Syllabus of 4 + 1 Year Integrated UG and PG Programme

w. e. f 2024-25 Academic Year

GRADUATE SCHOOL

Mahatma Gandhi University

P. D. Hills P O

Kottayam, Kerala

www.gs.mgu.ac.in

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Schools offering Majors

SL.No	School/Centre
1	School of Bio Sciences
2	School of Chemical Sciences
3	School of Computer Sciences
4	School of Environmental Sciences
5	School of Gandhian Thought and Development Studies
6	School of International Relations and Politics
7	School of Pure and Applied Physics
8	School of Social Sciences

Sl. No.	Major	Intake
SCIENCE		
1	Bio Sciences	6**
2	Chemistry	6
3	Computer Science	6
4	Environmental Science	6
5	Physics	6
SOCIAL SCIENCES		
1	Development Studies	5
2	Gandhian Studies	5
3	History	10
4	International Relations and Politics	10

Majors offered and Intake *1 seat shall be sanctioned over and above the intake in each major in the 3rd semester for students who opt for a change of major after two semesters.

**Progression to PG Shall be based on the specialization selected by students as Biochemistry (2 seats) Biotechnology (2 seats) and Microbiology (2 seats) based on merit.

Schools offering Minors/MDCs/AECs/VACs/SECs

SL.No	School/Centre
1	School of Artificial Intelligence And Robotics
2	School of Behavioural Sciences
3	School of Biosciences
4	School of Chemical Sciences
5	School of Computer Sciences
6	School of Data Analytics
7	School of Energy Materials
8	School of Environmental Sciences
9	School of Food Science And Technology
10	School of Gandhian Thought And Development Studies
11	School of Gender Studies
12	School of Indian Legal Thought
13	School of International Relations And Politics
14	School of Letters
15	School of Mathematics And Statistics
16	School of Nanoscience And Nano Technology
17	School of Pedagogical Sciences
18	School of Polymer Science And Technology
19	School of Pure And Applied Physics
20	School of Social Sciences
21	School of Tourism Studies
22	International and Inter University Centre for Nanoscience and Nanotechnology
23	K N Raj School of Economics

Scheme for 4 + 1 Integrated UG and PG Programme
Graduate School
Mahatma Gandhi University
School of Chemical Sciences

Course Code	Title	Credits	Hours per Week		Level	Type
			Theory	Practicals		
SEMESTER I						
MG1DSCUCY101	Fundamentals of Chemistry 1	4	4		Foundation (100-199)	Major
MG1DSCUCH121	General Chemistry 1	4	4		"	Minor A
MG1DSCUCH141	Applied Chemistry 1	4	4		"	Minor B
MG1MDCUCH101	Science and Society	3	3		"	MDC
	AEC (Eng)	3	3		"	AEC
	AEC (Mal)	3			"	AEC
SEMESTER II						
MG2DSCUCY101	Fundamentals of Chemistry 2	4	3	1	"	Major
MG2DSCUCH121	General Chemistry 2	4	3	1	"	Minor A
MG2DSCUCH141	Applied Chemistry 1	4	4		"	Minor B
MG2MDCUCH101	World of Chemistry	3	3		"	MDC
	AEC (Eng)	3	3		"	AEC
	AEC (Mal)	3	3		"	AEC
SEMESTER III						
MG3DSCUCY201	Physical Chemistry	4	3	1	Intermediate (200-299)	Major
MG3DSCUCY202	Organic Chemistry I	4	4		"	Major
MG3DSCUCY203	Inorganic Chemistry	4	4		"	Major
MG3DSCUCH221	Advanced Chemistry 1	4	4		"	Minor A
MG3MDCUCH201	The Fascinating world of Gels	3	3		"	MDC

MG3VACUCH201	Chemistry for Sustainable Society	3	3		"	VAC
SEMESTER IV						
MG4DSCUCY201	Inorganic and Physical Chemistry	4	4		"	Major
MG4DSCUCY202	Organic Chemistry II	4	4		"	Major
MG4DSCUCY203	Spectroscopic methods in Chemistry	4	4		"	Major
MG4DSCUCH241	Analytical Chemistry	4	4		"	Minor B
MG4SECUCH201	Basic Computation Skills for Science	3	3		"	SEC
MG4VACUCH201	Sustainable Chemical approaches	3	3		"	VAC
MG4INTUCY201	Internship/Fieldwork	2	2			
SEMESTER V						
MG5DSCUCY301	Inorganic Chemistry	4	4		Higher (300-399)	Major
MG5DSCUCY302	Organic Chemistry III	4	4		"	Major
MG5DSCUCY303	Physical Chemistry	4	4		"	Major
MG5DSCUCY304	Practical Chemistry	4		4	"	Major
MG5SECUCH301	Research skills and scientific data analysis	3	3		"	SEC
MG5VACUCH301	Chemistry of Aesthetic	3	3		"	VAC
SEMESTER VI						
MG6DSCUCY301	Inorganic and Physical Chemistry	4	4		"	Major
MG6DSCUCY302	Organic Chemistry IV	4	4		"	Major
MG6DSCUCY303	Polymer Chemistry	4	4		"	Major
MG6DSEUCY301	Natural Polymer Chemistry	4	4		"	Major (E)
MG6DSEUCY302	Chemistry of materials					
MG6DSEUCY303	Medicinal Chemistry					

MG6DSEUCY304	Heterocyclic Chemistry	4	4		"	Major (E)
MG6DSEUCY305	Polymer composites: From macro to nano scale					
MG6DSEUCY306	Electrochemical Energy storage and conversion devices					
MG6VACUCH301	Academic and Scientific Presentation	3	3		"	SEC
Total Credits		**133**				

SEMESTER VII						
MG7DSCUCY401	Advanced Topics in Chemistry 1	4	4		Advanced (400-499)	Major
MG7DSEUCY401	Polymer blends	4	4		"	Major (E)
MG7DSEUCY402	Nanomaterials Synthesis & Device					
MG7DSEUCY403	Photochemistry and pericyclic reactions					
MG7DSEUCY404	Biochemistry					
MG7DSEUCY405	Polymer additives and Compounding	4	4		"	Major (E)
MG7DSEUCY406	Advanced Characterization Techniques					
MG7DSEUCY407	Transition metals in chemical synthesis					
MG7DSCUCH421	Advanced Chemistry	4	4		"	Minor A/B
MG7DSEUCH421	Polymer blends	4	4		"	Minor A/B (E)
MG7DSEUCH422	Nanomaterials Synthesis & Device					

MG7DSEUCH423	Photochemistry and pericyclic reactions					
MG7DSEUCH424	Biochemistry					
MG7DSEUCH425	Polymer additives and Compounding	4	4		"	Minor A/B (E)
MG7DSEUCH426	Advanced Characterization Techniques					
MG7DSEUCH427	Transition metals in chemical synthesis					
SEMESTER VIII						
MG8DSCUCY401	Advanced Topics Chemistry in 2	4	4		"	Major
MG8DSEUCY402	Solar Energy-Advanced Materials for Photovoltaics	4	4		"	Major (E)
MG8DSEUCY403	Chemistry of natural products					
MG8DSEUCY404	Supramolecular chemistry					
MG8DSEUCY405	Polymer processing					
MG8DSEUCY406	Polymer testing					
MG8RPHUCY400	Research Project	12			"	
MG8DSCUCY407	Advanced Inorganic Chemistry	4	4		"	Major*
MG8DSCUCY408	Advanced Physical Chemistry	4	4		"	Major*
MG8DSCUCY409	Advanced Organic Chemistry	4	4		"	Major*
Total Credits		**44**				
SEMESTER IX						
MG09DSCUCY501	Advanced Organic Synthesis	4	4		PG Level (500-	Major

					599)	
MG09DSCUCY502	Theoretical and Computational Chemistry	4	4		"	Major
MG09DSCUCY503	Research Methodology and Ethics	4	4		"	Major
MG09DSCUCY504	Analytical Chemistry	4	4		"	Major
MG09DSCUCY505	Advanced Chemistry Practical's	4		4	"	Major
SEMESTER X						
MG10RPHUCY500	Research Project	20			"	
	Major**	4			"	
	Major**	4			"	
	Major**	4			"	
	Major**	4			"	
	Major**	4			"	
Total Credits		**40**				

*Only for 4-Years Honours Students
**Only for students who opt for theory courses instead of Research Project

Note: General foundations courses shall be offered by different schools. Students can flexibly choose the courses across disciplines.

Level	Foundation (100-199	Intermediate (200-299)	Higher (300-399)	Advanced (400-499)	PG Level (500-599)

Type	Major	Minor	MDC	SEC	VAC	AEC

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Fundamentals of Chemistry 1**		
Course Type	**Major (Discipline-specific foundation course)**		
Course Level	100-199		
Course Code	MG1DSCUCY101		
Course Overview	Fundamentals of Chemistry is a foundation-level course and it equips the students with the knowledge of basic chemistry concepts for entry to learn various advanced topics in all branches of chemistry. The course covers the evolution of chemistry and its significance, fundamental themes of the atomic structure, properties, states of matter and carbon compounds. Students explore the chemical bonding and chemical & physical properties of elements based on the periodic table. Students learn about how the properties of different states of matter evolved, from a molecular level. Students will also learn to name any organic compounds and predict their properties based on the type of carbon bond.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Should know fundamental particles (electron, proton, neutron), charge, Bohr atomic model, the periodic table, catenation in carbon and difference between solid, liquid and gas		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand modern chemistry's basic facts, principles, theories, and methods.	R, U	
2	Apply atomic models to forecast and explain electronic configurations, atomic behaviour, and characteristics.	R, U, A	
3	Analyse periodic trends, the relationship between electronic configuration and the chemical reactivity of elements, including the formation of chemical bonds.	A, An	
4	Describe the relevance of organic chemistry, able to remember and name organic compounds and can predict their physical as well as chemical properties	R, A	
5	Describe the fundamental principles governing the behaviour of different states of matter.	U	
6	Compare the properties of solids, liquids, and gases and evaluate them based on real-life conditions.	E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Chemistry a Colourful Sciences	**Hours**	**CO No**
Definition of Science. Scientific methods - hypothesis-experiment – theory – law. Evolution of Chemistry- Early form of chemistry -alchemy, the origin of modern chemistry. Chemistry as a central science - Branches of chemistry. Interdisciplinary areas involving chemistry- Nanotechnology and biotechnology. Basic concepts in medicinal and pharmaceutical chemistry as well as methods of pharmaceutical and biomedical analysis: Drug discovery and development process, Review of organic functional groups found in drug molecules.	**12**	**1**
Module 2: Introduction to Atomic Structure and Bonding	**Hours**	
Atomic structure: The Atomic theory of matter, Discovery of atomic structure, Electromagnetic radiation – wave and particle nature, Planck's Quantum Theory, Black body radiation, Photoelectric	**16**	**2,3**

effect, Dual behaviour, Bohr's model for Hydrogen atom and its limitations – Stark and Zeeman effect. **Chemical bonding**: Lewis's symbol, Octet rule, Ionic bond – Lattice enthalpy, Born-Lande equation, Born-Haber cycle, Covalent bond- Strengths and Length, Resonance, Dipole moment, Fajan's rule, Co-ordinate bond, Hydrogen bonding. The Valence Shell Electron Pair Repulsion Theory (VSEPR), Molecular geometry, Orbital Overlap, Hybridization, Valence Bond Theory (VBT), and Molecular Orbital Theory (MOT). **Periodic table- classification of elements and properties**: Development of Periodic table, Block elements- s, p, d and f block, Periodicity, Structure and properties Alkali and alkaline earth metals, p-block elements- B, C, N, P and O family oxoacids of Sulphur and Halogens, Noble gases, Chemical properties, Diagonal relationship, biological importance of Na, K, Ca and Mg. Transition elements –Lanthanides and Actinides,		
Module 3: Organic Chemistry for Beginners	**Hours**	
IUPAC nomenclature: Alkanes, cyclo-alkanes, alkenes, alkynes, halogen compounds, Functional groups and structural diversity, Conformational analysis: alcohols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds. Hybridization and Geometry of Molecules: methane, ethane, ethylene, acetylene. Electronic Effects: Inductive, resonance, hyperconjugation, and steric effect. Concepts of acidity: Acids and bases. Nucleophiles and electrophiles. Cleavage of bonds: homolytic and heterolytic C-C bond fission. Reaction Intermediates and their stability: carbocations, carbanions, and free radicals. Polymers and Macromolecules	**16**	**4**
Module 4: Understanding States of Matter	**Hours**	
Gases: The gas laws; the ideal gas equation; Gas mixtures and partial pressures; Gas mixtures and partial pressures; kinetic-molecular theory of gases; molecular effusion and diffusion; real gases. **Liquid:** A molecular comparison of gases, liquids, and solids; intermolecular forces, select properties of liquids; phase changes; vapour pressure, Phase diagrams; liquid crystals. **Solids:** Bonding in solids; structures of solids, unit cells; classification of solids; metallic bonding; ionic solids; molecular Solids: covalent-network solids	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination

Learning Resources

1. P. Atkins, T. Overton, J. Rourke, F. Armstrong, and M. Hagerman, Shriver and Atkins' Inorganic Chemistry, 5ed, W. H. Freeman and Company New York, 2009.
2. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 3rd ed., Pearson, 2008.
3. J. E. House, Inorganic Chemistry, 3rd ed., Academic Press, 2019.
4. J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th ed., Pearson Education, 2006.
5. J. M. McIintosh, Organic Chemistry Fundamentals and Concepts, 2nd Edn., De Gruyter, 2022
6. T. W. G. Solomons, C. B. Fryhle and S. A. Snyder, Solomons' Organic Chemistry, Global Edn., 12th Edn., Wiley International, 2024

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of discipline-specific foundation courses. Students will be empowered with the basic knowledge of chemistry and its significance in the modern world.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**General Chemistry 1**		
Course Type	**Minor**		
Course Level	100-199		
Course Code	MG1DSCUCH121		
Course Overview	General Chemistry 1 is a foundation-level course and it equips the students with the knowledge of basic chemistry concepts for entry to learn various advanced topics in all branches of chemistry. The course covers the evolution of chemistry and its significance, fundamental themes of the atomic structure, properties, states of matter and carbon compounds. Students explore the chemical bonding and chemical & physical properties of elements based on the periodic table. Students learn about how the properties of different states of matter evolved, from a molecular level. Students will also learn to name any organic compounds and predict their properties based on the type of carbon bond.		
Semester	1	**Credit**	4

Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**
	60	
Pre-requisite	Should know fundamental particles (electron, proton, neutron), charge, Bohr atomic model, the periodic table, catenation in carbon and difference between solid, liquid and gas	

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** *Upon completion of this course, students will be able to**;***	**Learning Domains**	**PSO No.**
1	Understand the basic facts, principles, theories, and methods of modern chemistry.	R, U	
2	Apply atomic models to forecast and explain electronic configurations, atomic behaviour, and characteristics.	R, U, A	
3	Analyse periodic trends, the relationship between electronic configuration and the chemical reactivity of elements, including the formation of chemical bonds.	A, An	
4	Describe the relevance of organic chemistry, able to remember and name organic compounds and can predict their physical as well as chemical properties	R, A	
5	Describe the fundamental principles governing the behaviour of different states of matter.	U	
6	Compare the properties of solids, liquids, and gases and evaluate them based on real-life conditions.	E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Chemistry a Colourful Sciences	**Hours**	**CO No**
Definition of Science. Scientific methods - hypothesis-experiment – theory – law. Evolution of Chemistry-Early form of chemistry -alchemy, the origin of modern chemistry. Chemistry as a central science - Branches of chemistry. Interdisciplinary areas involving chemistry- Nanotechnology and biotechnology. Basic concepts in medicinal and pharmaceutical chemistry as well as methods of pharmaceutical and biomedical analysis: Drug discovery and development process, Review of organic functional groups found in drug molecules.	**12**	**1**
Module 2: Introduction to Atomic Structure and Bonding	**Hours**	
Atomic structure: The Atomic theory of matter, Discovery of atomic structure, Electromagnetic radiation – wave and particle nature, Planck's Quantum Theory, Black body radiation, Photoelectric effect, Dual behaviour, Bohr's model for Hydrogen atom and its limitations – Stark and Zeeman effect. **Chemical bonding**: Lewis's symbol, Octet rule, Ionic bond – Lattice enthalpy, Born-Lande equation, Born-Haber cycle, Covalent bond- Strengths and Length, Resonance, Dipole moment, Fajan's rule, Co-ordinate bond, Hydrogen bonding. The Valence Shell Electron Pair Repulsion Theory (VSEPR), Molecular geometry, Orbital Overlap, Hybridization, Valence Bond Theory (VBT), and Molecular Orbital Theory (MOT). **Periodic table- classification of elements and properties**: Development of Periodic table, Block elements- s, p, d and f block, Periodicity, Structure and properties Alkali and alkaline earth metals, p-block elements- B, C, N, P and O family oxoacids of Sulphur and Halogens, Noble gases, Chemical properties, Diagonal relationship, biological importance of Na, K, Ca and Mg. Transition elements –Lanthanides and Actinides	**16**	**2,3**
Module 3: Organic Chemistry for Beginners	**Hours**	
IUPAC nomenclature: Alkanes, cyclo-alkanes, alkenes, alkynes, halogen compounds, Functional groups and structural diversity, Conformational analysis: alcohols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds. Hybridization and Geometry of Molecules: methane, ethane, ethylene, acetylene. Electronic Effects: Inductive, resonance,	**16**	**4**

hyperconjugation, and steric effect. Concepts of acidity: Acids and bases. Nucleophiles and electrophiles. Cleavage of bonds: homolytic and heterolytic C-C bond fission. Reaction Intermediates and their stability: carbocations, carbanions, and free radicals. Polymers and Macromolecules		
Module 4: Understanding States of Matter	**Hours**	
Gases: The gas laws; the ideal gas equation; Gas mixtures and partial pressures; Gas mixtures and partial pressures; kinetic-molecular theory of gases; molecular effusion and diffusion; real gases. **Liquid:** A molecular comparison of gases, liquids, and solids; intermolecular forces, select properties of liquids; phase changes; vapour pressure, Phase diagrams; liquid crystals. **Solids:** Bonding in solids; structures of solids, unit cells; classification of solids; metallic bonding; ionic solids; molecular Solids: covalent-network solids	**16**	**5,6**

Mode of Transaction	Classroom activities: Recitation, Seminar, Quiz Lab-based activities
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination

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Relevance of Learning the Course/ Employability of the Course

It is very relevant in terms of foundation courses. Students will be empowered with the basic knowledge of chemistry and its significance in the modern world.

54	MAHATMA GANDHI UNIVERSITY Graduate School
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Applied Chemistry 1**		
Course Type	**Minor**		
Course Level	100-199		
Course Code	MG1DSCUCH141		
Course Overview	Applied Chemistry-1 course gives an overview of key areas which influence the day-to-day activities of the society. The students get general information about various industries such as fuel, fertilizer, pesticide, polymer and pharma industries, etc. The students get an idea about the origin of various chemical products they use in daily life. Students will also learn about natural resources, environmental contamination, occupational health and safety, risk management, and environmental toxicology.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Should be familiar with various consumable products (like medicine, fuel, etc)		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the significance of sustainability and the need to keep the environment free of pollution.	R, U	
2	Remember different chemicals and their uses and how they can be specifically applied to enhance the quality of life.	R, U, A	
3	Will get detailed knowledge regarding the significance of petroleum and petrochemicals in the modern world.	A, An	
4	Will get an overview of various types of polymers used in the modern world and get familiarized with the significance of polymer recycling.	R, A	
5	Realialize how chemistry has helped to develop modern medicines.	U	
6	Will be able to analyze the specific relation between the structure/chemistry of the drug to their pharmacological activity.	E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1: Industrial Chemistry	Hours	CO No
Sustainable use of- chemical feedstocks, water, energy. Environmental pollution control. Industrial Processes in practice: Basic chemical data, Flow charts; chemical process selection, design, and operation, Plant location, safety, construction of plant, process system engineering. Fuel Industries: Calorific value, the modern concept of fuels, classification, criteria for selection, comparison of gas, liquid, and solid fuels, properties, methods of processing various fuels, solid fuels, and Gaseous fuels. Agrichemical Industries: Fertilizers – Fertilizer type, need for fertilizer, essential requirements, plant nutrients and regulators, soil fertility, pH of the soil, classification of fertilizer, natural fertilizers, nitrogenous fertilizer, Phosphate fertilizers, NPK fertilizers, the effect of fertilizer- pollution. Insecticides classification, DDT, BHC, Gammexane, Endosulfan.	**12**	**1**

Module 2: Petrochemistry	**Hours**	
Origin and formation of petroleum, Composition, Characteristics, Constituents of Petroleum or crude oil. Types of Hydrocarbons and Non- hydrocarbons present in petroleum, their physical and chemical properties. Salty crude oil, sweet and sour crude oil. Classification of crude oil and natural gas: Characterization factor, Correlation index. Primary raw material for petrochemicals: Introduction to paraffinic hydrocarbons, olefinic hydrocarbons, dienes, and aromatic hydrocarbons with their properties. uses as building blocks for various petrochemicals.	**16**	**2,3**
Module 3: Polymer Chemistry	**Hours**	
Rubber, Plastics, and Fibres – Introduction, Viscoelasticity, Tg, Tm, and Crystallinity. Polymer: A wonder material – Specialty polymers – Engineering plastics – Self-curing polymers – Shape memory polymers – Polymer blends-composites – Nanocomposites –Synthetic and natural biopolymers – Polymer waste management and recycling – Applications of polymers (Engineering-Packaging-Biomedical-Electronic-Space-Automotive)	**16**	**4**
Module 4: Pharmaceutical Chemistry	**Hours**	
Development of medicinal chemistry, Basic principles, Basic terminology in drug discovery, MIC, Efficacy, Adsorption, Distribution, Metabolism, Excretion, Drug and disease classification, drug targets, Pharmacology, Pharmacokinetics, Generic and trade names, Lipinski rule, Dose-response curves-Stages in drug discovery, SAR, Natural and synthetic drugs, Introduction to Process Chemistry. Cancer research: Anti-cancer-agents, Antibiotics: Penicillins, Tetracyclines, and Quinolones, Basic knowledge of TB and its treatment, Viral and fungal diseases, Analgesics and Anti-inflammatory drugs-NSAIDS, Proton pump inhibitors: Hyperacidity, Peptic Ulcer disease (PUD), Gastroesophageal reflux disease (GERD), Cardiovascular diseases: Hypertension, Cardiovascular drugs-Statin drugs, ACE inhibitors, Calcium channel inhibitors, Cholesterol absorption inhibitors	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination

Learning Resources

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Relevance of Learning the Course/ Employability of the Course
Applied Chemistry course can help students to work in many designated roles such as Chemistry Content Writer, Scientific Data Entry Specialist, Chemical Business Analyst, Quality Assurance, etc.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Science and Society**		
Course Type	**MDC**		
Course Level	100-199		
Course Code	MG1MDCUCH101		
Course Overview	This multidisciplinary course aims to provide a critical understanding for learners of the significance of science in society and vice-versa. The syllabus covers the history of science, developments of sciences, and approaches in science. The syllabus also deals with various processes and approaches adopted in scientific research. Finally, consciousness about scientific ethics is also discussed. This course further offers the prospects for understanding the contemporary trends and growth in diverse fields of scientific research. After completion of this course, students will be able to correlate the mutual relationship and significance between science and society.		
Semester	1	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	54		
Pre-requisite	Should be familiar with various consumable products (like medicine, fuel, etc)		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	To acquire a concrete understanding of the importance of scientific knowledge and its implications in society.	U, An, A	
2	To provide sufficient knowledge about the history of major scientific discoveries and developments.	R, U, E, A	
3	To understand the peculiarities of scientific approaches.	U, A	
4	To Correlate the relationship between scientific and social developments in mankind.	An, E	
5	To outline the basic steps in scientific research.	U, A	
6	To develop critical thinking and reasoning ability and to impart scientific ethics among learners.	A, U, An, E, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1: The History of Science	**Hours**	**CO No**
Ancient civilization in India, China, Babylon, Egypt, Greece, Rome, Aristotelian views, Archimedes, The Copernican revolution, Contributions of Galileo, Louis Pasteur, Newton, Einstein, Linus Pauling, Developments and Revolutions in various branches of science, The evolution of modern Science and Technology, Science in the twenty-first century.	**10**	**1**
Module 2: The Scientific Approach	**Hours**	
Process of science and the nature of scientific knowledge. Ideas in science: Research Process, hypotheses, theories, and laws. The process of science beyond methods: Science as a creative human activity and art, creativity in science. Reasoning and Critical thinking, Affective and Cognitive strategies, Science and Knowledge, Beliefs and superstitions, Justification, Scientific temper.	**10**	**2,3**

Module 3: The Practice of Science	**Hours**	
Research methods: Identification of a problem, determination of methodology, literature survey, mode of approach of actual investigation, drawing influences from data, qualitative and quantitative analysis, assessing the status of the problem, results and conclusions, presenting a scientific seminar, abstraction of the research paper, publication of research paper, e-journals, art of writing a thesis. Science Communication: Conventional and Social media role, internet and its applications, Scientific controversies.	**20**	**4**
Module 4: Scientific ethics	**Hours**	
Verifiability and reproducibility, Plagiarism, IPR, Cyber laws, Internet security	**14**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination

Learning Resources

1. J. S. Avery, Science and Society, World scientific

Suggested Reading

1. J. D. Bernal, Science in history, 1-4 Volumes, MIT Press, Cambridge, 1971.
2. W. Durant, The Story of Civilization, Simon and Schuster Publishers, United States, 1975
3. B. Russell, The Scientific Outlook, Routledge Classics, United Kingdom, 2009
4. K. Sujatha, S. Kurien, Evolution of the Philosophy of Science-Literary Perspectives, Ane Books Pvt. Ltd, 2011.
5. G. Gammow, One, two, three…infinity, Dover Publications, INC, NewYork,1974
6. T. Crump, A Brief History of Science, Universities Press, 2001.
7. B. N. Ghosh, Lectures on Scientific Method, Sterling, 1986.

Relevance of Learning the Course/ Employability of the Course

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Fundamentals of Chemistry 2**		
Course Type	**Major (Discipline-specific foundation course)**		
Course Level	100-199		
Course Code	MG2DSCUCY101		
Course Overview	Fundamentals of Chemistry 2 is a foundation-level course and it equips the students with the knowledge of basic Quantum mechanics and its application in chemical bonding. The course also covers the concepts of acid-base theory. Stereochemistry gives an overview of the structure of organic molecules, and how to distinguish between different types of isomers, including enantiomers and diastereomers. Students will be introduced to chemical thermodynamics and will get familiarized with physical concepts such as work, heat, enthalpy, entropy etc. Students will be introduced to the chemistry lab where they learn about various safety aspects and hazards associated with chemicals, MSDS etc. Students will learn to carry out fundamental experiments such as finding boiling points, melting points, calibrating instruments etc.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Should know fundamental particles (electron, proton, neutron), charge, Bohr atomic model, the periodic table, and basic organic chemistry including naming organic compounds. Students should be aware of basic physical		

	concepts like work, energy etc. Should know about various laboratory glasswares.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the fundamentals of quantum mechanics and explain chemical bonding based on the theories of quantum mechanics.	R, U	
2	Compare the relative strengths of acids and bases, and the different factors affecting acidity and basicity	R, U, A	
3	Identify stereogenic centres in organic molecules, and distinguish between different types of isomers, including enantiomers and diastereomers	A, An	
4	Understand principles of classical thermodynamics and apply them to analyze systems and thermodynamic cycles	R, A	
5	Understand the various hazards associated with chemicals. Applying this knowledge for handling and disposing of chemicals	R U A	
6	Develop the necessary skills to work in a chemistry lab.	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Basic Inorganic Chemistry	Hours	CO No
Quantum mechanical model of atom and bonding: Dual behaviour of matter, Heisenberg's Uncertainty Principle, double slit experiments, Classical wave equation, Schrödinger equation, Operators, Postulates of quantum mechanics, Particle-in-a-box, Schrödinger equation for the hydrogen atom, Qualitative description of many-electron systems, concepts of orbitals and quantum numbers. Shapes of orbitals, Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Valence bond and molecular orbital descriptions of bonding, Linear combination of atomic orbitals (LCAO) approach,	**16**	**1**

Hybridization and Bonding. Bonding in homonuclear and heteronuclear diatomic molecules, Bond orders. **Chemistry of Solid:** Classification of solids, Classification of crystalline solids, Crystal lattices and unit cell, seven crystal systems, Bravais's lattices, Number of atoms in a unit cell, packing in solids, Packing efficiency, Density of unit cell, Imperfection in solids, Crystal directions and planes, Crystal diffraction – Bragg's law, Electrical and Magnetic properties **Oxidation and reduction:** Reduction potential; electrochemical series, Redox reactions Balancing of redox equations, Factors affecting redox stability, Frost diagrams for redox reactions, Ellingham diagram and extraction of elements. **Acids and bases:** Arrhenius concept, solvent systems, Brønsted concept, Lux-Flood concept and Lewis's concept; HSAB principle, Superacid, Relative strengths of acids, Acid-base neutralization curves and indicators.		
Module 2: Basics of Stereochemistry	**Hours**	
Introduction, Concept of Isomerism, Classification of Stereoisomers, Optical Isomerism, Chirality & Elements of Symmetry, Wedge formula, Fischer projection, Newmann projection. Relative and absolute configurations, sequence rules, D & L, R & S systems of nomenclature. Understanding with examples for Enantiomers, mesoform, erythro/threo forms, diastereoisomers, inversion, retention, and racemization. Conformational understanding with an example of ethane, n-butane, Cyclohexane and Decalin.	**16**	**2,3**
Module 3: Concepts of Physical Chemistry	**Hours**	
Thermodynamics: Thermodynamic terms, State and path functions. Concept of heat and work. First Law of thermodynamics, Second law of thermodynamics, Third law of thermodynamics, Fundamental concepts of Statistical Thermodynamics - Probability - Partition function - ensembles - Boltzmann distribution. Chemical Equilibria: Law of mass action, thermodynamic derivation of law of chemical equilibrium. derivation of relations between the	**12**	**4**

various equilibrium constants Kp, Kc and Kx (using chemical potential). Ionic Equilibria: pKa, pKb and pH – Buffer solutions. Mechanism of buffer action – Buffer index – Henderson equation – Applications of buffers - Hydrolysis of salts of all types – Degree of hydrolysis – Hydrolysis constant and its relation with Kw - Solubility product and common ion effect.		
Module 4: Basic Chemistry Laboratory Practices	**Hours**	
Laboratory orientation and safety protocols Safe lab practices-PPE, Fire and electrical safety. Chemicals and solvents-Storage and handling, Material Safety Data Sheet (MSDS), Special precautions for hazardous chemicals usage. Segregation and disposal of chemicals-sodium and broken mercury thermometer. Introduction to glassware and equipment in the lab and their working. Emergency response and evacuation- chemical spills, gas leakage and fire. Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkalis - Burns due to phenol and bromine. Scientific ethics in lab-working individually and in a team. Maintaining lab record, Cleanliness and punctuality. 2. Basic principles & experiments related to sample/reagent preparation: practical concept of Molarity, Molality, Normality, equivalence, weight %, vol.%, Preparation of standard solutions, Dilution 0.1 M to 0.001 M solutions. 3. Calibration and use of Electronic Balances, thermometer (using 80-82 °C; Naphthalene, 113.5-114 °C; Acetanilide, 132.5-133°C; Urea, 100 °C; Distilled Water), melting point apparatus (Naphthalene 80-82 °C, Benzoic Acid 121.5-122 °C, Urea 132.5-133 °C, Succinic Acid 184.5-185 ° C, Cinnamic Acid 132.5-133 °C, Salicylic Acid 157.5-158 °C Acetanilide 113.5-114 °C, m-Dinitrobenzene 90 °C p-Dichlorobenzene 52 °C, Aspirin 135 °C) Determination of Boiling Point- Ethanol 78 °C, Cyclohexane 81.4 °C, Toluene 110.6 °C. Working principle of separating funnel, distillation setup, centrifuge, hot air oven, magnetic stirrer, rotary evaporator. 4. Separating homo and heterogeneous mixtures- Filtration, Concentration, Evaporation, recrystallisation, sublimation, separating funnel, distillation, chromatography.	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1. D. A. McQuarrie, Quantum Chemistry, Viva Student ed., Viva, 2011.
2. P. Atkins, J. de Paula and J. Keeler, Atkins' Physical Chemistry, 11th ed., OUP, 2018.
3. J. Barrett, Structure and Bonding, Wiley-Royal Society of Chemistry, 2002.
4. T. Engel and P. Reid, Physical Chemistry, 3rd ed., Pearson, 2013.
5. R. J. Silbey, R. A. Alberty and M. G. Bawendi, Physical Chemistry, 4th ed., Wiley Student ed., 2006.
6. J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th ed., Pearson Education, 2006.
7. T. W. G. Solomons, C. B. Fryhle and S. A. Snyder, Solomons' Organic Chemistry, Global Edn., 12th Edn., Wiley International, 2024
8. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 3rd Edn., New age international, 2018
9. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th Edn., New Age International, 2022
10. Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
11. Vogel's Textbook of Practical Organic Chemistry (5th Edition)
12. Vogel's Inorganic Practical Chemistry

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of discipline-specific foundation courses. Students will be empowered with the basic knowledge of chemistry and its significance in the modern world.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**General Chemistry 2**		
Course Type	**Minor**		
Course Level	100-199		
Course Code	MG2DSCUCH121		
Course Overview	General Chemistry 2 is a foundation-level course and it equips the students with the knowledge of basic Quantum mechanics and its application in chemical bonding. The course also covers the concepts of acid-base theory. Stereochemistry gives an overview of the structure of organic molecules, and how to distinguish between different types of isomers, including enantiomers and diastereomers. Students will be introduced to chemical thermodynamics and will get familiarized with physical concepts such as work, heat, enthalpy, entropy etc. Students will be introduced to the chemistry lab where they learn about various safety aspects and hazards associated with chemicals, MSDS etc. Students will learn to carry out fundamental experiments such as finding boiling points, melting points, calibrating instruments etc.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		

Pre-requisite	Should know fundamental particles (electron, proton, neutron), charge, Bohr atomic model, the periodic table, and basic organic chemistry including naming organic compounds. Students should be aware of basic physical concepts like work, energy etc. Should know about various laboratory glasswares.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the fundamentals of quantum mechanics and explain chemical bonding based on the theories of quantum mechanics.	R, U	
2	Compare the relative strengths of acids and bases, and the different factors affecting acidity and basicity	R, U, A	
3	Identify stereogenic centres in organic molecules, and distinguish between different types of isomers, including enantiomers and diastereomers	A, An	
4	Understand principles of classical thermodynamics and apply them to analyze systems and thermodynamic cycles	R, A	
5	Understand the various hazards associated with chemicals. Applying this knowledge for handling and disposing of chemicals	R U A	
6	Develop the necessary skills to work in a chemistry lab.	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Basic Inorganic Chemistry	Hours	CO No
Quantum mechanical model of atom and bonding: Dual behaviour of matter, Heisenberg's Uncertainty Principle, double slit experiments, Classical wave equation, Schrödinger equation, Operators, Postulates of quantum mechanics, Particle-in-a-box, Schrödinger equation for the hydrogen atom,	**16**	**1**

Qualitative description of many-electron systems, concepts of orbitals and quantum numbers. Shapes of orbitals, Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Valence bond and molecular orbital descriptions of bonding, Linear combination of atomic orbitals (LCAO) approach, Hybridization and Bonding. Bonding in homonuclear and heteronuclear diatomic molecules, Bond orders. **Chemistry of Solid:** Classification of solids, Classification of crystalline solids, Crystal lattices and unit cell, seven crystal systems, Bravais's lattices, Number of atoms in a unit cell, packing in solids, Packing efficiency, Density of unit cell, Imperfection in solids, Crystal directions and planes, Crystal diffraction – Bragg's law, Electrical and Magnetic properties **Oxidation and reduction:** Reduction potential; electrochemical series, Redox reactions Balancing of redox equations, Factors affecting redox stability, Frost diagrams for redox reactions, Ellingham diagram and extraction of elements. **Acids and bases:** Arrhenius concept, solvent systems, Brønsted concept, Lux-Flood concept and Lewis's concept; HSAB principle, Superacid, Relative strengths of acids, Acid-base neutralization curves and indicators.		
Module 2: Basics of Stereochemistry	**Hours**	
Introduction, Concept of Isomerism, Classification of Stereoisomers, Optical Isomerism, Chirality & Elements of Symmetry, Wedge formula, Fischer projection, Newmann projection. Relative and absolute configurations, sequence rules, D & L, R & S systems of nomenclature. Understanding with examples for Enantiomers, mesoform, erythro/threo forms, diastereoisomers, inversion, retention, and racemization. Conformational understanding with an example of ethane, n-butane, Cyclohexane and Decalin.	**16**	**2,3**
Module 3: Concepts of Physical Chemistry	**Hours**	
Thermodynamics: Thermodynamic terms, State and path functions. Concept of heat and work. First Law of thermodynamics, Second law of thermodynamics, Third law of thermodynamics, Fundamental concepts	**12**	**4**

of Statistical Thermodynamics - Probability - Partition function - ensembles - Boltzmann distribution. Chemical Equilibria: Law of mass action, thermodynamic derivation of law of chemical equilibrium. derivation of relations between the various equilibrium constants Kp, Kc and Kx (using chemical potential). Ionic Equilibria: pKa, pKb and pH – Buffer solutions. Mechanism of buffer action – Buffer index – Henderson equation – Applications of buffers - Hydrolysis of salts of all types – Degree of hydrolysis – Hydrolysis constant and its relation with Kw - Solubility product and common ion effect.		
Module 4: Basic Chemistry Laboratory Practices	**Hours**	
Laboratory orientation and safety protocols Safe lab practices-PPE, Fire and electrical safety. Chemicals and solvents-Storage and handling, Material Safety Data Sheet (MSDS), Special precautions for hazardous chemicals usage. Segregation and disposal of chemicals-sodium and broken mercury thermometer. Introduction to glassware and equipment in the lab and their working. Emergency response and evacuation- chemical spills, gas leakage and fire. Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkalis - Burns due to phenol and bromine. Scientific ethics in lab-working individually and in a team. Maintaining lab record, Cleanliness and punctuality. 2. Basic principles & experiments related to sample/reagent preparation: practical concept of Molarity, Molality, Normality, equivalence, weight %, vol.%, Preparation of standard solutions, Dilution 0.1 M to 0.001 M solutions. 3. Calibration and use of Electronic Balances, thermometer (using 80-82 °C; Naphthalene, 113.5-114 °C; Acetanilide, 132.5-133°C; Urea, 100 °C; Distilled Water), melting point apparatus (Naphthalene 80-82 °C, Benzoic Acid 121.5-122 °C, Urea 132.5-133 °C, Succinic Acid 184.5-185 ° C, Cinnamic Acid 132.5-133 °C, Salicylic Acid 157.5-158 °C Acetanilide 113.5-114 °C, m-Dinitrobenzene 90 °C p-Dichlorobenzene 52 °C, Aspirin 135 °C) Determination of Boiling Point- Ethanol 78 °C, Cyclohexane 81.4 °C, Toluene 110.6 °C. Working principle of separating funnel, distillation setup,	**16**	**5,6**

centrifuge, hot air oven, magnetic stirrer, rotary evaporator. 4. Separating homo and heterogeneous mixtures- Filtration, Concentration, Evaporation, recrystallisation, sublimation, separating funnel, distillation, chromatography.		

Mode of Transaction	Classroom activities: Recitation, Seminar, Quiz Field activities: Lab-based activities:
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1. D. A. McQuarrie, Quantum Chemistry, Viva Student ed., Viva, 2011.
2. P. Atkins, J. de Paula and J. Keeler, Atkins' Physical Chemistry, 11th ed., OUP, 2018.
3. J. Barrett, Structure and Bonding, Wiley-Royal Society of Chemistry, 2002.
4. T. Engel and P. Reid, Physical Chemistry, 3rd ed., Pearson, 2013.
5. R. J. Silbey, R. A. Alberty and M. G. Bawendi, Physical Chemistry, 4th ed., Wiley Student ed., 2006.
6. J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th ed., Pearson Education, 2006.
7. T. W. G. Solomons, C. B. Fryhle and S. A. Snyder, Solomons' Organic Chemistry, Global Edn., 12th Edn., Wiley International, 2024
8. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 3rd Edn., New age international, 2018
9. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th Edn., New Age International, 2022
10. Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
11. Vogel's Textbook of Practical Organic Chemistry (5th Edition)
12. Vogel's Inorganic Practical Chemistry

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of discipline-specific foundation courses. Students will be empowered with the basic knowledge of chemistry and its significance in the modern world.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Applied Chemistry 2**		
Course Type	**Minor**		
Course Level	100-199		
Course Code	MG2DSCUCH141		
Course Overview	The Applied Chemistry-2 course gives an overview of the chemistry of various commodities which a person uses daily. of how chemistry influences day to day activity of a person. The students get general information about the chemical nature of the food they consume. The course gives an overview of the chemistry of different biomolecules and how they act as building blocks for life. The course will introduce the students to the field of forensic sciences and how chemistry has contributed to its success.		
Semester	1	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Should be familiar with various consumable products (like medicine, fuel, etc)		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the important concepts of the chemical, physical and functional properties of food constituents	R, U	
2	Evaluate and explain how the highly complex nature of food results in biological activities.	R, U, A	
3	Will be able to understand and explain the physical as well as chemical properties of dyes and pigments	A, An	
4	Will get an overview of the development of forensic chemistry.	R, A	
5	Apply fundamental chemistry to solve forensic problems.	U	
6	Will be able to develop an understanding of the chemistry of biomolecules such as proteins and nucleic acids	E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1: Food Chemistry	**Hours**	**CO No**
Food Lipids: Edible fats and Oil, classification and chemical composition Food Carbohydrates: properties and utilization of common polysaccharides, Food minerals: Main elements and trace elements in common food, Enzymes in Food: Importance enzymes available in common food, the effect of inhibitors, pH and temperature on enzymes, Food Additives: Vitamins, Amino acids and Minerals, Aromo compounds, Flavour enhancers, Sugar substitutes, Food colour, Food contaminants: Impact of adulterant on food (melamine, formaldehyde, rhodamine etc) Beverages: Health benefits and its anti-oxidant properties, Food Preservation: Physical and chemical preservation of food	**16**	**1, 2**
Module 2: Dyes and Pigments	**Hours**	
Definition, colour and constitution of dyes- Armstrong theory (quinonoid theory) and its limitations. Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic	**12**	**3**

effect. Modern theories; Valence Bond theory and Molecular Orbital Theory. Requirements and properties of dyes, Classification based on origin: Natural dyes, Synthetic dyes-history and examples, Classification based on chromophore, examples with structure and synthesis, Chemistry of dying and dye industry, Mordants, Classification based on dying process, Analysis of dyes, health and safety aspects, Introduction to Fluorescence and laser dyes. Pigments: Introduction, Natural pigments - Structures of Porphyrins, Bile pigments. Synthetic pigments – Phthalocyanines; synthesis, properties and applications		
Module 3: Forensic Chemistry	**Hours**	
History of Development of Forensic Science: Functions of forensic science. Historical aspects of forensic science. Definitions and concepts in forensic science. Scope of forensic science. Need of forensic science. Basic principles of forensic science, Branches of Forensic science. Forensic Chemistry: Tools and techniques in forensic chemistry, Introduction, Colour & Spot test, microcrystal tests, inorganic and organic analysis. Analysis of Beverages, trace evidence and petroleum products. Classification of commonly encountered drugs and it's analysis. Recent trends in Forensic science - Biometrics in Personal Identification- Role in person Identification, Techniques and Technologies.	**16**	**4, 5**
Module 4: Biomolecules	**Hours**	
Structure and Functions of Biomolecules: Carbohydrates; Lipids; Amino acids and proteins; Nucleic acid: DNA and RNA, Coenzymes and cofactors.	**12**	**6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination

Learning Resources

1. Nanda, B.B. and Tewari, R.K. Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi (2001).
2. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
3. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
4. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
5. R. M. Christie, Colour Chemistry, 2nd Edn., Royal Society of Chemistry, 2012
6. Fennema's Food Chemistry, fourth edition, edited by S. Damodaran, K.L. Parkin, and O. R. Fennema, 2007, published by CRC Press

Relevance of Learning the Course/ Employability of the Course
Applied Chemistry course can help students to work in many designated roles such as Chemistry Content Writer, Scientific Data Entry Specialist, Chemical Business Analyst, Quality Assurance, etc.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**World of Chemistry**		
Course Type	**MDC**		
Course Level	100-199		
Course Code	MG2MDCUCH101		
Course Overview	This multidisciplinary course targets multiciliary leaners and hence provides a fundamental understanding on the significance and importance of chemistry as a central science. The strong influence of chemistry in our daily life is emphasized through various modules. The chemistry in and around us is presented followed by a brief introduction to the chemistry of nature involving biomolecules, natural products and atmospheric processes. The applications of chemistry in various sectors such as petroleum, agrochemicals, pharmaceuticals, forensic and polymer etc is also included. The overall objective of this course to inculcate an appreciation among students about the importance of chemistry		
Semester	2	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	54		

Pre-requisite	A basic idea about the significance and diverse applications of chemistry in our life.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Appreciate the significance of chemistry	U, A	
2	Understand the importance of chemistry in daily life	U An	
3	To familiarise the chemistry involved in natural compounds and processes	U, E	
4	To correlate different segments of atmospheric chemistry & their influences	U, An,	
5	To understand the basics of petroleum, agrochemicals, drugs, and forensic chemistry	U, An	
6	To familiarise with various class of polymeric materials and their applications	A, An	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1: Chemistry as central science	**Hours**	**CO No**
Evolution of chemistry-alchemy, ancient concepts to particulate nature of matter, laws of chemical combination, mole concept, molarity and normality; Branches of chemistry, Atomic structure and chemical bonding, periodic table, Contribution of chemistry to mankind and society, Need for Green Chemistry, 12 principles of Green Chemistry. Chemistry in everyday life: Chemistry everyehere: Agriculture, food, textile, Petrochemicals, medicines, Automobiles, building materials (bricks, marbles, granites, cement, paints and coatings etc), household goods: plastics, rubber, ceramics, steel, wood, electrical and electronics etc; soaps and detergents; Stellar energy : fission and fusion reactions, solar cells.	**10**	**1,2**
Module 2: Chemistry of Nature	**Hours**	

Origin of life, Amino acids, water, Basic elements; Chemistry in and around us, Chemical composition of the earth's atmosphere, Composition of the Human Body and chemical processes, Chemistry of vision; Chemistry of flowers. Biomolecules: Structure and Functions of Biomolecules: Carbohydrates; Lipids; Amino acids and proteins; Nucleic acid: DNA and RNA, Enzymes, plant pigments, cellulose, collagen, vitamins Natural Products and processes: NR latex, Photosynthesis, Phosphorescence and fluorescence, Bioluminescence, Bioinorganic chemistry: Hemoglobin and Myoglobin, Chlorophyll and photosynthesis, Nitrogen fixation and vitamin B12 Atmospheric chemistry: Various segments of atmosphere & their significance, sources and toxic effects of air pollutants, Stratospheric Chemistry-Ozone formation, processes for catalytic decomposition of ozone; Tropospheric Chemistry-Smog, Phototransformation,, Acid rains, sources & sinks, The chemistry of global climate, greenhouse gases & global warming	**20**	**3,4**
Module 3: Applied Chemistry	**Hours**	
Fuels and Petroleum:, classifications: gas, liquid and solid fuels, comparison, properties and methods of fuel processing; Calorific value, Origin and formation of petroleum, Constituents of Petroleum or crude oil, Types of Hydrocarbons and Non- hydrocarbons present in petroleum Agrichemicals: classification of fertilizers, natural fertilizers, nitrogenous fertilizer, Phosphate fertilizers, NPK fertilizers, the effect of fertilizer- pollution. Insecticides classification, DDT, BHC, Gammexane, Endosulfan. Pharmaceuticals: An overview of drugs and drug targets; Basic terminology in drug discovery, IC50, LogP, LogD, MIC, classification of drugs and diseases, structure, functions and applications of common drugs (one example each): Antibiotics, antibacterials, Antiviral drugs, Analgesics and anti inflammatory drugs, non-steroid anti-inflammatory drugs(NSAIDS), ATPase inhibitors and cardiovascular drugs. Forensic chemistry: Introduction, Colour & Spot test, microcrystal tests, inorganic and organic analysis. Analysis of Beverages	**24**	**5, 6**

Polymers: Synthesis, Properties and aapplications of various commodity polymers: Thermoplastics, Resins, elastomers, fibres, silicone polymers; Specialty polymers – Engineering plastics, biomedical polymers; Natural and Synthetic rubbers, vulcanization; Synthetic Fibers: preparation, properties, Rayon, Nylons, Orlon, Teflon.		

Mode of Transaction	Direct Instruction: Lecture, Explicit Teaching, E-learning Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination

Learning Resources

1. Lehninger's Principles of Biochemistry, Cox and Nelson, Fifth Edition (Reference).
2. Eagle's Applied Chemistry - I by S. C. Ahuja & G. H. Hugar, Eagle Prakashan, Jalandhar.
3. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5. An Introduction to Medicinal Chemistry, Graham L. Patrick; Second Edition.
6. F.W.Billmeyer, Text Book of Polymer Science, Wiley interscience, 1976.
7. H. R. Allock, F.W. Lampe. 'Contemporary Polymer Chemistry'. Prentice hall, 1981

Relevance of Learning the Course/ Employability of the Course
Job prospects in Several industrial sector discussed above.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Physical Chemistry**		
Course Type	**Major**		
Course Level	200-299		
Course Code	MG3DSCUCY201		
Course Overview	Understanding the fundamental properties and behaviours of solids and liquids. Understanding the fundamental principles and laws of thermodynamics and learn about the behaviour of gases, liquids, and solids under various conditions. Learn about the various colligative properties and their significance. Analyze the effect of solutes on the properties of solvents. Apply colligative properties to solve real-world chemical problems. Understand the fundamental principles and mechanisms of photochemical reactions. Learn about the interaction of light with matter and the resulting chemical processes		
Semester	3	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60	0	
Pre-requisite	Basic knowledge about states of matter		

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains**	**PSO No.**
	*Upon completion of this course, students will be able to**;***		

1	Will understand the concepts of Viscosity and Surface tension and will be able to correlate them in real-life application	R, U	
2	Understand the principle of X-ray diffraction and apply it to indices diffraction patterns	R, U, A	
3	Able to understand the laws of thermodynamics and solve problems involving heat and work.	A, An	
4	Will be able to apply the principles of colligative properties in real-life	U A E	
5	Understand the significance of Jablonski diagram	R U	
6	Will be able to understand different photophysical process and how and why it happens	E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Liquid and Solid State	**Hours**	**CO No**
Quantum Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.	**16**	**1**
Module 2: Thermodynamics	**Hours**	
Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state. Partial molar quantities, the dependence of thermodynamic parameters on composition; Gibbs-	**16**	**2,3**

Duhem equation, the chemical potential of ideal mixtures, change in thermodynamic functions in the mixing of ideal gases.		
Module 3: Colligative Properties	**Hours**	
Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.	**12**	**4**
Module 4: Fundamentals of Photochemistry	**Hours**	
Frontier Molecular orbitals of simple molecules like ethene, 1,3-butadiene, 1,3,5-hexatriene, Jablonski diagram, Photon Absorption, electronic excitation, photochemical laws- Grotthuss- Draper law and Stark–Einstein law, characteristics of electronically excited states-life times, Energy dissipation by radiative and non-radiative processes, absorption spectra, Emission spectra, Fluorescence and photosphorescence, Franck-Condon principle, Photochemical stages- primary and secondary processes, the process of photosensitization, photochemistry in biological processes, photochemistry of vision.	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1. D. A. McQuarrie, Quantum Chemistry, Viva Student ed., Viva, 2011.

2. P. Atkins, J. de Paula and J. Keeler, Atkins' Physical Chemistry, 11th ed., OUP, 2018.
3. J. Barrett, Structure and Bonding, Wiley-Royal Society of Chemistry, 2002.
4. T. Engel and P. Reid, Physical Chemistry, 3rd ed., Pearson, 2013.
5. R. J. Silbey, R. A. Alberty and M. G. Bawendi, Physical Chemistry, 4th ed., Wiley Student ed., 2006.
6. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
7. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
8. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
9. G. Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall of India, 2001.
10. H. Kaur, Spectroscopy, 6th Edn., Pragati Prakashan, 2011.
11. Organic Chemistry, Carey and Sundberg
12. Advanced organic chemistry by J March

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of practical application and quality control-related jobs. This course provides the fundamental knowledge which is necessary to understand the formation of substance, the nature of the substance etc.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Organic Chemistry 1**		
Course Type	**Major**		
Course Level	200-299		
Course Code	MG3DSCUCY202		
Course Overview	Understand the fundamental principles of organic synthesis, Learn the key reactions and mechanisms in organic chemistry		
Semester	3	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Naming of Organic compounds and Basic Steriochemistry		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		

1	Will understand the steps involved in forming and breaking chemical bonds	R, U	
2	Analyze and predict the mechanisms of organic reactions	R, U, A	
3	Able to design multi-step synthetic routes for target molecules	A, An	
4	Understanding various factors affecting the organic reactions	U A E	
5	Identifying different reagents and reaction conditions for organic synthesis. Will be able to apply this skill for evaluating synthetic and biochemical reactions	E, S	
6	Will be able to apply the organic synethsis for real-world applications	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Basic Organic Synthesis and Principles	**Hours**	**CO No**
Alkanes: Preparation by reduction of alkyl halides, Wurtz reaction and Kolbe‘s electrolytic methods with mechanism; Alkenes: preparation by dehydration of alcohols, dehydrohalogenation of alkylhalides, dehalogenation of vicdihalides and by Kolbe‘s electrolytic method. Alkynes: Preparation by dehydrohalogenation of vic-dihalides and gem-dihalides, dehalogenation of tetrahalides. Reactions: addition reactions with hydrogen, halogens, hydrogen halide (markownikoffs rule, peroxide effect), hydroboration, ozonolysis, hydroxylation with KMnO4, allylic substitution by NBS.	**16**	**1**
Module 2: Organic Reactions	**Hours**	
SN_1 and SN_2 reaction mechanism: effects of structure, substrate, solvent, nucleophile and leaving groups. Mechanisms of E_1 and E_2 reactions, Hoffmann and Saytzeffs rules cis and trans eliminations, Elimination Vs substitution. Addition reactions.	**16**	**2,3**
Module 3: Aromaticity and Aryl Compounds	**Hours**	
Aromatic hydrocarbons and aromaticity, resonance in benzene, Huckel's (4n+2) rule and its simple applications. Acidic character of phenols - explanation based on resonance stabilization. Electrophilic	**12**	**4**

substitution reactions in aromatic compounds. ortho/para/meta directive influence with examples. Activating and deactivating groups with examples. Benzyne mechanism The aryl group, Aromatic nucleus and side chain, Side chain reactions of benzene derivatives, Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.		
Module 4: Alcohols and Phenols	**Hours**	
Methods to distinguish between Primary, secondary and tertiary alcohols (Lucas, Victor Meyer's and oxidation method). Preparation of monohydric alcohols from carbonyl compounds using Grignard reagents, reduction of aldehydes, ketones, carboxylic acids and esters,Rosenmund's reduction, Hydrogen bonding, Acidic nature, Reactions of alcohols.Dihydric alcohols: methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO4] and pinacol-pinacolone rearrangement. Trihydric alcohols: methods of formation, reactions of glycerol. Nomenclature, structure and bonding of phenols, Preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, Reactions of phenols - electrophillic aromatic substitution, acylation and carboxylation Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch, Lederer-Manasse and Reimer-Tiemann reaction	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature

	2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1. Organic Chemistry by T. W. Graham Solomons, Craig B. Fryhle and Scott A. Snyder, Twelfth Edition, Wiley, 2016.
2. Advanced organic chemistry by J. March, 6th Ed.
3. Advanced organic chemistry part-A. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)
4. Organic Chemistry, J. Clayden, N. Greeves, S Warren, P. Wothers, Oxford University Press, Oxford, 2001
5. Principle of Organic Synthesis, Third Edition, Richard Norman and James M. Coxon.

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of understanding the structure, properties, and reactions of organic compounds and materials. Students can find jobs in Pharmaceuticals, Biochemistry, Environmental Science, Agricultural sector etc.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Inorganic Chemistry**		
Course Type	**Major**		
Course Level	200-299		
Course Code	MG3DSCUCY203		
Course Overview	This course integrates key topics in inorganic chemistry, material science, and nuclear chemistry, providing students with a comprehensive understanding of the properties, behaviors, and applications of main group elements, metallurgy, inorganic polymers, and nuclear reactions. This multidisciplinary approach highlights the crucial role of these areas in modern science and technology, from materials manufacturing to energy production and nuclear safety. By the end of the course, students will have a strong foundation in the behavior and applications of main group elements, the practical principles of metallurgy, and the Structure-Property Relationships in emerging field of inorganic polymers, empowering them to contribute to innovations in materials science, energy production, and the safe application of nuclear technology.		
Semester	3	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	

	60	
Pre-requisite	Students should be comfortable with basic concepts in chemical reactions, atomic structure, thermodynamics, and bonding, as these concepts are integral to understanding the behavior of elements, the processes in metallurgy, and the chemistry of inorganic polymers.	

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome** *Upon completion of this course, students will be able to;*	**Learning Domains**	**PSO No.**
1	understand the chemistry of main group elements and their significance in biological, environmental and industrial contexts.	R, U	
2	learn the structure, properties, and applications of inorganic polymers and their role in advanced materials science.	U, A, An	
3	to explore the fundamental principles and applications of metallurgy, focusing on metal extraction, processing, and alloying.	U, A, An	
4	familiarize fundamental concepts of nuclear chemistry, focusing on radioactive decay, nuclear reactions, and their applications in energy and medicine	U A E	
5	will be capable of applying their theoretical knowledge to practical scenarios, including the synthesis of inorganic compounds, the selection of materials for industrial processes, and the	An,E	
6	Make them capable to design new materials with specific properties.	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S))

COURSE CONTENT

Module 1: Chemistry of Main group elements	**Hours**	**CO No**
S-block elements: The chemistry of hydrogen, extraction of alkali metals and alkaline earth metals, anomalous properties of s-block elements, chemical properties (important hydrides, hydroxides, oxides), alkali and alkaline earth metal complexes, biological importance of Na, K, Mg and Ca. *P-block elements:* Important compounds of boron and aluminium (boron hydride, boranes, diborane, Wades rule, borazine, boric acid, boron-nitrogen compounds, trihalides of B and Al), allotropes of carbon, structure and properties of graphite and diamond, fullerenes, silica, silicates, zeolites, oxoacids of phosphorous, sulphur and halogens, phosphazenes, phosphines, ozone, structure and bonding in interhalogen compounds, polyhalides Noble gases: Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of Xenon compounds. (XeF2, XeF4 and XeF6XeO3, XeO2F2, XeOF4, XeO4, XeO3F2 and [XeO6]4-), Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).	**22**	**1**
Module 2: Inorganic Polymers	**Hours**	
Types of inorganic polymers, comparison with organic polymers, synthesis and applications of polymers containing inorganic atoms: Main group containing polymers: polysiloxanes, polysilanes, Borazines polyphosphazenes, Polysulphates structure, and synthesis and preparation of Transition metal containing polymers., Organic-inorganic hybrid materials Organometallic magnets Metal coordination polymers (metal-organic frameworks), importance of supramolecular compounds in main group chemistry	**10**	**2,3**
Module 3: General Principles of metallurgy	**Hours**	
Types of metallurgy : extractive metallurgy, physical metallurgy, and mechanical metallurgy Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal	**12**	**4**

oxides using carbon and carbon monoxide as reducing agents. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.		
Module 4: Fundamentals of Nuclear chemistry	**Hours**	
Fundamentals of Nuclear chemistry, Radioactivity and radioactive decay: The theory of radioactive disintegration, and how an unstable atomic nucleus loses energy through radiation. Nuclear structure and stability: The structure of the nucleus and how it is stable, Nuclear reactions: The four main types of nuclear reactions: fission, fusion, nuclear decay, and transmutation	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva-Voce

Learning Resources

Relevance of Learning the Course/ Employability of the Course
This course is designed for undergraduate and graduate students in chemistry, materials science, engineering, and related disciplines who wish to deepen their knowledge of inorganic chemistry and materials technology.

References:

1. Principles of Inorganic chemistry by B.R Puri, L.R Sharma and K C Kalia
2. Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr
3. Concise in Inorganic chemistry by J.D. Lee
4. Essentials of nuclear chemistry by H J Arnikar
5. Nuclear Chemistry: For BSc & MSc Students of Indian Universities by C V Shekar

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Advanced Chemistry 1**		
Course Type	**Minor**		
Course Level	200-299		
Course Code	MG3DSCUCH221		
Course Overview	The course is designed to provide comprehensive knowledge about materials defined by nanoscale dimensions and their diverse applications Further, the course gives an overview of how materials are designed to have specific functional properties and their wide-ranging applications. Finally, the course will touch upon characterization techniques which is commonly used for material characterization.		
Semester	3	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Basic knowledge about main group elements		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the fundamentals of nanomaterials	R, U	
2	Understand the physical and chemical properties, will be able to analyse and evaluate the variation in properties with size	U, An, E	
3	Gain the idea of surface plasmon resonance (SPR) and its effect on colour of metal nanoparticles	U, An	
4	Familiarise various synthesis methods of nanaomaterials	U, R, A	
5	Develop knowledge on various low-dimensional solids	U, R	
6	Understand different techniques for nanomaterial characterization and will be able to apply these tools for evaluating nanomaterials	U, S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Nanomaterials	**Hours**	**CO No**
Definition of nanomaterial. Classification of nanomaterials (0D, 1D, 2D and 3D). Nanocrystals and Nanoclusters. Surface area. Size effect on material properties (optical, electronic, chemical, mechanical and magnetic). Colour of metal nanoparticles, Surface Plasmon resonance. Synthesis of nanomaterials Top down and bottom up approaches Physical methods: Mechanical milling and Sputtering, Chemical methods: Chemical reduction and Sol-gel method. Special nanomaterials: CNT, Fullerene, Quantum dots.	**16**	**1**
Module 2: Functional Materials	**Hours**	

Ceramics, composites, polymers, and glasses, Mechanical, electrical, thermal, and optical properties, Understanding the correlation between structure and properties, Case studies of functional materials	**16**	**2,3**
Module 3: Characterization techniques of nanomaterials	**Hours**	
Morphological analysis: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM). Spectroscopic methods: UV-Vis spectroscopy. Scanning Probe method: Atomic Force Microscope (AFM). X-ray Diffraction Analysis (XRD), Dynamic Light Scattering (DLS), Surface area and porosity - Brunauer-Emmett-Teller (BET).	**12**	**4**
Module 4: Application	**Hours**	
Energy harvesting and storage, Healthcare and biomedical applications, Electronics and information technology, Innovations in functional materials	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1. N. R. Rao, A. Muller, A. K. Cheetham, The Chemistry of Nanomaterials, Vol 1 &2, John Wiley & Sons, 2005.
2. G. L. Hornyak, J. Dutta, H. F. Tibbals, A. K. Rao, Introduction to Nanoscience, CRC Press, 2008.
3. G. L. Hornyak, H. F. Tibbals, J. Dutta, J. J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
4. J. E. Huheey, R. A. Keiter, R. L. Keiter, Inorganic Chemistry-Principles of Structure and Reactivity. Prentice Hall, 1997.
5. Nanostructures and Nanomaterials- Synthesis, Properties & applications by Guozhong Cao, Imperial College Press, 2006.
6. Nanomaterials and Nanochemistry by C. Brechignac.P. Houdy M. Lahmani SpringerVerlag, 2007.
7. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International, 1986.
8. J.M.G. Cowie, V. Arrighi, Polymers: Chemistry and Physics of Modern Materials, 3rd Edn., CRC Press, 2008.
9. F.W. Billmeyer, Text Book Of Polymer Science, 3rd Edn., Wiley, 1984.
10. P.J. Flory, Principles of Polymer Chemistry, Cornel University Press, 1953.

Relevance of Learning the Course/ Employability of the Course
This course is crucial for advancing technology and society in various innovative and sustainable ways. Students can find jobs in electronics and semiconductor industry, energy sector etc

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**The Fascinating world of gels**		
Course Type	**MDC**		
Course Level	200-299		
Course Code	MG3MDCUCH201		
Course Overview	It deals with the significance of gels and how their physical and chemical properties are unique. Briefs about various synthesis methods for Gels, how it is characterized and its applications		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Basic Chemistry		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.

	*Upon completion of this course, students will be able to**;***		
1	Understand the physical and chemical properties of Gels	R, U	
2	Remember how gels are classified	R, U, A	
3	Unserstand the significance and applications of hydrogels	A, An	
4	Enable them to synthesise and characterize gels	S	
5	How gels can be used in Biomedical application	S	
6	How gels can be used in Industrial and environmental applications	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Introduction to Gels	**Hours**	**CO No**
Definition and properties of the gel, Network structure and molecular interactions, Rheological, Swelling, and mechanical behaviour, Stimuli responsiveness and reversibility, Identification of gel-vial inversion test, Classification of gels Gelation mechanisms and theories. Polymer gel and Low molecular weight gels (LMWGs) Significance of hydrogels	**15**	**1, 2**
Module 2: Synthesis and Characterization of gels	**Hours**	
Chemical methods, Physical methods, Biological methods, Spectroscopic techniques, Microscopic techniques, Mechanical and rheological studies, Thermal and swelling studies	**15**	**3,4**
Module 3: Applications of gels	**Hours**	
Biomedical applications: Drug delivery, tissue engineering, wound healing, Industrial applications: Food additives, cosmetics, energy storage, contact lens, food packaging, 3-D printing, personal hygiene products, Environmental applications: Water purification, oil recovery, agriculture applications	**15**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1) Fundamentals and Applications of Polymer Gels, Ronald A. Siegel
2) Polymer gels, Fundamentals and Biomedical application, Danilo DeRossi,
3) Supramolecular Gels, Materials and emerging applications, Tifeng Jiao

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of practical application. Students can find jobs in Industry especially dealing with biomedical, food, and everyday consumables (like cosmetics, contact lenses, diapers etc).

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Chemistry for Sustainable Society**		
Course Type	**VAC**		
Course Level	200-299		
Course Code	MG3VACUCH201		
Course Overview	The course is designed to provide students with a thorough understanding of how chemistry can contribute to sustainability		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	45		
Pre-requisite	Understanding of basic chemistry principles, Familiarity with environmental science concepts		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.

	Upon completion of this course, students will be able to;		
1	Aware of the socioeconomic consequences of tragedies related to chemicals and radiation	R, U	
2	Learn about possible hazards associated with chemicals and radiation	R, U, A	
3	Identifying and analyzing risks and vulnerabilities	A, An	
4	Able to develop techniques which can mitigate disaster	U A E	
5	Understand sustainable development goals	S	
6	Learn about the role of chemistry in developing sustainable society	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Global Tragedies	**Hours**	**CO No**
An insight into significant global tragedies, Bhopal Gas Tragedy, Chernobyl and Fukushima Nuclear Accident, Minamata Disease, Endosulfan tragedy in Kerala, Halifax Explosion, the Texas City Disaster	**15**	**1**
Module 2: Disaster Management	**Hours**	
Mitigation of Industrial/chemical accidents, oil spills, nuclear accidents, urban fires, battery fires, ionising radiation exposure, warning systems, training, Risk assessment	**15**	**2,3**
Module 3: Sustainability	**Hours**	
Sustainable development goals, Role of Chemistry in sustainability, Green Chemistry, Renewable Energy, Waste Reduction, Clean Water, Biodegradable Materials. Use of modern technologies for sustainability	**15**	**4**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:**

	Lab-based activities:
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1) Global Disaster Management Challenges and Reactions, Bhimal Dhawan
2) World's Worst…Chemical Disasters Rob Alcraft
3) Sustainable Chemistry, G Reniers, WIT Press

Relevance of Learning the Course/ Employability of the Course
The course equips students with critical skills and knowledge for responding to and mitigating the impacts of various disasters. Graduates can find roles in government, industry, academic research, environmental consultancies, and think tanks as experts in green and sustainable chemistry

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Inorganic and Physical Chemistry**		
Course Type	**Major**		
Course Level	200-299		
Course Code	MG4DSCUCY201		
Course Overview	This advanced course provides a detailed introduction to quantum mechanics, focusing on its principles, mathematical formulations, and the various approximation methods used to solve complex quantum systems.The course also emphasizes the role of quantum mechanics in understanding chemical bonding in molecules and materials. Significance of symmetry and group theory and its applications towards spectroscopy will also be discussed. By the end of the course, students will have a solid foundation in quantum mechanics and its approximation methods, an appreciation for the role of symmetry and group theory in chemical analysis, and a deep understanding of how quantum mechanics explains the nature of chemical bonding. This knowledge will prepare them for advanced research and work in computational chemistry, molecular modeling, spectroscopy, and materials design.		
Semester	4	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		

Pre-requisite	To succeed in a course on Quantum Mechanics and Approximation Methods in Quantum Mechanics, students should have a strong foundation in mathematics (calculus, linear algebra, differential equations, and complex numbers), classical mechanics, and electromagnetism. Familiarity with classical wave theory,and an introductory understanding of quantum concepts.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	understand the core principles and mathematical foundations of quantum mechanics.	U,A, E	
2	learn to apply Schrödinger equation to simple systems such as the free particle, particle in a box, harmonic oscillator and rigid rotor and the hydrogen atom.	U, A, An	
3	To explore approximation methods that simplify quantum mechanical solutions for systems with many particles or complicated interactions.	A, An,E	
4	Significance of symmetry in chemical bonding	U A E	
5	Predict the vibrational modes in molecule	U S	
6	Predict the stability of conjugated organic molecules	U An E	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Foundation of Quantum Mechanics	Hours	CO No
Postulates of quantum mechanics, Schrödinger equation and its application to particles in 1-D box (complete solution) - quantization of energy levels, zero-point energy, probability distribution functions, nodal properties. Extension to 3-D boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave	**16**	**1,2**

functions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total momentum and z-component. Rigid rotator model of rotation of diatomic molecule: Schrödinger equation, transformation to spherical polar coordinates. Separation of variables (Preliminary treatment). The Hydrogen Atom, separation of variable, Radial wavefunction, spherical harmonics, polar diagrams, complete solutions and energies, orbitals and quantum numbers. Spin orbitals:Construction of spin orbitals from orbitals and spin functions,spin orbitals for many electron atoms, symmetric and antisymmetric wave functions. Pauli's exclusion principle,Slater determinants. Atomic and molecular term symbols.		
Module 2: Approximation Methods in Quantum Mechanics	**Hours**	
Quantum Theory of Hydrogen-like Atoms, Many-body problem and the need of approximation methods, independent particle model. Variation method:Variation theorem with proof, variation treatment for the ground state of the helium atom. Perturbation method, time-independent perturbation method (non-degenerate case only), first order correction to energy and wave function, illustration by application to particle in a 1D-box with slanted bottom, perturbation treatment of the ground state of the helium atom. Hartree-Fock method,multi-electron atoms. Hartree-Fock equations (no derivation). The Fock operator, core hamiltonian, coulomb operator and exchange operator.Qualitative treatment of Hartree-Fock Self-Consistent Field (HFSCF) method. Roothan's concept of basis functions, Slater type orbitals (STO) and Gaussian type orbitals (GTO), sketches of STO and GTO.	**16**	**2,3**
Module 3: Symmetry & Group Theory	**Hours**	
Introduction to Elements of symmetry of molecules (Identity, proper axis of rotation, plane of symmetry, centre of symmetry and improper axis of rotation) – corresponding symmetry operations – Schoenflies notation – binary combinations of symmetry operations. Rules for a set of elements to form a mathematical group - point group classification Group multiplication table, Great Orthogonality Theorem, Reducible and Irreducible representation, Character table, application of group theory in Vibrational Spectroscopy	**12**	**4**
Module 4: Chemical Bonding	**Hours**	

Molecular Orbital Theory, Molecular Orbitals of homonuclear and heteronuclear diatomic molecules, Identifying Molecular Orbital symmetries, Symmetry Adapted Linear Combination (Bend and Planar Molecules). treatment of H2+ . Bonding and antibonding orbitals. Qualitative extension to H2. Comparison of LCAO-MO and VB treatments of H2 (only wave functions, detailed solution not required) and their limitations. Localized and non-localized molecular orbitals treatment of triatomic (BeH2, H2O) molecules Huckels Molecular Orbital Theory, Setting up the Huckel secular determinant, Solving the HMO determinantal equation for orbital energies.	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

Relevance of Learning the Course/ Employability of the Course
Quantum mechanics is the foundational theory that explains the behavior of matter and energy at microscopic scales. It provides insight into the structure of atoms, molecules, and subatomic particles. Mastery of quantum mechanics is essential for anyone pursuing research in physics, chemistry, or material science, as it helps explain phenomena that cannot be understood using classical physics, such as atomic spectra, quantum tunneling, and particle-wave duality.Understanding fundamental phenomena is essential for designing advanced materials and systems, and driving new technologies such as quantum computing, renewable energy, and nanotechnology

References:

1. Principles of Physical chemistry by B.R Puri, L.R Sharma and K C Kalia
2. Quantum Chemistry by Levine
3. Quantum Chemistry by A. K Chandra
4. Quantum Mechanics by R.K Prasad
5. Chemical applications of group theory, F Albert Cotton

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Organic Chemistry II**		
Course Type	**Major**		
Course Level	200-299		
Course Code	MG4DSCUCY202		
Course Overview	Learn about various functional groups and understand the mechanism of reactions involving		
Semester	4	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Basic Organic Chemistry, naming compounds		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Understand the structure propoperties of different functional group	R, U	

	Name different functional groups using IUPAC rules.		
2	Learn various preparation methods for introducing functional groups	R, U, A	
3	Analyze the mechanisms of reactions involving these functional groups	A, An	
4	Apply knowledge to real-world organic synthesis problems.	U A E	
5	Understand the importance and applications of these compounds in industry and research	S	
6	Enabling students for laboratory experiments to prepare various compounds	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Ethers, Epoxides, Aldehydes and Ketones	**Hours**	**CO No**
Nomenclature and methods of formation, physical properties, Chemical reactions: cleavage and autoxidation, Zeisel's method. Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides. Preparation of aldehydes and ketones, Oppeanauer oxidation. Synthesis of aldehydes and ketones from acid chlorides, 1,3-dithianes, nitriles and carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group: Perkin and Knoevengel condensations, Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction, Use of acetals as protecting group. Reactions of aldehydes and ketones (Reduction using LiA1H4, Clemensen and Wolf-Kishner reduction, reaction with alcohols) Baeyer-Villiger oxidation, Meerwein-PondorofVerley, Clemmensen, and NaBH4 reductions, Mechanism of Aldol condensation, Cannizzaro's reaction, Reimer – Tiemann reaction, Perkin's reaction, Benzoin condensation.	**16**	**1**
Module 2: Carboxylic Acids & Derivatives	**Hours**	
Acidity of Carboxylic Acids, Effects of Substituent's on Acid Strength. Preparation and reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Mechanisms of esterification and hydrolysis (acidic and basic). Reduction of carboxylic acids, Mechanism of decarboxylation, effect of heat and dehydrating agents, methods of formation and chemical	**16**	**2,3**

reactions of unsaturated monocarboxylic acids, Dicarboxylic acids, haloacids, hydroxy acids-Malic, tartaric & citric acid and acid anhydrides. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.		
Module 3: Alkanes, Cycloalkanes, Alkyl and Aryl Halides	**Hours**	
Corey House reactions and decarboxylation of carboxylic acids, Mechanism of free radical halogination of alkanes, Cycloalkanes: Nomenclature, methods of preparations, chemical reactions, Bayer's strain theory and its limitations, Ring strain in cyclopropane and cyclobutanes, Theory of stainless rings. The case of cyclopropane ring: banana bonds. Methods of formation alkyl halide, Mechanisms of nucleophilic substitution reactions of alkyl halides, substitution at the allylic and vinylic positions of alkenes, Mechanisms of elimination reactions of alkyl halides. Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition, mechanisms of nucleophilic aromatic substitution reactions.	**12**	**4**
Module 4:: Alkenes, Cycloalkenes, Dienes and Alkynes	**Hours**	
Regio-selectivity: Saytzeff rule, Hoffmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes: hydroboration-oxidation, oxymercuration-reduction, Epoxidation, hydration, polymerization of alkenes, Substitution at the allylic and vinylic positions of alkenes. Cycloalkenes: conformation, synthesis, and chemical reactions. Dienes: nomenclature, isolated, conjugated and cumulated dienes: structure, method of formation, polymerization, chemical reaction-1,2 and 1,4 additions, diels-alder reaction. Alkynes: hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test

	Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1. Organic Chemistry by T. W. Graham Solomons, Craig B. Fryhle and Scott A. Snyder, Twelfth Edition, Wiley, 2016.
2. Advanced organic chemistry by J. March, 6th Ed.
3. Advanced organic chemistry part-A. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)
4. Organic Chemistry, J. Clayden, N. Greeves, S Warren, P. Wothers, Oxford University Press, Oxford, 2001
5. Principle of Organic Synthesis, Third Edition, Richard Norman and James M. Coxon.

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of understanding the structure, properties, and reactions of organic compounds and materials. Students can find jobs in Pharmaceuticals, Biochemistry, Environmental Science, Agricultural sector etc.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Spectroscopic Methods in Chemistry**		
Course Type	**Major**		
Course Level	200-299		
Course Code	MG4DSCUCY203		
Course Overview	This course is designed at providing students with theoretical concepts of various spectroscopy, i.e., Atomic, Molecular, Vibrational, Raman, NMR, EPR, Mossbauer and electronic to analyses the molecular and electronic structure of atoms and molecules. Interaction of light with molecules, spectral transitions, and theoretical explanation of spectral data will be discussed. Students will be able to use quantum mechanics and group theory principles to understand molecular spectra; Also, they will be able to identify the relationship between molecular spectra and molecular properties which will helps the students to analyses the structure of atoms and molecules using spectroscopic methods.		
Semester	4	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Knowledge of Electromagnetic spectrum, Basic Mathematics, Structure of atom		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the fundamental principles of spectroscopy	R, U	
2	Understand the principle of magnetic resonance spectroscopy	R, U, A	
3	Analyse and interpret spectroscopic data	A, An	
4	Apply spectroscopic techniques to molecular structure determination	U A E	
5	Integrate spectroscopic and analytical techniques to solve problems	S	
6	Data analysis and interpretation	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Fundamentals of Spectroscopy	Hours	CO No
Introduction to Spectroscopy, Electromagnetic spectrum and its characteristics, intercation of electromagnetic radiation with matter (elastic and innelastic scattering) Origin of different spectra, intensity of absorption signal-to-noise ratio, natural line width, influencing factors spectral intensity-Transition Probability, Maxwell-Boltzmann Distribution, Collision broadening, Doppler broadening, Lamb dip spectrum, Beers-Lamberts law Born Oppenheimer approximation, energy dissipation from excited states, relaxation time. Rotational Spectroscopy: Rigid rotor- Expression for energy- Selection rules- Intensities of spectral lines, Instrumentation Vibrational Spectroscopy: Simple harmonic oscillator - Energy levels -Force constant- Selection rules - Anharmonicity -Fundamental frequencies - Overtones – Fingerprint- Group frequency concept -Degree of freedom for polyatomic molecules -Modes of vibrations, Instrumentation Raman Spectroscopy: Basic principles -concept of polarizability- Qualitative treatment of pure rotational - Vibrational Raman spectra - Stokes & anti-stokes lines and their intensity difference - Selection rules - Mutual exclusion principle.	**20**	**1**

Electronic Spectroscopy: Basic principles-Frank-Condon principle -Electronic transitions- Beer Lamberts law, -Chromophore and auxochrome- Bathochromic and hypsochromic shifts. Instrumentation Introduction to Moessbauer spectrsocopy		
Module 2: Magnetic Resonance Spectroscopy and Mass Spectroscopy	**Hours**	
Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR & 13C NMR- Principle-Number and position of signals, Chemical shift, Different scales, Spin-spin coupling (qualitative concept). Instrumentation Electron Spin Resonance (ESR) Spectroscopy: Principle-Hyperfine structure, instrumentation Principles of mass spectrometry: Ion production methods: Electron ionization (EI), chemical ionization (CI), Soft ionization methods: SIMS, FAB, MALDI, and DI; electron spray ionization (ESI).	**20**	**2,3**
Module 3: Instrumental Methods of Analysis	**Hours**	
Principle, and applications of following spectrophotometers - Atomic Absorption Spectroscopy (AAS), Flame Emission Spectroscopy -Colorimetry -Spectrophotometry, Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Thermogravimetry (TGA), Differential Scanning Calorimetry (DSC)	**12**	**4**
Module 4: Introduction to structure elucidation	**Hours**	
Overview of structure elucidation, Identification of structures of organic and inorganic compound based on the data UV-Vis, IR, 1H NMR, 13C NMR, EPR, and Mass spectroscopy.	**8**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature

	2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1) C.N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy.
2) W. Kemp, Organic Spectroscopy.
3) R.M. Silverstein, G.C. Bassler, T.C. Morril, Spectroscopic Identification of Organic Compounds, Wiley.

Relevance of Learning the Course/ Employability of the Course
It is highly relevant due to its broad range of applications and the critical skills it imparts. Students can find jobs in healthcare and medicine, environmental protection, food and agriculture, forensics, industry and manufacturing.

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Analytical Chemistry**		
Course Type	**Minor**		
Course Level	200-299		
Course Code	MG4DSCUCH221		
Course Overview	This course is designed at providing students with theoretical concepts of various spectroscopy, i.e., Atomic, Molecular, Vibrational, Raman, NMR, EPR, Mossbauer and electronic to analyses the molecular and electronic structure of atoms and molecules. Interaction of light with molecules, spectral transitions, and theoretical explanation of spectral data will be discussed. Students will be able to use quantum mechanics and group theory principles to understand molecular spectra; Also, they will be able to identify the relationship between molecular spectra and molecular properties which will helps the students to analyses the structure of atoms and molecules using spectroscopic methods.		
Semester	4	**Credit**	4
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	60		
Pre-requisite	Knowledge of Electromagnetic spectrum, Basic Mathematics, Structure of atom		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domains	PSO No.
1	Understand the fundamental principles of spectroscopy	R, U	
2	Understand the principle of magnetic resonance spectroscopy	R, U, A	
3	Analyse and interpret spectroscopic data	A, An	
4	Apply spectroscopic techniques to molecular structure determination	U A E	
5	Integrate spectroscopic and analytical techniques to solve problems	S	
6	Data analysis and interpretation	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1:Fundamentals of Spectroscopy	Hours	CO No
Introduction to Spectroscopy, Electromagnetic spectrum and its characteristics, intercation of electromagnetic radiation with matter (elastic and innelastic scattering) Origin of different spectra, intensity of absorption signal-to-noise ratio, natural line width, influencing factors spectral intensity-Transition Probability, Maxwell-Boltzmann Distribution, Collision broadening, Doppler broadening, Lamb dip spectrum, Beers-Lamberts law Born Oppenheimer approximation, energy dissipation from excited states, relaxation time. Rotational Spectroscopy: Rigid rotor- Expression for energy- Selection rules- Intensities of spectral lines, Instrumentation Vibrational Spectroscopy: Simple harmonic oscillator - Energy levels -Force constant- Selection rules - Anharmonicity -Fundamental frequencies - Overtones – Fingerprint- Group frequency concept -Degree of freedom for polyatomic molecules -Modes of vibrations, Instrumentation Raman Spectroscopy: Basic principles -concept of polarizability- Qualitative treatment of pure rotational - Vibrational Raman spectra - Stokes & anti-stokes lines and their intensity difference - Selection rules - Mutual exclusion principle.	**16**	**1**

Electronic Spectroscopy: Basic principles-Frank-Condon principle -Electronic transitions- Beer Lamberts law, -Chromophore and auxochrome- Bathochromic and hypsochromic shifts. Instrumentation Introduction to Moessbauer spectrsocopy		
Module 2: Magnetic Resonance Spectroscopy and Mass Spectroscopy	**Hours**	
Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR & 13C NMR- Principle-Number and position of signals, Chemical shift, Different scales, Spin-spin coupling (qualitative concept). Instrumentation Electron Spin Resonance (ESR) Spectroscopy: Principle-Hyperfine structure, instrumentation Principles of mass spectrometry: Ion production methods: Electron ionization (EI), chemical ionization (CI), Soft ionization methods: SIMS, FAB, MALDI, and DI; electron spray ionization (ESI).	**16**	**2,3**
Module 3: Instrumental Methods of Analysis	**Hours**	
Principle, and applications of following spectrophotometers - Atomic Absorption Spectroscopy (AAS), Flame Emission Spectroscopy -Colorimetry -Spectrophotometry, Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Thermogravimetry (TGA), Differential Scanning Calorimetry (DSC)	**12**	**4**
Module 4: Introduction to structure elucidation	**Hours**	
Overview of structure elucidation, Identification of structures of organic and inorganic compound based on the data UV-Vis, IR, 1H NMR, 13C NMR, EPR, and Mass spectroscopy.	**16**	**5,6**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature

	2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1) C.N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy.
2) W. Kemp, Organic Spectroscopy.
3) R.M. Silverstein, G.C. Bassler, T.C. Morril, Spectroscopic Identification of Organic Compounds, Wiley.

Relevance of Learning the Course/ Employability of the Course
It is highly relevant due to its broad range of applications and the critical skills it imparts. Students can find jobs in healthcare and medicine, environmental protection, food and agriculture, forensics, industry and manufacturing

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Basic Computation Skills for Science**		
Course Type	**SEC**		
Course Level	200-299		
Course Code	MG4SECUCH201		
Course Overview	Develop skills in using computational tools and software for presenting data and to solve scientific problems		
Semester	3	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	15		
Pre-requisite	Knowledge to operate computer		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		
1	Learn how to write and format research manuscript	U A C, S	

2	Learn to create and present high quality slides and graphs	U A C S	
3	Understand how to effectively use software tools to analyse scientific data	A, An	
4	Sort and arrange literature database	U A S	
5	Extract, analyse and compare scientific database	C, An E	
6	Learn about ethics in data analysis	R, A	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1:Preparation of manuscript and presentation	**Hours**	**CO No**
Preparation of manuscript: Effectively use tables, numbering and bulleting, equations, table of contents, and references. Mathematical functions, Statistical functions, Calculations, Sort and Filtering, Conditional Formatting, High-Quality data presentation (Graphs and Chart), Creating slides, presentation and animations	**15**	**1**
Module 2: Scientific data reduction and analytic software	**Hours**	
ChemDraw: Molecular Visualization, MestReNova: NMR data analysis, Diamond: Crystal Structure Visualization, Fullprof for Rietveld refinement	**15**	**2,3**
Module 3: Scientific and Literature Database	**Hours**	
ICSD for generating Crystallographic information files, IR, UV, NMR, and Mass database. Endnote, Mendeley and Zotero, Ethics in data analysis	**10**	**4**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature

	2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1) https://endnote.com/?srsltid=AfmBOopWWs3Ju0q_5jBfYsX3l6dK1teHEAyvXBia5OGAf8AXxlxe0mJR
2) https://www.zotero.org/
3) MS Office
4) https://mestrelab.com/
5) https://www.ill.eu/sites/fullprof/
6) https://revvitysignals.com/products/research/chemdraw

Relevance of Learning the Course/ Employability of the Course
Computational skills are applicable across various industries such as biotechnology, pharmaceuticals, environmental science, and IT. With the growing reliance on digital literacy, a strong foundation in computational competency ensures better job readiness

	MAHATMA GANDHI UNIVERSITY **Graduate School**
	4 + 1 Integrated UG and PG Programme

School	**School of Chemical Sciences**		
Programme	**4 + 1 Integrated UG and PG Programme**		
Course Title	**Sustainable Chemical approaches**		
Course Type	**VAC**		
Course Level	200-299		
Course Code	MG4VACUCH201		
Course Overview	The course highlights the role of sustainable chemistry in addressing global environmental issues		
Semester	4	**Credit**	3
Total Student Learning Time	**Instructional hours for theory**	**Instructional hours for practical/lab work/field work**	
	45		
Pre-requisite	Basic Chemistry and General Knowledge about environmental issues		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PSO No.
	Upon completion of this course, students will be able to;		

1	Understanding of green chemistry principles	R, U	
2	Analysis of chemical reactions and process. Awareness of environmental impact	A, An	
3	Design of sustainable chemical process	S	
4	Understand the principles of water and soil sustainability.	U	
5	Explore solutions for sustainable water and soil management.	A, An	
6	Develop skills to select appropriate recycling methods.	S	

*(Learning Domains: Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E) , Create (C), Skill (S))

COURSE CONTENT

Module 1: Green Chemistry	**Hours**	**CO No**
Introduction to Green Chemistry: Definition, Principle, History and Development of Green Chemistry. Green Solvents and reaction conditions: Alternative Solvents, Solvent-free reactions, Microwave-assisted reactions, Ultrasound-assisted reactions. Green Catalysis: Homogeneous and Heterogeneous Catalysis, Biocatalysis, Nanocatalysis. Green Chemistry in Industry. Green Chemistry and Sustainable Development: SDGs, climate change, water conservation and waste management.	**15**	**1**
Module 2: Water and Soil	**Hours**	
Importance of water and soil sustainability, water and soil use and conservation techniques, water pollution and treatment methods, soil composition and classification, soil fertility and nutrient cycling, Real-world examples of successful water and soil sustainability projects, climate change and its impact on water and soil, Industrial impact on water and soil	**15**	**2,3**
Module 3: Plastic recycling	**Hours**	
Types of plastic waste and its economic and environmental impact, Sources of plastic waste, plastic cycle and waste management, Recycling methods, plastic reducing strategies, reuse strategies, recovery methods, impact of recycling on the environment, polymer degradation and sustainability	**15**	**4**

Mode of Transaction	**Classroom activities: Recitation, Seminar, Quiz** **Field activities:** **Lab-based activities:**
Mode of Assessment	1. Continuous Internal Assessment (CIA) Internal Test Assignment – Every student needs to write an assignment on a given topic based on the available published literature 2. Seminar Presentation – A topic needs to be presented and discussed with the class 3. Semester End Examination 4. Viva

Learning Resources

1) Green Chemistry: Theory and Practice, Paul T Anastas
2) Soil And Water Conservation Engineering, Suresh
3) Understanding Plastics Recycling: Economic, Ecological, and Technical Aspects of Plastic Waste Handling, Natalie Rudolp
4) Recycling of Polymers: Methods, Characterization and Applications. (2016). Germany: Wiley.
5) Rudolph, N., Kiesel, R., Aumnate, C. (2020). Understanding Plastics Recycling: Economic, Ecological, and Technical Aspects of Plastic Waste Handling. Germany: Carl Hanser Verlag GmbH & Company KG.
6) Frontiers in the Science and Technology of Polymer Recycling. (2013). Netherlands: Springer Netherlands.
7) Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions. (2020). Netherlands: Academic Press.

Relevance of Learning the Course/ Employability of the Course
It is very relevant in terms of practical application and quality control-related jobs. This course provides the fundamental knowledge which is necessary to understand the formation of substance, the nature of the substance etc.