2 |
| | **CLO3** | Apply the second and third law of thermodynamics to thermochemistry, the study of energy changes in chemical reactions, enthalpy, entropy, and Gibbs free energy, thermodynamical concepts on chemical equilibrium. | A2, C2 |
| | **CLO4** | Demonstrate the conduction with different theories. | A1, B2 |
| | **CLO5** | Application of thermodynamic principle, electrochemical cells and cell potentials. | C2 |
| | **CLO6** | Demonstrate the conditions of the spontaneity of chemical reactions and physical processes. | B2, C1, D2 |
| | **CLO7** | Assess how to apply concepts of catalysis on chemical equilibrium and its importance. | A1, C1, D1 |

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**Course Contents:**

| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks) |
|---|---|---|---|---|
| **1** | **Chemical Thermodynamics:** Second law of thermodynamics, spontaneous changes: Carnot cycle, entropy and entropy changes in various system, absolute entropy, Clausius-Clapeyron equation; Gibb's free energy and work function, Gibb's- Helmholtz equation; Nernst's heat theorem, third law of thermodynamics; Maxwell's relations; Vant-Hoff equation; chemical potential and fugacity, partial molar quantities, Gibb's–Duhem equation, thermodynamic derivation of colligative properties. | Lecture, Group Discussion, Assignment | 1 | 6 |
| **2** | **Applications of Thermodynamic Principles:** Energy conversion in chemistry, efficiencies of power plants, fuels and combustion, ignition, flash point. Exergonic and endergonic reaction, Coupling reaction, thermodynamics of ATP, Ellingham diagram. | Lecture, Group Discussion, Assignment | 2 | 3 |
| **3** | **Theories of Electrolytes:** Electrolyte, electrolysis and Faraday's laws, Debye-Hückel limiting law, Debye-Hückel-Onsagar equation: limitations and applications. | Lecture, Group Discussion, Assignment | 3 | 3 |
| **4** | **Conductance:** Specific conductance, molar conductance, conductometric titration; ionic mobility, ion transport number and its determination. | Lecture, Group Discussion, Assignment | 4 | 3 |
| **5** | **Electrochemical Cells and Cell Potentials:** Cells: electrolytic and Galvanic cells; half cells; different types of electrodes and half cells, half-cell reactions & cell reactions, standard hydrogen electrode, electrode potentials, Nernst's equation, measurement of emf of a cell, relation between emf and free energy changes, equilibrium constant, standard Weston cadmium cell. dry cell, alkaline cell, lithium-ion cell, fuel cell. Applications of electrochemistry in Chloro-alkali industries and electrometallurgy, electrochemical treatment of industrial effluents. | Lecture, Group Discussion, Assignment | 4, 5 | 8 |

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| | | | | |
|---|---|---|---|---|
| **6** | **Rates of Chemical reaction:** Rate of reaction, rate constant, order and molecularity of reaction, concentration vs time curves, rate equation, zero, first, second, third- order reaction, factors affecting the rate of a reaction, elementary reaction, pseudo first-order reaction. | Lecture, Group Discussion, Assignment | 6 | 3 |
| **7** | **A brief treatment of Catalyst:** Definition of catalysis and types of catalysts, Homogeneous and heterogeneous catalyst, and their theories, Enzyme catalysis, acid-base catalysis. | Lecture, Group Discussion, Assignment | 7 | 3 |

**Course Assessment Framework:**

Total Course Marks: 100 Examination Duration: 4 Hours

| Assessment Category | Assessment Component | Weightage |
|---|---|---|
| Formative Assessment (20%) | Attendance & Class Participation | 5% |
| | In-course Examination | 10% |
| | Quiz / Assignment Presentation | 5% |
| Summative Assessment (80%) | Final Examination<br>• Students will have to answer 8 questions out of 12<br>• 10 marks per question ($8 \times 10 = 80$ marks)<br>• Each question may contain maximum 3 sub-sections (e.g., a, b, c) | 80% |

**Book recommended:**


Atkins, P. (2024). *Physical chemistry*. W. H. Freeman and Company New York.

Bahl, A., Bahl, B. S., & Tuli, G. D. (2022). *Essentials of physical chemistry* (28th ed.). Published by S. Chand, India.

Chang, R. (2008). *General Chemistry: The Essential Concepts*. McGraw-Hill.

Ebbing, D. (2009). *General Chemistry*. Publisher Brooks/Cole Cengage Learning.

Haque & Nawab. (2009). *Principles of Physical Chemistry*. Published by Brothers' Publication 3/5, Rafine Plaza Mirpur Road, Dhaka-1205.

হোসেন, এম. এম., ও রহিম, এ. (২০১৬). *রাসায়নিক গতিবিদ্যা ও আলোক রসায়ন.* পাঞ্জেরী পাবলিকেশন্স লিমিটেড।

রেজা, এ. এফ. জি. এম., আলম, এফ. আর., ও রায়, বি. কে. (২০২৬). *ভৌত রসায়ন* [Physical chemistry: 2nd year], জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।

পাল, এস. সি., ও চক্রবর্তী, পি. কে. (১৯৮৮). *স্নাতক ভৌত রসায়ন (দ্বাদশ সংস্করণ).* বাংলাদেশ বুক করপোরেশন।


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| Course Code | 8222853 | Marks: 100 | Credits: 4 | Class Durations: 28 Weeks |
|---|---|---|---|---|
| Course Title | Organic Chemistry | | | |

**Course Objective:**

- To design the course for the students to impart and improve fundamental knowledge and aspects related to organic acid base, polynuclear aromatic hydrocarbons, naphthalene, anthracene, phenanthrene, Aliphatic and aromatic, heterocyclic compounds-furan, pyrrole, thiophene and pyridine.

- To develop and extend student's knowledge on other organic compounds such as Nitro and Nitroso Compounds, Dye, Organo-Sulphur and Organo-Phosphorus Compounds, Bifunctional Compounds.

**Course Learning Outcomes (CLOs)**

After completing this course, students will be able to:

| | | | Mapping with PLOs |
|---|---|---|---|
| **Course Learning Outcomes (CLOs)** | **CLO1** | Explain the concepts of acid and base in organic chemistry | A1, B1 |
| | **CLO2** | Draw and name the different functional groups; such as aldehydes, ketones, carboxylic acids, esters, amino-, nitro-compounds, organo-Sulphur and Organo-Phosphorus, heterocyclic organic compounds. | A2 |
| | **CLO3** | Explain the physical properties of organic compounds with different functional groups. | C2 |
| | **CLO4** | Prepare the different classes of organic compounds containing one or more functional groups. | D1 |
| | **CLO5** | Describe the reactivity and mechanism of different organic compounds containing different functional groups | A1, B1, D2 |
| | **CLO6** | Synthesize the important compounds from different classes of organic materials, aspirin, paracetamol, azo dyes. | A1, A3, B1 |
| | **CLO7** | Explain the basic color theory in nature and compare color of dyes and apply the basic skills in the preparation of the dyes. | A2, B2 |
| | **CLO8** | Describe the preparations and reaction mechanism, polynuclear aromatic hydrocarbons, heterocyclic compounds. | A3, D2 |

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**Course Contents**

| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks) |
|---|---|---|---|---|
| **1** | **Organic Acids and Bases:** Organic acids and bases and their strength, inductive, mesomeric, structural, steric and solvent effects affecting the acidity and basicity. | Lecture, Group Discussion, Assignment | 1 | 2 |
| **2** | **Carbonyl Compounds: S**tructure and Orbital picture of carbonyl group. General methods of preparation and reactions of aliphatic and aromatic aldehydes and ketones; nucleophilic addition reaction of carbonyl compounds. | Lecture, Group Discussion, Assignment | 2, 3 | 3 |
| **3** | **Carboxylic Acids:** Structure and orbital picture; acidity, resonance effect and inductive effect on acidity, general methods of preparation and reactions of aliphatic and aromatic carboxylic acids. Preparation of carboxylic acid derivatives and their relative activity. | Lecture, Group Discussion, Assignment | 2-4 | 4 |
| **4** | **Amino compounds:** Aliphatic and aromatic amines; preparation and reaction of amines, Hofmann degradation reaction, separation of amines, preparation and reactions of diazonium salt; organic dyes, coupling reaction. | Lecture, Group Discussion, Assignment | 2-4 | 4 |
| **5** | **Nitro and Nitroso Compounds:** Synthesis, reactivity and reactions of aliphatic and aromatic nitro and nitroso compounds. | Lecture, Group Discussion, Assignment | 4, 7 | 2 |
| **6** | **Organo-Sulphur and Organo-Phosphorus Compounds:** Structure, shape, synthesis, physical and chemical properties of thiols, alkyl-, dialkyl-, alkylaryl phosphines and sulphides, phosphonium salts. Organic Compounds containing C–N bond**:** Structure, synthesis, properties of nitriles, thiocyanates, ureas. | Lecture, Group Discussion, Assignment | 2, 6 | 4 |
| **7** | **Bifunctional Compounds:** Chemical properties of α-β-unsaturated carbonyl compounds, hydroxy ketones, 1, 2- and 1, 3- diketones, keto-enol tautomerism. | Lecture, Group Discussion, Assignment | 2, 5 | 2 |

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| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks) |
|---|---|---|---|---|
| **8** | **Polynuclear Aromatic Hydrocarbons:** Structure and orbital picture; general methods of preparation and reactions of naphthalene, anthracene, phenanthrene. | Lecture, Group Discussion, Assignment | 1, 8 | 3 |
| **9** | **Heterocyclic organic chemistry:** Classification, aromatic character, chemistry and structure of heterocyclic compounds; furan, pyrrole, thiophene and pyridine, applications of heterocyclic compounds. | Lecture, Group Discussion, Assignment | 1, 8 | 4 |

**Course Assessment Framework:**

Total Course Marks: 100 Examination Duration: 4 Hours

| Assessment Category | Assessment Component | Weightage |
|---|---|---|
| Formative Assessment (20%) | Attendance & Class Participation | 5% |
| | In-course Examination | 10% |
| | Quiz / Assignment Presentation | 5% |
| Summative Assessment (80%) | Final Examination<br>• Students will have to answer 8 questions out of 12<br>• 10 marks per question ($8 \times 10 = 80$ marks)<br>• Each question may contain maximum 3 sub-sections (e.g., a, b, c) | 80% |

**Books Recommended:**


Bahl, B. S., & Bahl, A. (2024). *Text- Book of Organic Chemistry*. S. Chand & Company Ltd Ram Nagar, New Delhi-1I005S

Finar, I. L. (1973). *Organic Chemistry, Vol. I*. Pearson Education India.

Griffin, R. W. (2024). *Modern Organic Chemistry*. McGraw Hill.

Morrison, R.T. and Boyd, R. N. (1992). *Organic Chemistry*. Benjamin-Cummings Pub Co

Solomons, T. W. G. (2008). *Fundamental of Organic Chemistry*. Wiley.

পাল, এস. সি., ও চক্রবর্তী, পি. কে. (১৯৮৮). *স্নাতক জৈব রসায়ন* (দ্বাদশ সংস্করণ) [Degree organic chemistry]. বাংলাদেশ বুক করপোরেশন।

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *জৈব রসায়ন* [Organic chemistry: 2nd year]. জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।


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| Course Code | 8222855 | Marks: 100 | Credits: 4 | Class Durations: 28 Weeks |
|---|---|---|---|---|
| Course Title | Chemistry of the Representative Elements & Its applications | | | |

**Course Objective:**

- To design the course for the students to impart and improve fundamental knowledge and aspects related to hydrogen, ortho and para hydrogen molecules, alkali metals alkaline earth metals, boron Family.
- To develop and extend student's knowledge on carbon and its congeners, nitrogen Family, chalcogens, halogens, inert Gases and Group-12 elements.

**Course Learning Outcomes (CLOs)**

After completing this course, students will be able to:

| | | | Mapping with PLOs |
|---|---|---|---|
| **Course Learning Outcomes (CLOs)** | **CLO1** | Assimilate the physical and chemical behavior of hydrogen and hydrides. | A1, B1 |
| | **CLO2** | Describe the biological importance of group I and II elements. | A2 |
| | **CLO3** | Recapitulate the physical and chemical properties of the boron and carbon. | A1, B1, C2 |
| | **CLO4** | Explain the inter-halogen compound and the pseudo halogen compounds. | A1, B1, D2 |
| | **CLO5** | Analyze the physical and chemical behavior of titanium, vanadium, copper, zinc, molybdenum, cobalt, nickel and iron. | A2, C3 |
| | **CLO6** | Describe the chemistry of group 15, 16, 17 and 18. | A2 |

**Course Contents:**

| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks |
|---|---|---|---|---|
| **1** | **Hydrogen:** Resemblance with alkali metals and with halogens, various forms of hydrogen (nascent hydrogen, atomic hydrogen, and ortho and para hydrogen), manufacture of hydrogen, hydrogen as a fuel and water gas**.** Isotopes of hydrogen, binary hydrides and their classification. Dihydrogen complex. | Lecture, Group Discussion, Assignment | 1 | 2 |
| **2** | **The Group-1 Elements: P**osition in the periodic table, General characteristics e.g., ionization energies, cation size, reduction properties, flame coloration etc, chemical | Lecture, Group | 2 | 3 |

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| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks |
|---|---|---|---|---|
| | characteristics, Solubility of group I salts; hydration and lattice energies, anomalous behavior of Li, diagonal relationship of Li with Mg. Extraction and important compounds of Li, Na and K. Organolithium compounds. Applications of alkali metals. | Discussion, Assignment | | |
| **3** | **The Group-2 Elements: P**osition in the periodic table, comparative properties, ionization energies, cation sizes, reducing character nature, flame coloration, hydration energy, lattice energy, solubility and thermal stability of alkaline earth metal compounds: anomalous behavior of Be, diagonal relationship between Be and Al, Extraction and important compounds of Be, Mg and Ca, Hardness of water, biological role of magnesium and calcium ions. | Lecture, Group Discussion, Assignment | 2 | 3 |
| **4** | **The Group-13 Elements:** Periodic position, general properties and allotropy of boron, Anomalous behavior of Boron, extraction of B and Al, electron deficient compounds. Chemistry of boron hydrides, boron nitrides borax and boric acid, borazine and its similarity and dissimilarity with benzene, Lewis's acid, character of $BX_3$ compounds. Important compounds of aluminum. | Lecture, Group Discussion, Assignment | 3 | 3 |
| **5** | **The Group-14 Elements:** Periodic position and general properties, structure and allotropy of the elements, catenation, structure of graphite and diamond, carbides, oxides of carbon and carbonic acid, physiological aspects of CO, multiple bonding in carbon and silicon, silicates, classification of silicates, structure of silicates, lead and its toxicity, carbon dating. | Lecture, Group Discussion, Assignment | 3 | 3 |
| **6** | **The Group-15 Elements:** General properties, anomalous nature of nitrogen, nitrogen fixation, nitrogen hydrides, $NH_3$ as a nonaqueous solvent, hydroxylamine, azides, oxides and oxo-acids of nitrogen, allotropes of phosphorus, oxides and oxo-acids of phosphorus, phosphagens and cyclophosphagens, arsenic as a water pollutant. | Lecture, Group Discussion, Assignment | 6 | 3 |
| **7** | **The Group-16 Elements:** General properties, anomalous nature of oxygen, allotropes of oxygen, uses of oxygen, ozone- its production and importance in atmosphere, Ionic and covalent oxides, peroxides and superoxide's, | Lecture, Group Discussion, Assignment | 6 | 3 |

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| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks |
|---|---|---|---|---|
| | occurrence and allotropes of sulfur, oxides and oxo-acids of sulfur, acid rain and $SO_2$. | | | |
| **8** | **The Group-17 Elements:** Occurrence, comparative properties, colors and physical states of di-halogens, trends in bond dissociation energies, electrolytic production of $F_2$ and $Cl_2$ and their uses, hydrogen halides, bridging halides, interhalogen compounds. | Lecture, Group Discussion, Assignment | 4 | 3 |
| **9** | **The Group-18 Elements:** Occurrence, isolation, chemistry and uses, xenon compounds: fluorides, oxides and oxo - acids and their structures, complexes of xenon, clathrate compounds of noble gases. | Lecture, Group Discussion, Assignment | 6 | 2 |
| **10** | **The Group-12 Elements:** Zinc (Zn), cadmium (Cd), mercury (Hg): General properties, occurrence, extraction and uses, Oxidation state, divalent and monovalent compounds with their applications. | Lecture, Group Discussion, Assignment | 5 | 3 |

**Course Assessment Framework:**

Total Course Marks: 100 Examination Duration: 4 Hours

| Assessment Category | Assessment Component | Weightage |
|---|---|---|
| Formative Assessment (20%) | Attendance & Class Participation | 5% |
| | In-course Examination | 10% |
| | Quiz / Assignment Presentation | 5% |
| Summative Assessment (80%) | Final Examination<br>• Students will have to answer 8 questions out of 12<br>• 10 marks per question ($8 \times 10 = 80$ marks)<br>• Each question may contain maximum 3 sub-sections (e.g., a, b, c) | 80% |

PROVISIONAL

**Books Recommended:**


Cotton, F. A., Wilkinson, G., & Gaus, P. L. (1995). *Basic Inorganic Chemistry*. John Wiley & Sons.

Ebbing, D. D. (2021). *General Chemistry*. Houghton Mifflin Co.

Madan, R. D. (2024). *Modern Inorganic Chemistry*. S. Chand & Company Ltd. New- Delhi.

Silberberg, M. & Amateis, P. (2017). *Chemistry – The Molecular Nature of Matter and Change*. McGraw-Hill Education.

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *অজৈব রসায়ন* [Inorganic chemistry: 2nd year]. জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।

কুণ্ড, কে. (১৯৯৮). *অজৈব রসায়ন.* গ্লোব লাইব্রেরী (প্রাঃ) লি.


PROVISIONAL

| Course Code | 8222856 | Marks: 100 | Credits: 4 | Class Duration: 28 Weeks |
|---|---|---|---|---|
| Course Title: | Quantitative Inorganic Analysis (Practical) | | | |

**Course Objectives**:

- To design the course for the students to learn the data significant and collection, perform titrimetric analysis such as precipitation titration, neutralization titration, complexometric titration and gravimetric analysis volumetric and mixture analysis.

**Course Learning Outcomes (CLOs)**

After completing this course, students will be able to:

| | | | Mapping with PLOs |
|---|---|---|---|
| **Course Learning Outcomes (CLOs)** | **CLO1** | Apply and demonstrate the standard data handling techniques related to chemistry, and use of working curve, blank solution and curve fitting. | A1, B1, C1, D2 |
| | **CLO2** | Demonstrate the principle of volumetric analysis and classification methods, preparation of different types solutions. | B1, D1, D2 |
| | **CLO3** | Assess different types of neutralization titrations, redox titration, iodometric titrations, precipitation titration and complexometric titration. | A4, C2, D2 |
| | **CLO4** | Analyze the principle and utilize the application of gravimetric methods. | A4, B1, C3, D2 |
| | **CLO5** | Utilize the titration techniques to separate and estimate the concentration of different metal in solution. | A4, C3, D2 |

**Course Contents:**

| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks) |
|---|---|---|---|---|
| 1 | **Data Collection and Processing:** Introduction to analytical balance, volumetric glassware's, reagents and standard solutions, calibration of weights and glassware's, uncertainty in measurements, accuracy and precision, standard deviation, systematic error, random error, rounding off, significant figures, primary and secondary standard substances. Gaussian curve drawing and analysis. | Lecture, Group Discussion, Assignment | 1 | 2 |

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| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks) |
|---|---|---|---|---|
| 2 | **Volumetric Analysis:** The principle of volumetric analysis, preparation of standard solutions, other solutions, classifications of methods in volumetric analysis. | Lecture, Group Discussion, Experimental, Assignment | 2 | 2 |
| | **(a)** ***Neutralization Method****:* Standardization of sodium hydroxide solution using oxalic acid solution as a primary standard titrant, standardization of hydrochloric acid using standard sodium hydroxide solution, determination of acetic acid content in vinegar, determination of carbonate in washing soda. | Lecture, Group Discussion, Experimental, Assignment | 2, 3 | 3 |
| | **(b)** ***Oxidation-Reduction Method****:* Standardization of potassium permanganate using standard oxalic acid solution, determination of Fe(II) using standard permanganate solution, determination of Fe(II) using potassium dichromate solution as primary standard titrant, determination of Fe(II) and Fe(III) in a Fe(II)-Fe(III) mixture. | Lecture, Group Discussion, Experimental, Assignment | 2, 3 | 4 |
| | **(c)** ***Iodometric Method****:* Iodometry and Iodimetry; *Standardization* of sodium thiosulphate solution using dichromate solution, iodometric determination of copper (II). | Lecture, Group Discussion, Experimental, Assignment | 2, 3 | 4 |
| | **(d)** ***Precipitation Method****:* Preparation of standard silver nitrate solution, standardization of ammonium or potassium thiocyanate solution, determination of chloride by Volhard's method. | Lecture, Group Discussion, Experimental, Assignment | 2, 3 | 3 |
| | **(e)** ***Complexometric Method****:* Preparation of standard EDTA solution, complexometric determination of copper using Fast sulphon Black as indicator, zinc using Eriochrome Black T as indicator, nickel using mixture as indicator, determination of hardness of water. | Lecture, Group Discussion, Experimental, Assignment | 2, 3 | 3 |

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| | Topics | Teaching Learning Strategy | CLOs | Duration of the Classes (Weeks) |
|---|---|---|---|---|
| 3 | **Gravimetric Analysis:** Determination of calcium as oxalate, aluminum as 8-hydroxyquinolate, sulfate as barium sulfate. | Lecture, Group Discussion, Experimental, Assignment | 4 | 3 |
| 4 | **Analysis of Mixtures:** Separation and quantitative determination of copper (II) and nickel (II), copper (II) and zinc (II) from the respective binary mixtures using suitable methods. | Lecture, Group Discussion, Experimental, Assignment | 5 | 4 |

**Course Assessment Framework:**

Total Course Marks: 100 Exam Duration: 12 Hours (Each day 6 Hours)

| Assessment Category | Assessment Component | Weightage |
|---|---|---|
| Formative Assessment (20%) | Attendance Practical Class | 5% |
| | Lab report writing | 5% |
| | Viva-voce | 10% |
| Summative Assessment (80%) | Lab Final Examination (Practical Examination)<br>• Students will have to answer 4 questions<br>• 2.5 marks per question ($2.5 \times 4 = 10$ marks)<br>• Students will have to Experiment 2 questions out of 4<br>• 35 marks per question ($35 \times 2 = 70$ marks) | 80% |

**Books Recommended:**


Braun, D. R. (2024). *Introduction to Chemical Analysis*. McGraw Hill International,

Vogel, A. I. (2017). *A Text-Book of Macro and Semimicro Qualitative Inorganic Analysis*. Longmans, Green and Co. Ltd.

Vogel, A. I. (2017 Reprint). *A Text-Book of Quantitive Inorganic Analysis*. Longmans, Green and Co. Ltd.

Vogel, A. I. (2017 Reprint). *A Text-Book of Qualitative Inorganic Analysis*. Longmans, Green and Co. Ltd.

সিংহ হাজারী, এস. কে., ও নাগ, এইচ. (২০২৪). *ব্যবহারিক রসায়ন* [Practical chemistry] (নতুন সংস্করণ). হাসান বুক হাউস।

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *ব্যবহারিক রসায়ন* [Practical chemistry: 2nd year]. জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।


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| Course Code | 8222858 | Marks: 50 | Credits: 2 | Class Duration: 14 Weeks |
|---|---|---|---|---|
| Course Title: | Viva-Voce (Chemistry) | | | |

**Course Description**

The Viva-Voce is a comprehensive oral examination designed to evaluate students' overall academic achievement, fundamental chemical knowledge, laboratory skills, communication abilities, and professional readiness acquired during the second-year B.Sc. (Honours) Chemistry program. Conducted after the completion of written and practical examinations, this course provides students with an opportunity to demonstrate their understanding of Physical Chemistry, Organic Chemistry, Representative Elements, and Quantitative Inorganic Analysis. The examination assesses students' ability to explain chemical principles, discuss reaction mechanisms, interpret experimental data, apply analytical techniques, and communicate scientific concepts effectively in academic and professional settings.

**Course Objectives**

The objectives of the course are to:

1. Evaluate students' knowledge of major branches of chemistry, including physical chemistry, organic chemistry, inorganic chemistry, and quantitative analysis.
2. Assess students' ability to explain fundamental concepts, theories, chemical structures, and laboratory methodologies.
3. Develop effective oral communication, presentation skills, and scientific confidence among students.
4. Evaluate students' analytical thinking and problem-solving capabilities when responding to chemical inquiries.
5. Assess students' understanding of laboratory safety, data handling, environmental considerations, and practical applications of chemistry.
6. Prepare students for advanced studies, research, industrial careers, and professional opportunities related to chemistry and allied fields.

**Course Learning Outcomes (CLOs)**

After going through the viva-voce, the students will be able to:

- **CLO 1:** Demonstrate comprehensive knowledge of core chemical disciplines, including thermodynamics, organic reaction mechanisms, representative elements, and quantitative analysis.
- **CLO 2:** Explain and analyze important chemical concepts, equations, functional groups, and laboratory procedures.
- **CLO 3:** Communicate scientific ideas and experimental results effectively and confidently through oral presentations.
- **CLO 4:** Analyze and respond critically to questions related to chemical calculations, titration methods, data collection, and error analysis.
- **CLO 5:** Demonstrate a professional attitude, safety awareness, ethical values, and academic responsibility regarding chemical handling and environmental safety.
- **CLO 6:** Show readiness for higher education, research, laboratory careers, and professional development in chemical sciences.

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**CLO to PLO Mapping Matrix**

The mapping of CLOs to Program Learning Outcomes (PLOs) identifies the level of correlation between course-specific competencies and professional graduate attributes across fundamental, social, thinking, and personal domains.

| CLO / PLO | A1 | A2 | A3 | A4 | B1 | B2 | B3 | C1 | C2 | C3 | D1 | D2 | D3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO1** | H | M | - | - | M | - | - | - | M | - | - | - | - |
| **CLO2** | H | H | M | - | M | - | - | - | H | - | - | - | - |
| **CLO3** | M | M | - | M | H | H | M | - | - | - | - | - | - |
| **CLO4** | H | M | H | M | M | - | - | H | H | M | - | - | - |
| **CLO5** | M | M | - | H | M | H | - | - | - | - | H | H | M |
| **CLO6** | M | M | M | H | M | H | H | H | M | M | M | H | M |

*Note: H = High Correlation; M = Medium Correlation; L = Low Correlation; (-) = No Correlation.*

**Teaching System**

The Viva-Voce course follows an interactive and student-centered approach aligned with the Department of Chemistry's mission. Teaching and learning activities include orientation sessions, group discussions, question-answer sessions, mock viva examinations, review of core second-year chemistry topics (Physical, Organic, Inorganic, and Practical), individual guidance, and self-directed learning. Students are encouraged to cultivate analytical rigor, effective scientific communication, and professional confidence.

**Assessment Strategy**

Students will be assessed through a comprehensive viva-voce examination conducted by the designated Examination Committee after the completion of written and practical examinations. The assessment will evaluate the student's holistic understanding of chemical principles, laboratory practices, data processing, and safety protocols. Final grades are awarded based on performance, clarity of explanation, scientific reasoning, and professional demeanor demonstrated during the examination.

**Books Recommended:**


হোসেন, এম. এম., ও রহিম, এ. (২০১৬). *রাসায়নিক গতিবিদ্যা ও আলোক রসায়ন.* পাঞ্জেরী পাবলিকেশন্স লিমিটেড।

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *ভৌত রসায়ন* [Physical chemistry: 2nd year], জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।

পাল, এস. সি., ও চক্রবর্তী, পি. কে. (১৯৮৮). *স্নাতক ভৌত রসায়ন (দ্বাদশ সংস্করণ).* বাংলাদেশ বুক করপোরেশন।

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *জৈব রসায়ন* [Organic chemistry: 2nd year]. জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।

পাল, এস. সি., ও চক্রবর্তী, পি. কে. (১৯৮৮). *স্নাতক জৈব রসায়ন* (দ্বাদশ সংস্করণ) [Degree organic chemistry]. বাংলাদেশ বুক করপোরেশন।


PROVISIONAL

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *অজৈব রসায়ন* [Inorganic chemistry: 2nd year]. জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।

কুণ্ড, কে. (১৯৯৮). *অজৈব রসায়ন.* গ্লোব লাইব্রেরী (প্রাঃ) লি.

সিংহ হাজারী, এস. কে., ও নাগ, এইচ. (২০২৪). *ব্যবহারিক রসায়ন* [Practical chemistry] (নতুন সংস্করণ). হাসান বুক হাউস।

রেজা, এ. এফ. জি. এম., আলম, এফ. আর. ও রায়, বি. কে. (২০২৬). *ব্যবহারিক রসায়ন* [Practical chemistry: 2nd year]. জাতীয় বিশ্ববিদ্যালয়, গাজীপুর।

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# Allied Courses

| Course Code | 8223757 | Marks: 100 | Credits: 4 | Class Hours: 56 |
|---|---|---|---|---|
| Course Title | Calculus II and Ordinary Differential Equations | | | |

**Course Description**

This course introduces the fundamental concepts of multivariable calculus and ordinary differential equations. It develops students' analytical and problem-solving skills through the study of vector-valued functions, functions of several variables, multiple integrals, and ordinary differential equations. The course emphasizes the application of calculus and differential equations to mathematical modelling and problems arising in science, engineering, and related disciplines.

**Course Objectives (COs)**

This course aims to

1. develop a sound understanding of multivariable calculus and ordinary differential equations.
2. develop analytical and problem-solving skills for vector functions, partial differentiation, multiple integration, and differential equations.
3. enable students to apply calculus and differential equation techniques to mathematical models and problems in science, engineering, and related disciplines.

**Course Learning Outcomes (CLOs)**

| CLO | Course Learning Outcome | Bloom's Taxonomy Level |
|---|---|---|
| CLO1 | Explain and analyze vector-valued functions of a single variable, including limits, derivatives, integrals, and geometric properties such as tangent lines and arc length. | Analyze |
| CLO2 | Determine the curvature and radius of curvature, and identify properties of space curves using Cartesian and parametric equations. | Apply |
| CLO3 | Compute limits, partial derivatives, and differentials of functions of several variables, and apply optimization techniques including Lagrange multipliers. | Apply |
| CLO4 | Evaluate double and triple integrals over different regions and coordinate systems to compute areas, volumes, and other applications. | Evaluate |
| CLO5 | Classify ordinary differential equations and interpret their solutions using direction fields and basic existence and uniqueness concepts. | Analyze |
| CLO6 | Apply appropriate methods to solve first-order differential equations, including separable, linear, exact, homogeneous, Bernoulli, Riccati, and Clairaut's forms. | Apply |
| CLO7 | Solve higher-order linear differential equations, both homogeneous and non-homogeneous, using linear operators, reduction of order, and constant coefficient methods. | Apply |

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## Mapping of CLOs with PLOs

| CLO / PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO1** | √ | √ | √ | | | | | | √ | | | |
| **CLO2** | √ | √ | √ | | | | | | √ | | | |
| **CLO3** | √ | √ | √ | √ | | | | | √ | | | |
| **CLO4** | √ | √ | √ | √ | | | | | √ | | | |
| **CLO5** | √ | √ | √ | | | | | | √ | | | |
| **CLO6** | √ | √ | √ | √ | | | | | √ | | | √ |
| **CLO7** | √ | √ | √ | √ | | | | | √ | | | √ |

## Course Contents

| Week | Topic | Teaching Learning Strategy | Assessment | CLOs |
|---|---|---|---|---|
| 1–3 (3 weeks) | **Vector-valued functions of a single variable:** Limits. Derivatives and integrals. Tangent lines to graphs of such functions. Arc length from the vector viewpoint. Arc length parametrization. | Lecture; Whiteboard Teaching; Worked Examples | Written Quiz; Tutorial Exercise; Class Test | CLO1 |
| 4–6 (3 weeks) | **Curvature of space curves:** Definition. Curves of zero curvature. Curves of constant non-zero curvature. Cartesian equations and parametric equations. Radius of curvature. Centre of curvature. | Lecture; Worked Examples; Tutorial | Tutorial Exercise; Problem Solving; Class Test | CLO2 |
| 7–11 (5 weeks) | **Functions of several variables:** Limits and continuity. Partial derivatives. Differentiability, linearization, and differentials. The chain rule. Partial derivatives with constrained variables. Extreme values and saddle points of functions of several variables. Lagrange multipliers. | Lecture; Whiteboard Teaching; Problem Solving | Assignment; Problem Solving; Class Test | CLO3 |
| 12–15 (4 weeks) | **Multiple Integration:** Double integrals and iterated integrals. Double integrals over nonrectangular regions. Double integrals in polar coordinates. Area by double integrals. Triple integrals and iterated integrals: Volume as a triple integral. | Lecture; Worked Examples; Tutorial | Tutorial Exercise; Problem Solving; Class Test | CLO4 |
| 16–18 (3 weeks) | **Ordinary differential equations and their solutions:** Classification of differential equations. Solutions. Implicit solutions. Singular solutions. Initial value problems. Boundary value problems. Basic | Lecture; Whiteboard Teaching; Interactive | Written Quiz; Tutorial Exercise; Class Test | CLO5 |

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| | | | | |
|---|---|---|---|---|
| | existence and uniqueness theorems (statement and illustration only). Direction fields. Phase plane. | Discussion | | |
| 19–23 (5 weeks) | **Solution of first-order differential equations:** Separable equations. Linear equations. Exact equations. Special integrating factors. Substitutions and transformations. Homogeneous equations. Bernoulli equation. Ricatti equation. First-order higher degree equation solvable for x, y, and p. Clairaut's equation. | Lecture; Worked Examples; Problem Solving | Assignment; Problem Solving; Class Test | CLO6 |
| 24–28 (5 weeks) | **Solution of higher-order linear equations:** Linear differential operators. Basic theory of linear differential equations. Solution space of homogeneous linear equations. Fundamental solutions of homogeneous solutions. Reduction of orders, Homogeneous linear equations with constant coefficients. Non-homogeneous equation. | Lecture; Worked Examples; Problem Solving | Problem Solving; Tutorial Exercise; Class Test | CLO7 |

**Course Assessment Framework:**

Total Course Marks: 100 Examination Duration: 4 Hours

| Assessment Category | Assessment Component | Weightage |
|---|---|---|
| Formative Assessment (20%) | Attendance & Class Participation | 5% |
| | In-course Examination | 10% |
| | Quiz / Assignment Presentation | 5% |
| Summative Assessment (80%) | Final Examination<br>• Students will have to answer 8 questions out of 12<br>• 10 marks per question ($8 \times 10 = 80$ marks)<br>• Each question may contain maximum 3 sub-sections (e.g., a, b, c) | 80% |

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**List of Books**

Anton, H. (1995). *Calculus* (5th ed.). Wiley.

Ayres, F., & Ayres, J. R. (1999). *Theory and problems of differential equations* (Schaum's Outline Series). McGraw-Hill.

Braun, M. (1983). *An introduction to differential equations and their applications*. Springer-Verlag.

Gill, D. (1986). *Introduction to differential equations*. McGraw-Hill.

Ross, S. L. (1984). *Differential equations*. John Wiley & Sons.

Zill, D. G. (2009). *A first course in differential equations with applications*. Brooks/Cole, Cengage Learning.

| Course Code | 8223758 | Marks: 50 | Credits: 2 | Class Hours: 42 |
|---|---|---|---|---|
| Course Title | Math Lab (Mathematica) | | | |

**Course Description**

This course introduces students to the use of Mathematica, a powerful Computer Algebra System (CAS), for solving mathematical problems. Students will perform symbolic, numerical, and graphical computations. Emphasis is placed on applying these skills to topics from first-year mathematics courses.

**Course Objectives**

The main objectives of the course are as follows:

1. To familiarize students with Mathematica software.
2. To teach students how to use Mathematica for symbolic and numerical calculations, data analysis, visualization, and problem-solving in mathematics and scientific research.
3. To enhance students' proficiency in utilizing Mathematica to improve their understanding and problem-solving abilities in various mathematical domains.

**Course Learning Outcomes (CLOs)**

| CLO | Course Learning Outcome | Bloom's Taxonomy Level |
|---|---|---|
| CLO1 | Demonstrate fundamental skills in operating the Mathematica software interface and executing basic commands. | Apply |
| CLO2 | Apply Mathematica for symbolic and numerical computation, including operations with expressions, equations, and matrices. | Apply |
| CLO3 | Apply Mathematica to compute and verify derivatives, integrals, limits, and series solutions for problems drawn from Calculus and related mathematical courses. | Apply |
| CLO4 | Create 2D and 3D graphical representations of mathematical functions and data using Mathematica's visualization tools. | Create |
| CLO5 | Solve problems from first- and second-year allied math courses (e.g., Foundations of Mathematics, Calculus I, Calculus II, and Ordinary Differential Equations) using Mathematica's built-in functions and packages. | Apply |
| CLO6 | Utilize Mathematica to explore mathematical patterns, test conjectures, and support experimental mathematics. | Analyze |
| CLO7 | Integrate Mathematica into scientific or mathematical reporting, presentations, and research-oriented tasks. | Apply |

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**Mapping of CLOs with PLOs**

| CLO / PLO | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO1 | √ | √ | | | √ | | | | √ | | | |
| CLO2 | √ | √ | √ | | √ | | | | √ | | | |
| CLO3 | √ | √ | √ | | √ | | | | √ | | | |
| CLO4 | √ | √ | √ | | √ | √ | | | √ | | | |
| CLO5 | √ | √ | √ | √ | √ | | | | √ | | √ | √ |
| CLO6 | √ | √ | √ | √ | √ | | | | √ | | | √ |
| CLO7 | √ | √ | √ | √ | √ | √ | √ | √ | √ | | √ | √ |

**Course Contents:**

**Problem-solving using the Computer Algebra System (CAS) Mathematica:** Running the package. Numerical computation. Algebraic computation. Mathematical functions. Derivatives and integrals. Limits and series. Lists and matrices. Graphics. Standard packages. Solving problems in Foundations of Mathematics, Calculus I, Calculus II, and Ordinary Differential Equations that students studied in the first and second years.

**Teaching Learning Activities:**

**Class Lecture Lab-based** 21 (Each 2-hour lab class covers first- and second-year problems of allied Mathematics courses)

**Class Test** 1

**Lab Notebook** 1 (Instructors will assign at least 15 lab tasks)

**Assessment Strategy:**

| Type of evaluation | Time | Marks | Guideline |
|---|---|---|---|
| **Final Exam** | 2 hours | 30 | Three questions have to be answered out of the five questions |
| **Continuous Assessment (Class Test)** | 1 hour | 10 | Internal Assessment: Conducted during the academic year |
| **Continuous Assessment Lab Performance & Notebook** | ----- | 5 | Internal Assessment: Based on laboratory performance and completion of at least 15 laboratory exercises |
| **Class attendance** | ----- | 5 | Internal Assessment: Assessed according to the University's attendance policy |
| **Total** | | **50** | |

**List of Books**


Don, E. (2009). *Schaum's outline of Mathematica and the Wolfram language* (2nd ed.). McGraw-Hill Education.

Mangano, S. (2009). *Mathematica cookbook: Building blocks for science, engineering, finance, music, and more*. O'Reilly Media.

Wolfram Research, Inc. (2024). *Mathematica (Student Edition)* [Software]. Wolfram Research,


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**Course Information**

| Course Code | 8222757 | Marks: 100 | Credits: 4 | Class Hours: 56 |
|---|---|---|---|---|
| Course Title: | Physics-III (Electricity and Modern Physics) | | | |

**Course Description**

This course develops fundamental knowledge of electricity, magnetism, electronics, electromagnetism, special relativity, quantum physics, atomic physics and nuclear physics. Students learn to apply physical principles to solve theoretical and practical problems, analyze electromagnetic phenomena, explain quantum behavior of matter, and understand nuclear processes and their applications.

**Course Objectives**

Upon successful completion of this course, students will be able to:

1. Develop a sound understanding of electricity and modern physics.
2. Explain the phenomenon laws of electricity and modern physics.
3. Apply knowledge of electricity, magnetism and modern physics to analyze theory of relativity and quantum concept of physical phenomenon.
4. Understand the physical principles underlying modern technologies.
5. Solve practical problems involving circuits, nuclear physics and real-life applications of modern physics.

**Course Learning Outcomes (CLOs)**

Upon successful completion of this course, students will be able to:

| | |
|---|---|
| **CLO-1** | Explain the concepts of electrostatics, electric fields, electric potential, capacitance and dielectric materials using appropriate physical laws. |
| **CLO-2** | Analyze DC and AC electric circuits, electromagnetic induction and magnetic phenomena using mathematical techniques and circuit laws. |
| **CLO-3** | Apply the principles of electronics, semiconductors and transistor circuits in explaining the operation of electronic devices. |
| **CLO-4** | Interpret the principles of special relativity and quantum mechanics in explaining microscopic physical phenomena. |
| **CLO-5** | Explain atomic structure, nuclear properties, radioactivity, nuclear reactions and their technological applications. |
| **CLO-6** | Solve numerical and analytical problems involving electricity, magnetism, relativity, quantum physics and nuclear physics using appropriate mathematical and computational methods. |

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**Mapping of CLOs with Program Learning Outcomes**

| CLO | PLO1 Knowledge | PLO2 Problem Analysis | PLO3 Experimentation | PLO4 Modern Tools | PLO5 Communication | PLO6 Teamwork | PLO7 | PLO8 Lifelong Learning |
|---|---|---|---|---|---|---|---|---|
| CLO1 | ✓ | ✓ | | | | | | |
| CLO2 | ✓ | ✓ | ✓ | ✓ | | | | |
| CLO3 | ✓ | ✓ | ✓ | ✓ | | | | |
| CLO4 | ✓ | ✓ | | | | | | ✓ |
| CLO5 | ✓ | ✓ | | | ✓ | | ✓ | ✓ |
| CLO6 | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ |

## Course Contents

| Week | Topics | Teaching-Learning Strategy | Assessment Strategy | CLO |
|---|---|---|---|---|
| 1-2 | **Electrostatic Field**: Electric field, Electric field due to point charge, dipole and continuous charge distribution | Interactive lectures, Problem-solving sessions, | Quiz test, In-course and Final Examination | CLO1 |
| 3-4 | **Electrostatic potential**: Electric potential and potential energy, Relation between electric field and potential, Van de Graaff generator | Interactive lectures, Group discussions | Quiz test, In-course and Final Examination | CLO1 |
| 5 | **Flux of electrostatic field**: Electric flux Gauss's law, Solid angle, Applications of Gauss's law | Interactive lectures, Problem-solving sessions, | Quiz test, In-course and Final Examination | CLO1 |
| 6 | **Capacitor and Dielectrics:** Capacitors, Parallel plate and cylindrical capacitors, Dielectrics, Energy stored in electric field | Interactive lectures, Problem-solving sessions, | Quiz test, In-course and Final Examination | CLO1 |
| 7-8 | **Electric Current (D.C):** Current and current density. Resistance, Resistivity and conductivity, Atomic view of resistivity, Energy transfer in an electric circuit, Kirchhoff's laws and their applications. Potentiometer. Meter bridge and Post office box. | Interactive lectures, Problem-solving sessions, | Quiz test, In - course and Final Examination | CLO2 |

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| | | | | |
|---|---|---|---|---|
| 9-10 | **Magnetic Properties of matter:** Magnetic dipole, Gauss's Law for magnetism, Paramagnetism, Diamagnetism and ferromagnetism, Nuclear magnetism, Energy in a magnetic field, Hysteresis. | Interactive lectures,<br><br>Problem-solving sessions | Quiz test, In-course and Final Examination | |
| 10-13 | **The Magnetic field and Electromagnetic induction:** Motion of a charge in magnetic field. Magnetic force on a current, Torque on a current loop, the Hall effect, Circulating charges. Thomson`s experiment, Ampere's law, B near a long wire, Ampere's circuital law, B due to a solenoid, the Biot-Savart law and its applications. Time-varying magnetic fields, Energy density in a magnetic field. | Interactive lectures,<br><br>Problem-solving sessions, | Quiz test, In-course and Final Examination | CLO2 |
| 14-16 | **Alternating Currents:** Alternating current, Concept of r.m.s and average values of current and voltage, Resistive circuit, CR, LR and LCR circuits in series and parallel, Resonance, Phase and Power transformer. | Interactive lectures, Problem-solving sessions, | In- course and Final Examination | CLO2 |
| **17-18** | **Electronics:** Vacuum diodes and triodes, P-type, n-type semiconductors, p-n junctions, Transistors, Transistor biasing, Transistor amplifiers, Transmitters and Receivers. | Interactive lectures, Problem-solving sessions, | In- course and Final Examination | CLO3 |
| **19-21** | **Special Theory of Relativity:** Inertial frame, Galilean transformation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformation equations space contraction, Time dilation, Relativity of mass, Mass and energy. | Interactive lectures, Problem-solving sessions, | Quiz test, In-course and Final Examination | CLO4 |
| **22-23** | **Light and Quantum Physics:** Planck's radiation formula, Photoelectric effect, Einstein's Photon theory, The Compton effect, The hydrogen atom and The correspondence principle | Interactive lectures, Problem-solving sessions, Group discussions | Presentation, In- course and Final Examination | CLO4 |
| **24-25** | **Waves and particles:** Matter waves, atomic structure and standing waves, Mechanics, Uncertainty principle. | Interactive lectures, | In- course and Final Examination | CLO4 |
| **26** | **The atomic nucleus:** The nuclear force, Nuclear radius, Stable nuclei, The binding energy of stable nuclei mass defect and Packing fraction. | Interactive lectures,<br><br>Group discussions | Quiz test, In-course and Final Examination | CLO5 |
| **27-28** | **Radioactivity:** Meaning of radioactivity, Unstable nuclei, Exponential decay law, Half-life, Mean life and units of radioactivity, Basic ideas of nuclear reactor, Nuclear fission and Nuclear fusion. | Interactive lectures, Problem-solving sessions, | Quiz test, In-course and Final Examination | CLO5 |

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**Course Assessment Framework**

Total Course Marks: 100 Examination Duration: 4 Hours

| Assessment Category | Assessment Component | Weightage |
|---|---|---|
| Formative Assessment (20%) | Attendance & Class Participation | 5% |
| | In-course Examination | 10% |
| | Quiz / Assignment Presentation | 5% |
| Summative Assessment (80%) | Final Examination<br>• Students will have to answer 8 questions out of 12<br>• 10 marks per question ($8 \times 10 = 80$ marks)<br>• Each question may contain maximum 3 sub-sections (e.g., a, b, c) | 80% |

**Mapping of Course Contents with CLOs**

| Module | CLO1 | CLO2 | CLO3 | CLO4 | CLO5 | CLO6 |
|---|---|---|---|---|---|---|
| Electrostatics | ✓ | ✓ | | | | ✓ |
| Electric Current & Magnetism | | ✓ | | | | ✓ |
| AC & Electronics | | ✓ | ✓ | | | ✓ |
| Relativity & Quantum Physics | | | | ✓ | | ✓ |
| Nuclear Physics | | | | ✓ | ✓ | ✓ |

**List of Books**


Beiser, A. (2003), *Concepts of Modern Physics* (6th ed.). McGraw-Hill Higher Education

Goldstein, H., Poole, C. P., & Safko, J. L. (2002). *Classical mechanics* (3rd ed.). Addison-Wesley.

Halliday, D., Resnick, R., & Walker, J. (2018). *Fundamentals of physics* (11th ed.). Wiley.

Marion, J. B., & Thornton, S. T. (2003). *Classical dynamics of particles and systems* (5th ed.). Brooks/Cole.

Purcell, E. M., & Morin, D. J. (2013). *Electricity and magnetism* (3rd ed.). Cambridge University Press.

Reitz, J. R., Milford, F. J., & Christy, R. W. (2008). *Foundations of electromagnetic theory* (4th ed.). Pearson.

Tarrant, G. T. P. (1949). *Electricity, Magnetism and Modern Physics.* Dent, UK

Taylor, J. R. (2005). *Classical mechanics*. University Science Books.


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| | |
|---|---|
| **Course Code** | **8222758** |
| **Course Title** | Physics-IV (Physics Practical) |
| **Credits** | 2 |
| **Marks** | 50 |
| **Practical Hours** | 42 |
| **Examination Duration** | 6 Hours |

**Course Description**

This laboratory course is designed to provide students with practical knowledge and experimental skills in mechanics, thermal physics, electricity, magnetism, and optics. The course enables students to verify fundamental physical laws experimentally, acquire competence in handling laboratory instruments, analyze experimental data using graphical and statistical methods, estimate experimental errors, and prepare scientific laboratory reports. The laboratory activities strengthen the theoretical concepts learned in Physics courses and develop professional laboratory practices.

**Course Objectives (COs)**

After successful completion of this course, students will be able to

| | |
|---|---|
| **CO1.** | Develop proficiency in handling standard laboratory instruments used in mechanics, thermal physics, electricity, magnetism, and optics. |
| **CO2.** | Perform physics experiments systematically by following standard laboratory procedures and safety protocols. |
| **CO3.** | Analyze experimental observations using appropriate mathematical and graphical techniques. |
| **CO4.** | Estimate experimental uncertainties and interpret results using error analysis. |
| **CO5.** | Prepare scientific laboratory reports and communicate experimental findings effectively. |

**Course Learning Outcomes (CLOs)**

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

| CLO | Learning Outcome | Bloom's Level |
|---|---|---|
| CLO1 | Explain the theoretical principles underlying laboratory experiments in mechanics, thermal physics, electricity, magnetism, and optics. | Understand |
| CLO2 | Conduct laboratory experiments related to Mechanics and Thermal Physics using appropriate apparatus while following laboratory safety and ethical practices. | Apply |
| CLO3 | Conduct laboratory experiments related to Electricity and Optics using appropriate apparatus while following laboratory safety and ethical practices. | Apply |
| CLO4 | Analyze experimental data through calculations, graphs, and error estimation to obtain reliable physical parameters. | Analyze |
| CLO5 | Evaluate experimental results by comparing them with theoretical predictions and identifying possible sources of error. | Evaluate |
| CLO6 | Prepare well-organized laboratory reports and effectively communicate experimental findings during viva-voce examinations. | Create |

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## Mapping of CLOs with Program Learning Outcomes (PLOs)

| CLOs | PLO1 Knowledge | PLO2 Problem Analysis | PLO3 Experi-Cmentation | PLO4 Modern Tools | PLO5 Communication | PLO6 Ethics | PLO7 Teamwork | PLO8 Lifelong Learning |
|---|---|---|---|---|---|---|---|---|
| CLO1 | ✓ | | | | | | | |
| CLO2 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| CLO3 | ✓ | ✓ | ✓ | ✓ | | | | |
| CLO4 | ✓ | ✓ | ✓ | | ✓ | | | ✓ |
| CLO5 | | | ✓ | | ✓ | ✓ | | ✓ |

## Course Contents

### Group A: Mechanics and Thermal Physics Laboratory

Students will perform **one experiment** from the following list.

| Expt No | Experiment | Teaching Learning Weeks |
|---|---|---|
| | Safety in laboratory | 1 |
| | Lab report writing | 2 |
| 1 | Determination of acceleration due to gravity (g) by compound pendulum | 3 |
| 2 | Determination of Young's and rigidity modulus by Searle's dynamic method | 4 |
| 3 | Determination of Rigidity modulus by static method | 5 |
| 4 | Determination of Surface tension of water by capillary tube method | 6 |
| 5 | Determination of Spring constant, effective mass and rigidity modulus of a spiral spring | 7 |
| 6 | Determination of Young's modulus by bending (flexure) method | 8 |
| 7 | Determination of Moment of inertia of a flywheel | 9 |
| 8 | Determination of Surface tension of mercury by Quincke's method | 10 |
| 9 | Determination of Specific heat of a solid by method of mixtures | 11 |
| 10 | Determination of Specific heat of a liquid by cooling method | 12 |
| 11 | Determination of Thermal conductivity of a bad conductor by Lee's method | 13 |
| 12 | Determination of Mechanical equivalent of heat (J) with radiation correction | 14 |
| 13 | Verification of laws of transverse vibration using a sonometer (frequency against- length and frequency against tension curves ) | 15 |
| 14 | Determination of Frequency by Melde's experiment | 16 |

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**Group B: Electricity and Optics Laboratory**

Students will perform **one experiment** from the following list.

| Expt No. | Experiment | Practical Hours |
|---|---|---|
| 15 | Comparison of EMFs using potentiometer | 17 |
| 16 | Determination of Galvanometer resistance by half-deflection method | 18 |
| 17 | Determination of Low resistance by fall of potential method | 19 |
| 18 | Determination of Electrochemical equivalent of copper/silver | 20 |
| 19 | Determination of Refractive index of prism using spectrometer | 21 |
| 20 | Determination of Cauchy's constants and resolving power of prism | 22 |
| 21 | Determination of Wavelength determination using Newton's rings | 23 |
| 22 | Determination of Wavelength determination using Fresnel bi-prism | 24 |
| 23 | Investigation of Specific rotation using polarimeter | 25 |
| | Practice: Experiment and Viva | 26-28 |

**Teaching-Learning Strategies**

- Laboratory demonstrations
- Hands-on experiments
- Guided laboratory sessions
- Problem-solving during experiments
- Data analysis using graphical methods
- Laboratory discussions
- Viva-voce
- Scientific report writing

**Laboratory Safety Practices**

Students shall

- Follow laboratory safety regulations.
- Handle fragile optical and electrical instruments carefully.
- Maintain laboratory discipline.
- Record observations honestly.
- Report equipment malfunction immediately.
- Dispose of laboratory materials properly.

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**Assessment Strategy**

Examination duration: 6 hours

To perform two experiments (one from each group) each of 3 hours duration.

| | | | |
|---|---|---|---|
| i) | Experiments (3 hours each) | 2 X 17= | 34 |
| ii) | Laboratory note book | | 6 |
| iii) | Class attendance | | 5 |
| iv) Experimental Viva-voce | | | 5 |

Marks for each experiment shall be distributed as follows:

a) Theory 4

b) Data collection and Tabulation 6

c) Calculation, graphs and result 4

d) Discussion 3

Total marks = 17

| Assessment Component | CLOs Assessed |
|---|---|
| Experiment-1-14 | CLO1,2,3 and 5 |
| Experiment-15-23 | CLO1,2,4 and 5 |
| Laboratory Notebook | CLO4 and 5 |
| Experimental Viva-Voce | CLO1 to CLO6 |
| **Total** | |

**CLO–Assessment Mapping**

| Assessment Tool | CLO1 | CLO2 | CLO3 | CLO4 | CLO5 |
|---|---|---|---|---|---|
| Experiment Performance | ✓ | ✓ | ✓ | ✓ | |
| Data Analysis | | ✓ | ✓ | ✓ | |
| Laboratory Notebook | | | ✓ | | ✓ |
| Viva-Voce | ✓ | ✓ | ✓ | ✓ | ✓ |

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**Graduate Attributes Developed**

Upon completion of the course, students will develop:

- Practical laboratory skills
- Experimental design and execution
- Critical thinking
- Scientific reasoning
- Quantitative data analysis
- Technical communication
- Professional ethics
- Teamwork
- Lifelong learning attitude

**List of Books:**

Ahmed, G. U., & Uddin, M. S. (1992). *Practical physics for degree students* (3rd ed.). Hafiz Book House

Cerny, E. J. (1976). *Introduction to experimental physics*. McGraw-Hill.

Halliday, D., Resnick, R., & Walker, J. (2018). *Fundamentals of physics* (11th ed.). Wiley.

Nelkon, M., & Parker, P. (1978). *Advanced level physics*. Heinemann.

Singh, S. P. (2011). *Advanced practical physics* (18th ed.). Pragati Prakashan.

Squires, G. L. (2001). *Practical physics* (4th ed.). Cambridge University Press.

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