Gandhinagar Institute of Science (03)

Academic Regulation & Curriculum

for

Master of Science (09)

in

Chemistry (24)

Gandhinagar University

Khatraj-Kalol Road, Moti Bhoyan

Ta. Kalol, Dist. Gandhinagar – 382721

Gujarat

RELEASE DATE

July 2024

(Applicable from 2024 admitted Batch)

Preamble

The Department of Chemistry at Gandhinagar Institute of Science is dedicated to promoting academic excellence, scientific research, innovation, and ethical values in the field of Chemical Sciences. The department aims to develop skilled and responsible graduates who can contribute effectively to scientific advancement, industrial growth, environmental sustainability, and societal development. The Bachelor of Science in Chemistry programme is designed in accordance with the National Education Policy (NEP) and Choice Based Credit System (CBCS), ensuring a multidisciplinary, skill-oriented, and outcome-based approach to learning. The curriculum provides strong theoretical knowledge along with practical laboratory training, analytical skills, and research exposure to meet the current demands of academia, pharmaceutical industries, chemical industries, environmental sciences, research organizations, and emerging technological sectors.

The programme includes diverse and advanced areas such as Organic Chemistry, Inorganic Chemistry, Physical Chemistry, Analytical Chemistry, Environmental Chemistry, Industrial Chemistry, Green Chemistry, Medicinal Chemistry, Polymer Chemistry, Spectroscopy, and Nanotechnology. Special emphasis is given to laboratory experiments, project work, internships, industrial exposure, and training on modern analytical instruments to strengthen technical expertise, scientific thinking, problem-solving ability, and professional competence among students. The department also encourages experiential learning through seminars, workshops, industrial visits, research activities, MOOCs, and collaborative programmes to enhance innovation, communication skills, and lifelong learning abilities.

The curriculum has been developed after considering valuable feedback from academicians, industry experts, alumni, researchers, and other stakeholders to maintain relevance with modern scientific developments and employment opportunities. Equal importance is given to laboratory safety, ethical practices, environmental awareness, and sustainable scientific approaches. Through a dynamic academic environment and student-centered learning, the Department of Chemistry continuously strives to nurture creativity, critical thinking, interdisciplinary understanding, and research aptitude among students. The department remains committed to producing competent chemists and responsible citizens capable of contributing meaningfully to scientific innovation, sustainable development, and the betterment of society.

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1. Institutional Vision & Mission

Gandhinagar Institute of Science

1.1 VISION:

Gandhinagar Institute of Science aims to strengthen quality science education and research by fostering innovation, ethical values, and scientific temperament for societal and sustainable development.

1.2 MISSION:

• To provide quality education supported by modern infrastructure and an industry- oriented curriculum, while emphasizing ethics and critical thinking.

• To promote an innovative and research-oriented environment that fosters effective problem-solving skills and entrepreneurial development.

• To encourage innovation, entrepreneurship, and scientific ethics for developing responsible and skilled graduates.

• To foster interdisciplinary learning, sustainability, and community engagement for national development.

2. Department Vision & Mission

Department of Chemistry

2.1 VISION:

To be a premier department in Chemistry education by fostering scientific knowledge, research excellence, innovation, practical skills, and ethical values among students, thereby contributing to societal development and advancements in chemical sciences.

2.2 MISSION:

- To provide quality education in Chemistry through effective teaching-learning practices.
- To develop practical, analytical, and research skills among students through laboratory training, projects, and scientific exposure.
- To promote innovation, interdisciplinary learning, and application-oriented chemical knowledge for academic and industrial needs.
- To inculcate ethical values, environmental awareness, leadership qualities, and social responsibility among students.

3. Program Objectives

The program aims to:

1. **Cultivate proficiency in analytical and quantitative techniques** for assessing chemical and material properties.
2. **Train students in systematic experimental design and laboratory practices** for chemical synthesis, analysis, and process optimization.
3. **Impart comprehensive knowledge of chemical regulations, safety protocols, and environmental standards** relevant to laboratory and industrial operations.
4. **Introduce modern computational and experimental tools**, including chemical modeling software, spectroscopy, chromatography, and data analytics.
5. **Enhance research and consultancy capabilities** through hypothesis-driven investigations and applied chemical problem-solving.
6. **Promote sustainable and green chemistry practices**, emphasizing energy efficiency, waste reduction, and eco-friendly materials.
7. **Develop managerial and professional competencies** required for laboratory management, project execution, and scientific collaboration.
8. **Instill ethical and professional standards** necessary for responsible conduct in chemical research, industry consultancy, and compliance with national and international chemical regulations.

4. Program Educational Objectives (PEOs)

PEO-1: To develop strong fundamental and advanced knowledge in various branches of Chemistry through a flexible, research-oriented, and multidisciplinary curriculum that meets the evolving demands of academia, research, and chemical industries.

PEO-2: To inculcate professional ethics, scientific temperament, environmental awareness, and social responsibility while applying chemical knowledge for sustainable development, safety, health, and societal welfare.

PEO-3: To encourage students to participate effectively in individual and team-based scientific activities, projects, and interdisciplinary collaborations that enhance critical thinking, problem-solving abilities, communication skills, and professional competence.

PEO-4: To provide practical laboratory training, analytical skills, and exposure to modern chemical techniques and instrumentation for developing innovative approaches, entrepreneurship, and industrial applications in the field of Chemistry.

PEO-5: To nurture leadership qualities, lifelong learning abilities, techno-economic understanding, and professional values that enable graduates to adapt to emerging scientific advancements and contribute effectively to society and the global scientific community.

5. Program Details

5.1 Program Structure & Duration

- Duration & Intake: 4 Years & 60 Seats
- Semesters: 8
- Mode: Full Time
- Credit Structure: As per NEP/University norms
- Medium of Instruction: English

5.2 Eligibility criteria for admission

Candidates who have obtained a bachelor's degree in any discipline from a recognized University/Institution approved by UGC, with minimum 50% aggregate marks (45% for reserved category candidates as per applicable norms), shall be eligible for admission to the program

5.3 Admission procedure

Admission to the M.Sc. Chemistry program may be granted on the basis of merit obtained in the qualifying examination and/or performance in the Entrance Test and/or Personal Interview, as prescribed by the University from time to time. Candidates who have successfully completed B.Sc. Chemistry as one of the core subjects from a recognized board are eligible for admission. The University reserves the right to revise admission procedures.

6. Curriculum Structure

Gandhinagar Institute of Science

Program Name: Master of Science – Chemistry | **Program Code:24**

Semester / Year : First Year Master of Science- Semeter I | **Effective From Academic Year: 2024-25**

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
10240101	Core Course	Inorganic Chemistry - I	4	4	-	-	4	70	30	-	-	100
10240102	Core Course Specialization	Organic Chemistry - I	4	4	-	-	4	70	30	-	-	100
10240103	Core Course	Physical Chemistry - I	4	4	-	-	4	70	30	-	-	100
10240104	Core Course Specialization	Analytical Chemistry - I	4	4	-	-	4	70	30	-	-	100
20240105	Core Course	Practical Chemistry - I	4	-	-	8	8	-	-	140	60	200
			20				**24**					**600**

Note (If any):

Gandhinagar Institute of Science

Program Name: Master of Science – Chemistry | **Program Code:24**

Semester / Year : First Year Master of Science- Semeter II | **Effective From Academic Year: 2024-25**

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
10240201	Core Course	Inorganic Chemistry - II	4	4	-	-	4	70	30	-	-	100
10240202	Core Course Specialization	Organic Chemistry - II	4	4	-	-	4	70	30	-	-	100
10240203	Core Course	Physical Chemistry - II	4	4	-	-	4	70	30	-	-	100
10240204	Core Course Specialization	Analytical Chemistry - II	4	4	-	-	4	70	30	-	-	100
20240205	Core Course	Practical Chemistry - II	4	-	-	8	8	-	-	140	60	200
IKS0201	IKS	Indian Cultural and Heritage	2	1		2	3	-	25	25	-	50
			22				**27**					**650**

Note (If any):

Gandhinagar Institute of Science

Program Name: Master of Science – Chemistry(Organic)

Program Code:24

Semester / Year : Second Year Master of Science-Semeter III

Effective From Academic Year: 2024-25

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks) (Marks)		Practical		Total (Marks)
				L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
10240301	Core Course	Organic Chemistry	4	4	-	-	4	70	30	-	-	100
10240302	Core Course	Advanced Organic Synthesis	4	4	-	-	4	70	30	-	-	100
10240303	Core Course	Organic Spectroscopy	4	4	-	-	4	70	30	-	-	100
10240304	Core Course	Bio Organic Chemistry	4	4	-	-	4	70	30	-	-	100
20240305	Core Course	Practical Organic Chemistry	4	-	-	8	8	-	-	140	60	200
10240311	IKS	IKS Chemistry	2	1	-	2	3	-	25	25		50
			22				**27**					**650**

Note (If any):

Gandhinagar Institute of Science

Program Name: Master of Science – Chemistry(Analytical)

Program Code:24

Semester / Year : Second Year Master of Science-Semeter III

Effective From Academic Year: 2023-24

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks) (Marks)		Practical		Total (Marks)
				L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
10240306	Core Course	Analysis of Materials	4	4	-	-	4	70	30	-	-	100
10240307	Core Course	Analytical Spectroscopy	4	4	-	-	4	70	30	-	-	100
10240308	Core Course	Food Analysis	4	4	-	-	4	70	30	-	-	100
10240309	Core Course	Analytical Methods	4	4	-	-	4	70	30	-	-	100
20240310	Core Course	Practical Analytical Chemistry	4	-	-	8	8	-	-	140	60	200
10240311	IKS	IKS Chemistry	2	1	-	2	3	-	25	25		50
			22				**27**					**650**

Note (If any):

Gandhinagar Institute of Science

Program Name: Master of Science – Chemistry	**Program Code:24**
Semester / Year : Second Year Master of Science- Semeter IV	**Effective From Academic Year: 2023-24**

Subject Code	**Course Type**	**Subject Name**	**Credit**	**Hours per week**				**Theory (Marks)**		**Practical (Marks)**		**Total (Marks)**
				L	**T**	**P**	**Total**	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
10230401	Core Course	Research Methodology	4	4	-	-	4	70	30	-	-	100
10230402	Core Course	Seminar/Assignment	2	-	-	-	-	-	-	-	100	100
10230403	Core Course	Research Project	16	-	-	-	32	-	-	200	100	300
			22				**36**					**500**
Note (If any):												

7. Teaching Learning and Evaluation

7.1 Teaching Methodology

The program shall adopt:

- Classroom Teaching
- Case Studies
- Industry Interaction
- Site Visits
- Workshops
- GIS/Software Training
- Field Surveys
- Research Projects
- Internships
- AI-based Learning Tools
- Blended and Digital Learning

7.2 Attendance rules

- Minimum 75% attendance shall be mandatory in each course.
- Students below prescribed attendance may not be permitted to appear in examination.
- Additional attendance requirements may apply for practicals, internships, and field work.

7.3 Examination and Evaluation

7.3.1 Evaluation Components

- The evaluation may consist of Continuous Internal Evaluation (CIE) and End Semester Examination (ESE)
- Continuous Internal Evaluation (CIE) may include:
    - Mid-Semester Examination
    - Assignments
    - Presentations
    - Field work
    - Class Test
    - AI Quiz & Viva Voce
    - Dissertation
    - Project work

7.4 Suggested weightage:

- Continuous Internal Evaluation: 40%
- End Semester Examination: 50%

7.5 Passing Standard

- Minimum 50% marks in each component where applicable.
- Minimum 50% aggregate for passing the course/program.
- Separate passing may be required in theory and practical examinations.

7.6 Grading System

The program shall follow Gandhinagar University grading norms.

7.6.1 Grad Table:

Grade	Grade Points	From Marks	To Marks
AA	10	80	100
AB	9	75	79
BB	8	70	76
BC	7	65	69
CC	6	60	64
CD	5	55	59
DD	4	50	54
DF	0	0	49

7.7 Dissertation / project work

Students shall undertake Research Project OR Industry-Based Dissertation.

Requirements may include:

- Proposal Presentation
- Periodic Review
- Viva and Final Report Submission

The dissertation shall be evaluated by internal and external examiners.

8. Rules and Regulations

8.1 Rule for Promotion

A student shall be promoted to the next semester as per Gandhinagar University rules subject to fulfilment of academic requirements, minimum attendance and Completion of required credits.

8.2 Maximum Duration for Completion

The maximum duration for completing the program shall be 4 years from the date of admission (or as prescribed by the University.)

8.3 Internship Guidelines

8.3.1. Students shall undergo mandatory internship/field training in:

Chemical Industry

- Pharmaceutical Industry
- Research and Development (R&D)
- Analytical and Testing Laboratories
- Environmental Sector
- Food and Beverage Industry

8.3.2 Students must submit:

- Internship Report
- Work Diary/Logbook
- Completion Certificate
- Presentation

8.4 Discipline Rules

Students shall maintain discipline, professional ethics, and proper conduct within the institution, during field visits, internships, industry interactions, examinations, and all academic activities. Students are expected to attend classes regularly, follow institutional rules and regulations, respect faculty members, staff, fellow students, and institutional property, and maintain academic integrity in assignments, projects, and examinations. Any form of misconduct, ragging, indiscipline, use of unfair means in examinations, damage to institutional property, harassment, or behaviour affecting the academic environment shall be treated seriously and may result in disciplinary action including warning, suspension, cancellation of examination, withholding of results, or expulsion from the

8.5 Anti-Ragging Policy

The program shall strictly follow:

- UGC Anti-Ragging Regulations
- Anti-Ragging Affidavit requirements
- Institutional disciplinary

procedures

- Ragging in any form is strictly

prohibited.

8.6 Ethical use of Technology and AI Tools

Students are encouraged to use:

- Various Software and AI Tools
- Data Analytics Tools
- AI-based Learning Platforms
- Valuation Software
- Digital Survey Tools

Use of AI tools shall be ethical and academic integrity must be maintained

9. Student Support

9.1 Industry Collaboration

The Department shall actively promote collaboration with chemical industries, pharmaceutical companies, research laboratories, analytical testing centers, environmental agencies, educational institutions, government organizations, and professional scientific bodies to enhance practical exposure and academic relevance of the B.Sc. Chemistry program. Such collaborations may include internships, industrial training, laboratory visits, research projects, expert lectures, workshops, seminars, skill development programmes, and placement support. The institution may also establish Memoranda of Understanding (MoUs) with industries, research organizations, and professional bodies for academic enrichment, laboratory support, certification programmes, collaborative research, and technology transfer initiatives aimed at improving employability, entrepreneurship, innovation, scientific aptitude, and professional competency among students.

9.2 Research and Consultancy

The department shall encourage faculty members and students to actively engage in research, consultancy, innovation, and applied studies related to real estate, valuation, urban development, infrastructure planning, sustainability, smart cities, GIS, and emerging technologies. Students may undertake research projects, market surveys, valuation studies, policy analysis, urban development assessments, and data-driven studies as part of their academic and professional training. The institution may also undertake consultancy assignments for government agencies, local authorities, industries, financial institutions, developers, and other organizations in areas such as property valuation, feasibility analysis, urban planning, infrastructure assessment, GIS mapping, and real estate market studies. Participation in seminars, conferences, workshops, publications, funded projects, and collaborative research activities shall be encouraged to promote academic excellence, innovation, and industry- oriented learning.

9.3 Library and Laboratory Facilities

Adequate library, laboratory, and digital learning facilities shall be made available to support effective teaching, practical training, research, and skill development under the B.Sc. Chemistry programme. The department shall facilitate access to relevant textbooks, reference books, scientific journals, research publications, e-resources, laboratory manuals, chemical databases, and digital learning platforms related to organic, inorganic, physical, analytical, environmental, and applied chemistry. Necessary laboratory equipment, analytical instruments, computing facilities, scientific software, internet access, and other technical resources required for practical, project-based, and research-

oriented learning shall also be provided to enhance scientific knowledge, research capability, technical skills, and professional competency among students.

9.4 Student Support and Mentoring

A structured system for student support, academic mentoring, and professional guidance shall be implemented for students enrolled in the B.Sc. Chemistry programme. The department shall facilitate academic counselling, mentoring, career guidance, research support, and skill development activities to assist students in their academic progression and professional growth. Students may also be provided opportunities for interaction with scientists, researchers, industry professionals, and academicians through workshops, seminars, industrial visits, laboratory training programmes, research projects, and extracurricular activities aimed at enhancing scientific aptitude, employability, leadership qualities, communication skills, and overall personality development. Necessary support mechanisms for addressing academic and personal concerns shall also be made available as per institutional policies.

9.5 Placement and Career Development

The department shall promote placement assistance and career development activities for students through industry interaction, professional networking, training programs, internships, and campus engagement initiatives. Efforts shall be made to establish linkages with real estate companies, infrastructure organizations, valuation firms, financial institutions, urban development agencies, and related industries to facilitate internships, live projects, industrial exposure, and employment opportunities for students. Career development activities such as aptitude training, resume preparation, soft skill development, entrepreneurship guidance, certification programs, expert sessions, and placement-oriented workshops may also be organized to enhance professional competency and employability of students.

10. Program Credibility

10.1 Executive Summary

The M.Sc. Chemistry Programme is designed to develop scientifically competent graduates with strong theoretical knowledge, practical laboratory skills, analytical abilities, and research aptitude in various branches of chemistry. The programme provides a comprehensive foundation in Organic, Inorganic, Physical, Analytical, and Environmental Chemistry while integrating contemporary scientific developments and industrial applications.

All courses are delivered by qualified faculty members with expertise in their respective fields, ensuring that students receive high-quality education supported by practical training, laboratory experiments, and research-oriented learning. The curriculum emphasizes the development of critical thinking, problem-solving skills, scientific ethics, and hands-on experience through well-equipped laboratories and project-based activities. Specialized practical training is provided in modern analytical techniques, instrumental methods, chemical synthesis, spectroscopy, chromatography, and quality control practices. Students are encouraged to participate in seminars, workshops, industrial visits, research projects, and scientific events to enhance their academic and professional competencies.

The programme promotes collaboration with chemical industries, pharmaceutical companies, research laboratories, environmental agencies, and academic institutions to provide exposure to real-world applications of chemistry. Industry interactions, internships, expert lectures, and skill development programmes help bridge the gap between academic learning and professional practice. The curriculum is designed in accordance with contemporary educational frameworks and industry requirements, preparing students for higher studies, research careers, competitive examinations, and employment opportunities in chemical, pharmaceutical, petrochemical, environmental, food, agricultural, and allied industries.

Graduates of the programme are equipped with the knowledge, laboratory proficiency, analytical skills, and professional competence required for successful careers in scientific research, quality assurance, manufacturing, education, environmental monitoring, and emerging interdisciplinary fields of chemical sciences.

10.2 Scope and Career Opportunities

Graduates of the program may work in:

- Chemical Industry
- Pharmaceutical Industry
- Research and Development (R&D)
- Analytical and Testing Laboratories
- Environmental Sector
- Food and Beverage Industry
- Education and Academics
- Government Services
- Forensic Science

10.3 Potential Job Roles

- Chemist
- Analytical Chemist
- Quality Control (QC) Analyst
- Quality Assurance (QA) Officer
- Research Associate
- Laboratory Technician
- Chemical Analyst
- Pharmaceutical Chemist
- Production Chemist
- Environmental Chemist
- Forensic Science Analyst
- Food Quality Analyst
- Toxicologist
- Water Quality Analyst
- Industrial Chemist
- Research Scientist (after higher studies)
- Chemical Safety Officer
- Technical Executive
- Scientific Officer
- Regulatory Affairs Associate
- Academic Researcher
- Chemistry Teacher/Lecturer (after required qualifications)

- Sales and Marketing Executive (Chemical/Pharmaceutical Products)
- Patent Analyst (with additional training)
- Laboratory Manager (with experience)

10.4 Higher Study & Professional Opportunities

Students may pursue:

- M.Sc. in Chemistry (Organic, Inorganic, Physical, Analytical, Industrial, Environmental, etc.)
- Ph.D. in Chemistry and related disciplines
- Integrated Ph.D. Programs in Chemical Sciences
- M.Tech. in Chemical Engineering, Materials Science, Nanotechnology, or related fields
- MBA in Pharmaceutical Management, Healthcare Management, or Industrial Management
- Postgraduate Diplomas in Analytical Instrumentation, Quality Control, and Industrial Chemistry
- Professional Certifications in Laboratory Management, Quality Assurance, and Regulatory Affairs
- Research Fellowships through CSIR, UGC, DST, and other funding agencies
- Competitive Examinations such as CSIR-NET, GATE, SET, UPSC, and State PSCs
- Forensic Science and Toxicology Programs
- Environmental Science and Pollution Control Programs
- Patent Analysis and Intellectual Property Rights (IPR) Certifications
- Data Science and Computational Chemistry Courses

11. Collaborative Field Work / Experimental Work (M.Sc. Chemistry)

11.1 Water Quality Analysis

Students will collect water samples from different sources and analyze pH, hardness, alkalinity, chloride, and dissolved oxygen using standard analytical methods. A laboratory report with observations, calculations, and conclusions will be submitted.

11.2 Soil Analysis and Fertility Assessment

Students will collect soil samples and determine pH, moisture content, organic carbon, and nutrient levels. The study will include interpretation of soil fertility and recommendations for agricultural applications.

11.3 Industrial Visit – Chemical/Pharmaceutical Industry

Students will visit a chemical or pharmaceutical industry to observe manufacturing processes, quality control procedures, safety practices, and waste management systems. A visit report will be submitted.

11.4 Identification and Characterization of Chemical Compounds

Students will perform qualitative analysis of inorganic salts and organic compounds using standard laboratory techniques and submit an analytical report.

11.5 Environmental Monitoring Study

Students will assess environmental samples (water, soil, or air) for pollutants and compare results with prescribed standards. Findings will be presented in a structured report.

11.6 Instrumental Analysis Exercise

Students will use instruments such as UV-Visible Spectrophotometer, Flame Photometer, Conductometer, or pH Meter for quantitative analysis and interpretation of results**.**

11.7 Food Adulteration Testing

Students will test common food products for adulterants using standard chemical methods and prepare an illustrated report on food quality and safety.

11.8 Chemical Safety and Laboratory Audit

Students will evaluate laboratory safety measures, chemical storage practices, hazard labeling, and waste disposal procedures and submit a safety audit report**.**

11.9 Pharmaceutical Analysis Project

Students will analyze pharmaceutical formulations for active ingredient content using titrimetric or spectroscopic methods and compare results with standard specifications.

11.10 Industrial Effluent Analysis

Students will analyze industrial wastewater samples for pH, COD, BOD, TDS, and heavy metals and assess compliance with environmental regulations.

11.11 Green Chemistry Experiment

Students will perform eco-friendly synthesis or analytical procedures and evaluate the environmental benefits compared to conventional methods**.**

11.12 Chromatographic Separation Study

Students will separate and identify components of mixtures using Paper Chromatography or Thin Layer Chromatography (TLC) and prepare a laboratory report.

11.13 Polymer Synthesis and Characterization

Students will synthesize a polymer, study its properties, and relate its applications to industrial and commercial uses.

11.14 Dye Adsorption and Wastewater Treatment Study

Students will investigate adsorption of dyes using natural or synthetic adsorbents and evaluate removal efficiency through experimental analysis.

11.15 Advanced Instrumentation Training

Students will receive exposure to advanced analytical instruments such as HPLC, GC, FTIR, or AAS through laboratory demonstrations or industrial visits.

10.16 Research Methodology and Scientific Writing

Students will learn literature review, data analysis, referencing styles, and scientific report writing through a guided mini-research project.

11.17 Mandatory Industry Internship (6–8 Weeks)

Students will complete an internship in a chemical, pharmaceutical, environmental, food, or research laboratory and submit a detailed internship report.

11.18 Analytical Chemistry Project

Students will undertake a quantitative analysis project involving sample collection, analysis, data interpretation, and report preparation**.**

11.19 Quality Control Laboratory Training

Students will perform standard quality control tests on chemicals, pharmaceuticals, or food products and evaluate compliance with specifications.

11.20 Computational Chemistry and Data Analysis

Students will use software tools for molecular modeling, chemical data analysis, and interpretation of experimental results.

11.21 Industrial Safety and Hazard Management

Students will study chemical hazards, Material Safety Data Sheets (MSDS), risk assessment, and emergency response procedures**.**

11.22 Mini Research Project

Students will conduct a small-scale research project under faculty supervision involving experimentation, data analysis, and presentation of findings.

11.23 Scientific Seminar and Literature Review

Students will critically review recent research papers in chemistry and present their findings through seminars and written reports.

11.24 Live Industry Problem-Solving Project

Students will work on a real-world problem provided by an industry or laboratory and propose scientifically justified solutions.

11.25 Research Dissertation

Students will prepare a dissertation (5,000–10,000 words) based on experimental work, literature review, and data analysis, followed by a viva voce examination**.**

11.26 Portfolio Presentation and Exit Viva

Students will compile laboratory records, project reports, internship work, and research outputs into a portfolio and defend their work before a faculty panel.

Recommended Organizations/Agencies: Council of Scientific and Industrial Research, Indian Council of Agricultural Research, Department of Science and Technology, Indian Institute of Chemical Technology, Bureau of Indian Standards, Central Pollution Control Board.

12.0 Market Survey Review

The Chemistry course is studied because it is a fundamental branch of science that deals with the composition, structure, properties, and transformation of matter. The course provides detailed knowledge of subjects such as organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, environmental chemistry, polymer chemistry, medicinal chemistry, and spectroscopy. Through theoretical learning and practical laboratory training, students develop technical skills in chemical analysis, laboratory techniques, instrumentation handling, quality testing, and research methodologies that are widely used in scientific research and industrial applications.

One of the major reasons students choose B.Sc. Chemistry is the growing importance of chemistry in healthcare, industries, and environmental sustainability. Chemistry plays a vital role in the development of pharmaceuticals, medicines, dyes, polymers, fertilizers, cosmetics, and various industrial products. The field also contributes significantly to environmental protection through pollution control, water analysis, waste management, and green chemistry approaches. In industries, chemistry is essential for quality control, product development, petrochemical processing, food analysis, and material science applications.

The market survey review revealed that there is an increasing demand for skilled chemistry graduates in pharmaceutical industries, chemical manufacturing industries, environmental monitoring agencies, forensic laboratories, research institutes, food industries, and quality control laboratories. Students and industries emphasized the importance of practical laboratory training, analytical instrumentation skills, industrial exposure, internships, research opportunities, communication skills, and problem-solving abilities. Emerging areas identified during the survey include green chemistry, nanotechnology, medicinal chemistry, polymer science, environmental chemistry, material science, and analytical instrumentation, which are creating significant career opportunities for chemistry graduates.

The survey also highlighted that chemistry graduates can work as chemists, quality control analysts, laboratory technicians, research assistants, analytical chemists, environmental analysts, and educators, or pursue higher studies such as M.Sc., Ph.D., and specialized research programs. The departmental action plan is focused on curriculum enhancement, advanced laboratory training, skill development programs, industrial collaborations, seminars, workshops, internships, and professional training activities to meet current industrial and research demands.

In addition, the Chemistry course helps students develop scientific thinking, analytical abilities, research aptitude, and problem-solving skills. Practical exposure through laboratory work, industrial

visits, projects, and seminars prepares students for both academic and industrial careers. Chemistry is considered one of the most important scientific disciplines because it contributes to innovations in healthcare, environmental protection, industrial development, energy resources, and material science. Therefore, studying B.Sc. Chemistry provides students with both theoretical knowledge and practical expertise to contribute effectively to scientific advancement and societal development.

13. Review and Revision of Regulation

The University reserves the right to interpret, modify, revise, amend, or update any provision, rule, regulation, curriculum structure, evaluation pattern, academic requirement, or operational guideline related to the program from time to time in accordance with University regulations, statutory requirements, industry developments, and academic needs.

In case of any ambiguity or dispute regarding interpretation of any provision of this manual, the decision of the University/Competent Authority shall be final and binding on all stakeholders. Any amendments, additions, or revisions approved by the appropriate academic or statutory bodies of the University shall automatically become applicable to the program**.**

Annexure I: Detailed Syllabus

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-1

Subject Code: 10240101	**Subject Title:** Inorganic Chemistry-I
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the basic understandings about the inorganic chemistry and its application.

(2) To make student more advanced to learn the techniques for inorganic preparation, separation, purification, and synthesis.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Chemical Bonding:** Recapitulation of hybridization Derivation of wave functions for *sp*, sp^2, *sp3* orbital hybridization types considering only sigma bonding. Discussion of involvement of *d* orbitals in various types of hybridizations. Concept of resonance, resonance energy derivation expected. Formal charge with examples. Critical analysis of VBT. Molecular Orbital Theory for diatomic Weak forces of attraction:	15	25%
2	**Group Theory:** Concept of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups. Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. The Great Orthogonality Theorem and its application in construction of character tables for point groups C2v, C3v and D2h, structure of character tables.	15	25%
3	**Organometallic compounds:** Synthesis, uses and structure of organometallic compounds of π bonding organic ligands, 2-electron ligands, olifinic and acetylinic complexes, compound with 3 electron ligand – allylic complexes, compounds. With 4- electron ligands butadiene complexes, n4 complexes of cyclopentadiene.	15	25%
4	Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones. Structures of Compounds of the type: AB [nickel arsenide (NiAs)], AB2 [fluorite (CaF2) and anti-fluorite structures, rutile (TiO2)	15	25%

	structure and layer structure [cadmium chloride and iodide (CdCl2, CdI2)]. Methods of preparation for inorganic solids: Ceramic method, precursor method, sol-gel method (applications in Biosensors), microwave synthesis (discussion on principles, examples, merits and demerits)		

Course Outcome: After completion of this course, students,

- Students will be able to understand the concepts and basics of inorganic chemistry.
- Will have thorough knowledge of microscopic, spectroscopic, Chromatography techniques for the measurements of colligative properties.
- Will create insights of use of some instruments in inorganic chemistry.
- Will be able to troubleshoot the statistical errors in the analytical experiments.
- Will be able to analyze and interpret the experimental data.
- Course will advance the understanding and the applications of instrumentation chemistry.

List of Text Books:

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principle of Inorganic Chemistry, Milestone Publishers, 2013-2014.
2. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.

List of Reference Books:

1. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure and reactivity, 4th Ed., Harper Collins, 1993.
2. P. J. Durrant and B. Durrant, Introduction to Advanced Inorganic Chemistry, Oxford University Press, 1967.
3. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers and Distributers.
4. F. A. Cotton, Chemical Applications of Group Theory, 2nd Edition, Wiley Eastern Ltd., 1989.
5. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-1

Subject Code: 10240102	**Subject Title:** Organic Chemistry-I
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the basic understandings about the inorganic chemistry and its application.

(2) To make student more advanced to learn the techniques for inorganic preparation, separation, purification, and synthesis.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Organic reaction mechanisms:** Mechanism, Types of reactions, thermodynamic and kinetic input, Potential energy diagram. Energy of activation, Transition & intermediate states, methods for determining mechanism, primary and secondary isotope effects, solvent effects, substituent effects. Effect of structure on reactivity.	15	25%
2	**Aliphatic nucleophilic substitution reactions:** The SN1 , SN2 , and SNi reactions, their mechanisms and stereochemistry, leaving group effect and reaction medium, ambient nucleophile, Aliphatic addition reactions, electrophilic and nucleophilic addition reactions, mechanism, stereochemistry of additions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity.	15	25%
3	**Acids and Bases:** Factors affecting acidity and basicity: Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Levelling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.	15	25%
4	**Aromaticity:** Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. Application of HOMO to LUMO theory to	15	25%

	monocyclic conjugated systems. Frost-Musulin diagrams. Huckel's (4n+2) and 4n rules. Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles.		

Course Outcome: After completion of this course, students,

- Students will be able to understand the concepts and principles of basic Organic chemistry along with applications.
- Will have thorough knowledge of different spectroscopic, Chromatography techniques.
- Will have insights of use of some instruments in Organic chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Text Books:

1. Advanced Organic Chemistry, Jerry March
2. Stereochemistry: Conformation and Mechanism, P.S. Kalsi, New Age International, New Delhi.

List of References:

Organic Chemistry -R.T. Morrison and R. N. Boyd, 6th Edition

Reaction Mechanisms in Organic Chemistry, S. M. Mukherjee and S. P. Singh.

Jonathan Clayden, Organic Chemistry 2nd Ed. Oxford University Press

Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.

Donald L. Pavia, Introduction to Spectroscopy 5th Ed. Cengage India Private Limited.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-1

Subject Code: 10240103	**Subject Title:** Physical Chemistry-I
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the fundamental understandings about the physical chemistry and its application.

(2) To make student more advanced to learn the techniques for salt preparation, separation, solution, and titrations.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Thermodynamics:** State functions and exact differentials. Maxwell equations, Maxwell thermodynamic Relations: Significance and applications to ideal and real gases, Joule Thomson experiment, Joule Thomson coefficient, inversion temperature, Joule Thomson coefficient in terms of van der Waals constants. Third law of Thermodynamics, Entropy change for a phase transition, absolute entropies.	15	25%
2	**Chemical Kinetics**: Recapitulation. Complex Reactions: Reactions approaching equilibrium and steady states, Rate laws for consecutive, opposing and parallel reactions, explosive reactions. Techniques for gas phase reactions. Fast reactions; relaxation, stop flow and flash photolysis. Kinetics of enzyme reactions. Harpoon mechanism (Molecular Beam method).	15	25%
3	**Composite Reactions:** Recapitulation: Rate laws, Differential rate equations Consecutive reactions, Steady state Approximation, rate determining steps, Microscopic Reversibility and Detailed Balanced Chain reactions-chain initiation processes. Decomposition of ethane, decomposition of acetaldehyde Gas phase combustion.	15	25%
4	**Polymerization reactions:** Kinetics of stepwise polymerization, Calculation of degree of polymerization for stepwise reaction. Kinetics of free radical chain polymerization, Kinetic chain length and estimation of average no. of monomer units in the polymer produced by chain polymerization.	15	25%

Course Outcome: After completion of this course, students,

- Students will be able to understand the concepts and principles of basic thermodynamics.
- Students will be able to understand the concepts and principles of chemical kinetics.
- Students will be able to understand the concepts and principles of composites reaction.
- Students will be able to understand the concepts and principles of polymerization reactions

List of Text Books:

1. K L Kapoor A Text book of Physical Chemistry, Vol 5, 2^{nd} Edn.
2. S. Glasstone, *Text Book of Physical Chemistry*, 2^{nd} Edn., McMillan and Co. Ltd., London, 1962.

List of References:

1. Peter Atkins and Julio de Paula, Atkin's *Physical Chemistry*, 7^{th} Edn. Oxford University Press, 2002.
2. S. Glasstone, *Thermodynamics for Chemists*, Affiliated East-West Press, New Delhi, 1964.
3. K.J. Laidler & J.H. Meiser, Physical Chemistry 2nd Ed. CBS Publishers
4. Raja Ram J. and Kuriacose J.C., (1993). Kinetics and Mechanism of Chemical Transformations, MacMillan Indian Ltd., New Delhi.
5. A.K. Chandra, *Introductory Quantum Chemistry*, Tata McGraw – Hill, 1994

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-1

Subject Code: 10240104	**Subject Title:** Analytical Chemistry-I
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the fundamental understandings about the analytical chemistry and its application.

(2) To make student more advanced to learn the techniques for salt preparation, separation, solution, analytical tools.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Basic concepts of Analytical Chemistry:** An overview of analytical methods, types of instrumental methods, instruments for analysis, data domains, electrical and non-electrical domains, detectors, transducers and sensors, selection of an analytical method, accuracy, precision, selectivity, sensitivity, detection limit and dynamic range. Statistical errors, determinate and indeterminate errors. Types of determinate errors, tackling of errors. Quantitative methods of analysis: calibration curve, standard addition and internal standard method.	15	25%
2	**Automation in chemical analysis:** Need for automation, Objectives of automation, overview of automated instruments and instrumentation, process control analysis, flow injection analysis, discrete automated systems, automatic analysis based on multi-layered films, gas monitoring equipment's, Automatic titrators.	15	25%
3	**Chromatographic Techniques:** Column chromatography, Instrumentation, mechanism of separation and applications of adsorption, ion exchange, Instrumentation, TLC principles and applications, basic concepts of HPLC. Qualitative and quantitative analysis by chromatography.	15	25%
4	**Electrochemical methods:** Definitions and terminology involved in electrochemistry. Specific ion selective electrodes: Glass electrode for H^+ / Na^+ ions, solid membrane electrode for fluoride, liquid membrane electrode for calcium. Enzyme - substrate electrode for NH3, and gas sensing electrodes for SO_2/ NH_3/CO_2 / O2. Introduction to Amperometry and Non - aqueous titrations.	15	25%

Course Outcome: After completion of this course, students:

- Students will be able to understand the concepts and principles of basic analytical chemistry.
- Will have thorough knowledge of different spectroscopic techniques, Chromatography techniques.
- Will have insights of use of some instruments in analytical chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Text Books:

1. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education
2. Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5^{th} Edition.

List of References:

1. Fundamentals of Analytical Chemistry, By Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 9^{th} Edition, 2004.
2. Electrochemical Methods: Fundamentals and Applications, A.J. Bard and L.R. Faulkner 2nd Edition (2000), Wiley, New York.
3. Fundamentals of Electroanalytical Chemistry, P Monk, John Wiley, NY.
4. Svehla, Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson Education India.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-1

Subject Code: 10240105	**Subject Title:** Chemistry Practical – I
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the knowledge of basic chemistry tools and instrumentation.

(2) Encouraging for advanced hands on training in chemistry laboratory with appropriate instrumentation technology.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	12	06	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	1. Qualitative analysis of mixtures containing at least six radicals including ions of two rare elements: (a) Cations of: Ag, Pb, Hg, Cu, Cd, Sn, Bi, As, Sb, Fe, Al, Cr, Co, Ni, Mn, Zn, Ca, Sr, Ba, Mg, Na and K. NH4+. (b) Cations of rare elements: W, Tl, Mo, Ce, Ti, Th, Zr, U, V, Be and Li. (c) Anions: F-, Cl-, Br-, I-, NO_2^-, NO_3^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, $S_2O_3^{2-}$, CrO_4^{2-}. 2. Synthesis, analysis, and magnetic measurements of binary complexes (at least 5) of transition metal ions with monodentate and bidentate ligands like ammonia, thiocyanate, tertiary amines, ethylene diamine, acetyl acetone. 3. Synthesis of Aromatic Compounds (At least 5) 4. Separation and identification of components of organic compounds (at least 5). 5. Two stage organic preparations (at least 5). 6. Molecular weight of polymer by Viscometry 7. CMC by Surface Tension measurement.	60	100%

Course Outcome: After completion of this course, students:

- Collaborate effectively on team-oriented projects in the field of Chemistry or other related fields.
- Communicate scientific information in a clear and concise manner both orally and in Writing.

- Inculcate logical thinking to address a problem and become result oriented with a positive attitude.
- Explain environmental pollution issues and the remedies thereof.
- Apply the knowledge to develop the sustainable and eco-friendly technology in Industrial Chemistry.
- Have developed their critical reasoning, judgment and communication skills.
- Enhance the scientific temper among the students so as to develop a research culture and implementation of the policies to tackle the burning issues at global and local level.

List of Text Books:

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel
2. Experimental Inorganic Chemistry - W. G. Palmer

List of Reference Books:

1. Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
2. Experimental Physical Chemistry :V.D. Athawale and Parul Mathur.
3. Systematic Experimental Physical Chemistry :S.W. Rajbhoj and T.K. Chondhekar
4. Inorganic synthesis- King.
5. Synthetic Inorganic Chemistry-W.L.Jolly
6. The analysis of minerals and ores of the rarer elements – W. R. Schoeller and
7. A.R. Powell, Charles, Griffin and Company Limited.
8. A handbook of quantitative and qualitative analysis- H. T. Clarke

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-2

Subject Code: 10240201	**Subject Title:** Inorganic Chemistry-II
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the basic understandings about the inorganic chemistry and its application.

(2) To make student more advanced to learn the techniques for inorganic preparation, separation, purification, and synthesis.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Valence bond theory:** Formation of hybrid orbitals, their wavefunction and properties. Symmetry, composition of hybrid orbitals and formation of linear AB2, triangular AB3, AB4, AB5 and AB6 molecules. Molecular Orbital Theory: Symmetry adapted linear combinations of terminal atom orbitals and formation of molecular orbitals in simple polyatomic compounds with triangular, tetrahedral and square planar geometry and their applications.	15	25%
2	**Molecular geometry:** VSEPR theory. Walsh diagrams. M-M multiple bonds. Structure and bonding in the metal complexes with p -acids, on the basis of spectral evidence. Stabilization of unusual oxidation states. Synthesis, structure and bonding in metal carbonyls and nitrosyls. M-M bonds in metal clusters. Cluster valence electrons and Wade-Mingos-Lauher rules. Structure elucidation based on CVE and spectroscopic data. Isolobal analogies. Applications of metal clusters.	15	25%
3	**Inorganic Polymers and Ring compounds:** Linear and cyclic Borazenes, phosphazenes and thiazenes. Phosphonitrilic polymers. Synthesis, structure and bonding in organoboron, organosilicon, organo phosphorous and organotin compounds. Applications of these compounds in organic synthesis.	15	25%
4	**Inorganic Reactions:** Rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction (Direct chemical analysis, spectrophotometric method, electrochemical and flow methods). Redox	15	25%

	reactions: inner and outer sphere mechanisms, complimentary and non-complimentary reactions.		

Course Outcome: After completion of this course, students,

- Students will be able to understand the concepts and principles of basic inorganic chemistry.
- Will have thorough knowledge of different microscopic techniques, spectroscopic techniques, Chromatography techniques, and the techniques for the measurements of colligative properties.
- Will have insights of use of some instruments in inorganic chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List lf Text Books:

1. Inorganic Chemistry: Molecular Facets, De Gruyter Textbook.
2. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.

List of References:

1. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure and eactivity, 4th Ed., Harper Collins, 1993.
2. P. J. Durrant and B. Durrant, Introduction to Advanced Inorganic Chemistry, Oxford University Press, 1967.
3. F. A. Cotton, Chemical Applications of Group Theory, 2nd Edition, Wiley Eastern Ltd., 1989.
4. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-2

Subject Code: 10240202	**Subject Title:** Organic Chemistry-II
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the basic understandings about the inorganic chemistry and its application.

(2) To make student more advanced to learn the techniques for inorganic preparation, separation, purification, and synthesis.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Alkylation of Nucleophilic Carbon Intermediates:** Generation of carbanion, Regioselectivity in enolate formation, alkylation of enolates. Generation and alkylation of dianion, solvent effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. Alkylation of aldehydes, ketones, esters, amides and nitriles. Nitrogen analogs of enols and enolates- Enamines and Imines anions.	15	25%
2	**Reactions and Rearrangements** **Reactions:** Baylis-Hilman reaction, Cannizaro reaction, friedel craft, Norish I and II, Mannich reaction, knoevanegal Condensation. **Concerted rearrangements:** Hofmann, Curtius, Lossen, Schmidt, Wolff, Boulton- Katritzky. **Cationic rearrangements:** Tiffeneau-Demjanov, Pummerer, Dienone-phenol, Rupe, Wagner-Meerwein. **Anionic rearrangements:** Brook, Neber, Von Richter, Wittig, Gabriel–Colman, Payne. **Note: Follow the needful precautions.**	15	25%
3	**Molecular orbitals:** Formation of σ- and π-MOs by using LCAO method. Formation of π MOs of ethylene, butadiene, 1, 3, 5-hexatriene, allyl cation, anion and radical. Concept of nodal planes and energies of π-MOs.	15	25%

4	**Introduction to FMOs:** HOMO and LUMO, significance of HOMO-LUMO energy gaps in absorption spectra and chemical reactions. MOs of formaldehyde: The effect of electronegativity perturbation and orbital polarization in formaldehyde. HOMO and LUMO of formaldehyde. Brief description of MOs of nucleophiles and electrophiles	15	25%

Course Outcome: After completion of this course, students,

- Students will be able to understand the concepts and principles of basic Organic chemistry.
- Will have thorough knowledge of different spectroscopic techniques, Chromatography techniques.
- Will have insights of use of some instruments in Organic chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Text Books:

1. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.
2. Advanced Organic Chemistry, Jerry March
3. Stereochemistry: Conformation and Mechanism, P.S. Kalsi, New Age International, New Delhi.

List of References:

1. Organic Chemistry -R.T. Morrison and R. N. Boyd, 6th Edition
2. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
3. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley
4. Reaction Mechanisms in Organic Chemistry, S. M. Mukherjee and S. P. Singh.
5. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, Pearson Publication (7th Edition)
6. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-II

Subject Code: 10240203	**Subject Title:** Physical Chemistry-II
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the fundamental understandings about the physical chemistry and its application.

(2) To make student more advanced to learn the techniques for salt preparation, separation, solution, and titrations.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Chemical Thermodynamics:** Fugacity of real gases and determination using graphical method and from equation of state. Equilibrium constant for real gases in terms of fugacity. Gibbs energy of mixing, entropy and enthalpy of mixing and applications. **Real solutions:** Chemical potential in non-ideal solutions, excess functions of non-ideal solutions, calculation of partial molar volume and partial molar enthalpy, Gibbs Duhem Margules equation.	15	25%
2	**Statistical thermodynamics** Concepts of distribution of molecules, thermodynamic probability, permutations and combinations, Boltzmann distribution law, probable distribution, partition function – rotational, vibrational, translational, (rovitron), electronic nuclear partition functions.	15	25%
3	**Quantum Chemistry** Hydrogen atom, the two particle problem-Helium, separation of energy as translational and potential, separation of variables, total wave function, expression for energy, Density Functional Theory (DFT), radial and angular distribution plots, points of maximum probability, expressions for the total wave function for 1s,2s, 2p and 3d orbitals of hydrogen. Hückel Molecular	15	25%

	Orbitals theory for ethylene, 1,3-butadiene and benzene, quantum energy barrier and FRET. (Friccohesity Resonating Energy Transfer)		
4	**Phase equilibria** Recapitulation: Basics of phase rule and applications, Thermodynamic derivation of Gibbs Phase rule, degree of freedom. One component system: Cooling curve of water, triple point Two component system: a) Solid –Gas System, Phenol-water system, Amino compound formation b) Solid – Liquid System, Formation of a compound with congruent melting point, tie-lines, Formation of a compound with incongruent melting point. (With suitable examples)	15	25%

Course Outcome: After completion of this course, students,

- Students will be able to understand the concepts and principles of basic Physical chemistry.
- Will have thorough knowledge of different spectroscopic techniques, Chromatography techniques.
- Will have insights of use of some instruments in physical chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Text Books:

1. A.K. Chandra, *Introductory Quantum Chemistry*, Tata McGraw – Hill, 1994.
2. K L Kapoor A Text book of Physical Chemistry, Vol 5, 2^{nd} Edn.

List of References:

1. Peter Atkins and Julio de Paula, Atkin's *Physical Chemistry*, 7^{th} Edn. Oxford University Press, 2002.
2. S. Glasstone, *Thermodynamics for Chemists*, Affiliated East-West Press, New Delhi, 1964.
3. Raja Ram J. and Kuriacose J.C., (1993). Kinetics and Mechanism of Chemical Transformations, MacMillan Indian Ltd., New Delhi.
4. S. Glasstone, *Text Book of Physical Chemistry*, 2^{nd} Edn., McMillan and Co. Ltd., London, 1962.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-2

Subject Code: 10240204	**Subject Title:** Analytical Chemistry-II
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the fundamental understandings about the analytical chemistry and its application.

(2) To make student more advanced to learn the techniques for salt preparation, separation, solution, analytical tools.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Sample Preparation Techniques** Liquid-liquid extraction/solvent extraction-partition coefficient of Iodine, distribution ratio and percent extraction. Solvent extraction of metal ions-ion association complexes and metal chelates, multiple batch extraction, Craig's counter-current distribution. Accelerated and Microwave assisted extraction, protein precipitation and solid phase extraction (SPE).	15	25%
2	**Chromatographic Methods** Principles of chromatography, classification of chromatographic techniques based on mechanism of retention time, configuration, mobile and stationary phases. Efficiency of separation- plate theory (theoretical plate concept) and rate theory (Van Deemter equation). Principles and applications of Paper chromatography, thin layer chromatography (TLC) and Column chromatography. Counter-current chromatography for isolation of natural products.	15	25%
3	**pH metry and Conductometry** pH measurement with glass electrode, working of glass electrode, mechanism of pH measurement, calibration of glass electrode, errors in pH measurement. Electrical conductance in solutions of electrolytes, measurement of conductance, conductometric titrations- acid-base, precipitation and complex formation titrations.	15	25%
4	**Potentiometric and Ion-selective electrodes**	15	25%

	Electrochemical cell, cell potentials, sign convention for electrode potentials, types of reference and indicator electrodes-metallic indicator and membrane indicator electrodes. Classification of membrane electrodes-ion-selective and molecular-selective electrodes. Principle, properties and design of ion-selective electrodes. Crystalline and non-crystalline membrane electrodes. Gas-sensing probes and enzyme substrate electrodes.		

Course Outcome: After completion of this course, students:

- Students will be able to understand the concepts and principles of basic analytical chemistry.
- Will have thorough knowledge of different spectroscopic techniques, Chromatography techniques.
- Will have insights of use of some instruments in analytical chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Text Books:

1. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition,2002.
2. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education
3. Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5^{th} Edition.

List of References:

1. Principles of Instrumental Analysis" by Douglas A. Skoog, 3rdEdition, Holt-Saunders International Editions.
2. Fundamentals of Analytical Chemistry, By Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 9^{th} Edition, 2004.
3. Electrochemical Methods: Fundamentals and Applications, A.J. Bard and L.R. Faulkner 2nd Edition (2000), Wiley, New York.
4. Fundamentals of Electroanalytical Chemistry, P Monk, John Wiley, NY.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-II

Subject Code: 10240205	**Subject Title:** Chemistry Practical – II
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To increase knowledge of basic chemistry equipment and tools.
(2) To increase students' practical skills in a chemistry lab using cutting-edge gear.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	16	08	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	1. Qualitative analysis of mixtures containing at least six radicals including ions of two rare elements: Cations of rare elements: W, Tl, Mo, Ce, Ti, Th, Zr, U, V, Be and Li. Anions: $Cr_2O_7^{2-}$,CO_3^{2-}, PO_4^{3-}, AsO_4^{3-}, AsO_3^{3-},BO_3^{3-},CH_3COO-,$C_2O_4^{2-}$ and SiO_4^{4-}. 2. Synthesis of Aromatic Compounds (At least 5) 4. Separation and identification of components of organic compounds (at least 5). 6. Phase diagram: Phenol - Water System. 7. Determination of Cu(II) with ammonia by Spectrophotometric titration. 8. Estimation of detergents and their washing action by Survismeter. 9. Estimation of Na^+ & K^+ individually & in binary mixture by survismeter as green method. 10. Determination of purity of vanillin by conductometry 11. Assay of aspirin tablet by potentiometry 12. Paper chromatographic separation of metal ions (Pb2+, Ag+ and Hg2+) 13. TLC separation of sugars and amino acids 14. Column chromatographic separation and estimation of unknown organic compound. 15. Determination of COD of effluent sample. 16. Analysis of oils	60	100%

Course Outcome: After completion of this course, students:

- Collaborate effectively on team-oriented projects in the field of Chemistry or other related fields.
- Communicate scientific information in a clear and concise manner both orally and in Writing.
- Inculcate logical thinking to address a problem and become result oriented with a positive attitude.
- Explain environmental pollution issues and the remedies thereof.
- Apply the knowledge to develop the sustainable and eco-friendly technology in Industrial Chemistry.
- Have developed their critical reasoning, judgment and communication skills.
- Enhance the scientific temper among the students so as to develop a research culture and implementation of the policies to tackle the burning issues at global and local level.

List of Text Books:

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel
2. Experimental Inorganic Chemistry - W. G. Palmer

List of Reference Books:

1. Practical Physical Chemistry: B. Viswanathan and P.S. Raghavan
2. Experimental Physical Chemistry: V.D. Athawale and Parul Mathur.
3. Systematic Experimental Physical Chemistry: S.W. Rajbhoj and T.K. Chondhekar
4. Inorganic synthesis- King.
5. Synthetic Inorganic Chemistry-W.L.Jolly
6. The analysis of minerals and ores of the rarer elements – W. R. Schoeller and
7. A.R. Powell, Charles, Griffin and Company Limited.
8. A handbook of quantitative and qualitative analysis- H. T. Clarke

Gandhinagar University
M.Sc. CHEMISTRY
SEMESTER-II

Subject Code: IKS0201	Subject Title: Indian Ancient History and Cultural Heritage

Course Objective:

- Foster an appreciation for the composite nature of Indian history, culture and heritage.
- Instill a sense of love and belonging among learners, contributing to nation-building efforts.
- Provide an overview of various components of cultural heritage, including fairs, festivals, dances, art, architecture, and historical landmarks, which are crucial for a deeper understanding of history.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
01	0	2	02	0	25/ Project	25/ Project		50

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Credit**
1	**Indian Ancient History:** Introduction of Ancient India. Harappan Civilization. Rigvedic & Later Vedic Period. India in the 6th Century B.C. Persian and Greek invasions and its impact. Mauryan and Gupta Periods. Post – Mauryan. Brief History of the Sanskrit literature: The Vedas, The Brahmanas and Upanishads & Sutras, Epics: Ramayana and Mahabharata & Puranas.	15	1
2	**Indian Cultural Heritage:** Ethnic Indian Cultural Construct – Fairs & Festivals and their historical background. Indian dances as Cultural Heritage. Indian Architecture: Temples, Stupas, Caves, Chaityas. Medieval Architecture and Colonial Architecture. Social culture in India- Vedic culture. Ancient period- varna and jati, family and marriage in India, position of women in ancient India, Contemporary period; caste system and communalism.	15	1

Course Outcome: After completion of this course, students will be able to

- Demonstrate knowledge of the key events, periods, and figures that have shaped Indian history from ancient to modern times, including their impact on the socio-political and economic landscape.
- Analyze the rich cultural heritage of India, including art, architecture, literature, and philosophy, while recognizing the contributions of various communities to India's pluralistic society.

List of Text Books:

1. An advanced history of India – causes and decline of Guptas by B.C. Majumdar and others, 1967, Macmillan.
2. Ancient India by R.C. Majumdar, 1977, Motilal Banarasi Das.
3. History of Ancient India by Rama sankar Tripati, 1942, Motilal Banarasi Das.
4. History and culture of India to 1000 A.D. by H.V. Srinivasa Murthy, 1980, S. Chand and Co.
5. History of South India by K.A. Nilakanta Sastry 1976, Oxford University Press.
6. History of Ancient India by Krishnaswamy Aiyangar, 1980, Seema Publishers.
7. Ancient India by V.D. Mahajan, 1985, S.Chand and Company.
8. Advance History of India by K.A. Nilakantasastry and C.S.Srinivasachari, 1980, Allied Publishers.
9. Ancient Indian History and Civilization by Silendranath Sen, 1988, Wiley Eastern.
10. Lothal and Indus Civilizations by S.R.Rao, 1972, Asia Publishers, Madras

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. ORGANIC CHEMISTRY

Subject Code: 10240301	**Subject Title:** Organic Chemistry
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

SEMESTER-3

Course Objective: (1) Basic concepts of bonding, structures, resonance, aromaticity, hyperconjugation and tautomerism in organic molecules.

(2) Generation, structure, stability and reactivity of reactive intermediates.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Organic reaction mechanisms** Organic reactive intermediates, methods of generation, tability and important reactions involving carbocations, nitrenes, carbenes, arynes and ketenes. Neighbouring group participation: Mechanism and effects of anchimeric assistance, NGP by unshared/ lone pair electrons, πelectrons, aromatic rings, σ-bonds.	15	25%
2	**Pericyclic reactions** Cycloaddition reactions: Supra and antra facial additions, 4n and 4n+2 systems, 2+2 additions of ketenes. Diels-Alder reactions, 1, 3-Dipolar cycloaddition and cheletropic reactions, ene reaction, retro-Diels-Alder reaction. H-shifts and C-shifts, supra and antarafacial migrations, retention and inversion of configurations.	15	25%
3	**Stereochemistry-I** Conformational analysis of medium rings: Eight to ten membered rings and their unusual properties, I-strain, transannular reactions. Stereochemistry of fused ring and bridged ring compounds, Electrophilic addition, elimination, molecular rearrangements, reduction of cyclohexanones (with LiAlH4, selectride and MPV reduction) and oxidation of cyclohexanol.	15	25%
4	**Photochemistry** Principles of photochemistry: electronic energy transfer: photosensitization and quenching process. Photochemistry of carbonyl compounds, Norrish- I and Norrish-II cleavages, Paterno-Buchi reaction. Photo reduction, photochemical rearrangements of α, β-unsaturated ketones and cyclohexadienones.	15	25%

Course Outcome: After completion of this course, students,

- Apply the concepts of bonding, resonance, aromaticity, hyperconjugation and tautomerism to higher organic compounds.

- Predict the products, identify reaction intermediates and propose suitable mechanism for organic reactions.
- Identify stereogenic centres, recognize enantiomers, diastereomers, meso compounds, draw stereochemical structures, and provide R/S designations of stereocenters.
- Draw stable conformations for substituted cyclic compounds, fused and bridged rings.
- Use of various oxidizing and reducing reagents for application in organic transformations of industrially and pharmaceutically important organic compounds.
- Understand the host-guest interactions in molecular receptors.

List of Text Books:

1. March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, John Wiley and sons.
2. Pericyclic Reactions, S. Sankararaman, Wiley VCH, 2005.

List of Reference Books:

1. Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press (2002).
2. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication.
3. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press (2001).
4. Modern methods of Organic Synthesis, 4th Edition W. Carruthers and Iain Coldham, Cambridge University Press 2004

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. ORGANIC CHEMISTRY

Subject Code: 10240302	**Subject Title:** Advanced Organic Synthesis
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

SEMESTER-3

Course Objective: (1) Principles and terminologies in asymmetric synthesis and the importance of chirality in organic synthesis.

(2) Stereoselective, diastereoselective and enantioselective strategies and the use of chiral auxiliary components for asymmetric synthesis.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Radicals in organic synthesis Introduction** Generation, stability, reactivity and structural and stereochemical properties of free radicals, Persistent and charged radicals, Electrophilic and nucleophilic radical. Characteristic reactions - Free radical substitution, addition to multiple bonds. Radical chain reactions, Radical halogenation of hydrocarbons.	15	25%
2	**Mechanism of some name reactions** Aldol, Perkin, Benzoin, Cannizaro, Wittig, Fridel craft reaction, Grignard, Hoffmann Claisen and Favorsky rearrangements. Hydroboration - openauer oxidation, clemmensen reduction. Stork enamine reactions, Michael addition, Mannich Reaction, Diels - Alder reaction, Ene – reaction.	15	25%
3	**Rearrangements** Pinacol-Pinacolone, Fries, Beckmann, Hofmann, Curtius, Lossen and Schmidt rearrangements, Benzil-benzilic acid rearrangement, Arndt-Eistert reaction (Wolff), Stevens, Wittig and Favorskii rearrangements, Dienone-phenol, Baeyer-Villiger oxidation, Neber rearrangement.	15	25%
4	**Asymmetric synthesis** Principles of asymmetric synthesis: Introduction, the chiral pool in Nature, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions. Aldol and related reactions, Cram's rule, Sharpless enantioselective epoxidation, hydroxylation, aminohydroxylation, Diels-Alder reaction, reduction of prochiral carbonyl compounds and olefins.	15	25%

Course Outcome: After completion of this course, students,

- Understand and apply the principles of stability of complexes in synthesis of new molecules.
- Relate the structure of complexes to their properties.
- Use electronic spectroscopy as an analytical tool in the structural elucidation of complexes.
- Interpret the magnetic properties of transition metal complexes based on magnetic measurements.

- Explain the mechanistic pathway for aromatic substitutions, addition reactions, elimination reactions and rearrangements.
- Predict the stereochemistry of the products formed.
- Design reactions with the help of name reactions and rearrangements and use of suitable reagents

List of Text Books:

3. Advanced Organic Chemistry, Jerry March
4. Organic Synthesis, Jagadamba Singh and L. D. S. Yadav, Seventh Edition, 2011.

List of References:

1. Organic Chemistry -R.T. Morrison and R. N. Boyd, 6th Edition
2. Reaction Mechanisms in Organic Chemistry, S. M. Mukherjee and S. P. Singh.
3. Stereochemistry: Conformation and Mechanism, P.S. Kalsi, New Age International, New Delhi.
4. Jonathan Clayden, Organic Chemistry 2nd Ed. Oxford University Press
5. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY

Subject Code: 10240303	**Subject Title:** Organic Spectroscopy
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

SEMESTER-3

Course Objective: (1) Spectroscopic techniques including the basic principles for recording of NMR, IR, UV, and MS spectra.

(2) Identification and characteristics of organic compounds using spectroscopic techniques.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Infrared spectroscopy** Introduction, Units of frequency wave length and wave number, molecular vibrations, factors influencing vibrational frequencies, the IR spectrometer, sampling techniques, characteristic frequencies of organic molecules and interpretation of spectra.	15	25%
2	**Ultraviolet spectroscopy** Introduction, the absorption laws, measurement of the spectrum, chromophores, standard works of reference, definitions, applications of UV spectroscopy to Conjugated dines, trienes, unsaturated carbonyl compounds and aromatic compounds.	15	25%
3	**Nuclear Magnetic Resonance Spectroscopy** The measurement of spectra: the chemical shift: the intensity of NMR signals and integration factors affecting the chemical shifts: spin-spin coupling to 13C IH-IH first order coupling: some simple IH-IH splitting patterns: the magnitude of IH-IH coupling constants.	15	25%
4	**Optical rotatory dispersion and circular dichroism** Phenomena of ORD and CD. Classification of ORD and CD Curves; Cotton effect curves and their application to stereochemical problems; the Octant rule and its application to alicyclic ketones.	15	25%

Course Outcome: After completion of this course, students,

- Combine information from experimental NMR, IR, UV, and MS spectra and elucidate the structure of unknown organic compounds.
- Argue for a suggested molecular structure from analysis of the spectral data.
- Predict the NMR, IR, UV-Vis and MS spectra from a given molecular structure.

- Analyze data obtained from sophisticated equipment's for structure elucidation and chemical analysis.

List of Text Books:

1. Organic Spectroscopy, W. Kemp, ELBS London, 2000.
2. Spectroscopic Methods in Organic Chemistry. 4th Edition D.M. Williams and I. Fleming Tata - McGraw Hill, New Delhi, 1990. For all spectral methods except ORD and CD and ESR.

List of References:

1. Organic Spectroscopy, P. Laszlo and P. Stang, Harper &Row, New York, 1971.
2. Spectrometric Identification of Organic Compounds, R.M. Silverstein and W.P. Weber, 2005.
3. Introduction to Spectroscopy, 3rd Edition, D.L. Pavia, G.M. Laupman and G.S. Kriz, Harcourt College Publishers, 2001.
4. Organic Mass Spectroscopy, K.R. Dass & E.P. James, IBH New Delhi, 1976.

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY

Subject Code: 10240304	**Subject Title:** Bio Organic Chemistry
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

SEMESTER-3

Course Objective: (1) To introduce the basics of the chemical structure and function of important biological molecules.

(2) To impart the knowledge about natural product and different Biological aspects of Inorganic, Organic and Physical chemistry.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Carbohydrates and nucleic acid** Carbohydrates classification and stereochemistry, biologically important hexose derivatives, nomenclature of disaccharides, structure and role of some homo and hetero polysaccharides, Nucleic acid: compounds of nucleic acids, nomenclature of nucleotides, nucleosides, structure of DNA, and structure of RNA.	15	25%
2	**Lipids** Nomenclature, structure and physical properties of some naturally occurring fatty acids, triacelglycerol and waxes as sources of stored energy, insulation of water repellants, types of membrane lipids, introduction to glycerophospho lipids, galactolipids, sphingo lipids, phospholipids and sterols, bile acids.	15	25%
3	**Proteins** properties and conventions of common amino acids, peptides: formation, compositions and sizes of protein separation, purification and characterization, sequencing of peptides, sanger's method, protein sequences and evolution. Oxygen binding proteins, haemoglobin and myoglobin in oxygen transport and storage.	15	25%
4	**Enzymes** classification, nomenclature and extraction factors affecting catalytic activity and specificity in action, regulation of enzyme activity, enzyme inhibition, illustrative enzymatic reactions using chymotropsin, hexokinase, enolase and lysozyme.	15	25%

Course Outcome: After completion of this course, students:

- The concept of Bioinorganic Chemistry and its biological applications.
- Enzyme as biological catalysis and its remarkable catalytic power.
- Incorporate the basic terminology of cell structures and inculcating the understanding of the basic function different cell organelles as well as introducing the biomolecules.

- To impart understanding about the structure and function of important carbohydrates and learning the carbohydrate metabolism through various biological cycles.
- To know and gain information about various important lipid molecules in biological system and their role in the structure of biological membrane.
- To gain knowledge about the chemical and enzymatic reactions of peptides, proteins and amino acids, study amino acid metabolism and sequence determination.
- Understanding the chemical composition of the genetic material DNA and RNA as well as preliminary information about their replication.

List of Text Books:

1. Principles of biochemistry –Donald J.Voet, Judish G.Voet, charlotte w. pratt (John willey and sons)
2. Lehninger principles of biochemistry- David L.Nelson and Michael M.wx (Palgrave Macmillan / w.h. freeman company new york)

List of References:

3. Biochemistry – U.Satyanarayana Baro and allied P.Ltd., Kolkata
4. Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co. 2008.
5. Natural products chemistry and applications, Sujata V. Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011.
6. Organic Chemistry Natural Products Volume-II, O. P. Agarwal, Krishna Prakashan, 2011.

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY

Subject Code: 10240305	**Subject Title:** Practical Organic Chemistry
Pre-requisite: Student must have achieved Graduate degree in Science and chemistry should be one of the major subject with minimum 45%.	

SEMESTER-3

Course Objective: (1) To develop the knowledge of basic chemistry tools and instrumentation.
(2) Encouraging for advanced hands on training in chemistry laboratory with appropriate instrumentation technology.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	12	06	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	1. Synthesis of Organic compounds. 2. Identification and Separation of unknown organic compounds using analytical tools. 3. Crystallization of newly synthesized organic compounds. 4. Hands on training on basic instrumentation.	60	100%

Course Outcome: After completion of this course, students:

- To acquire knowledge on the qualitative analysis of separation of binary mixture of organic compounds and purification techniques.
- To understand separation by TLC methods, separation and purification by column chromatographic methods
- To develop knowledge on functional group identification using IR spectra.
- To prepare various organic compounds involving different reactive intermediates, study of reaction mechanism, characterization of products by various spectral techniques.

List of Text Books:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V.K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000.
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd

List of Reference Books:

1. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications
2. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.

3. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
4. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY
SEMESTER-3
Discipline-Specific IKS

Subject Code: 10240311	**Subject Title: IKS-Chemistry**
Pre-requisite: Candidate must have achieved regular B.Sc. degree in the 10+2+3 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course objectives:

1. Understand and explain the fundamental concepts of Indigenous Knowledge Systems related to chemistry, including traditional practices, natural materials, and their chemical properties.
2. Analyze and evaluate the relevance and application of Indigenous chemical knowledge in modern scientific contexts, including sustainable resource management and eco-friendly technologies.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	2	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
2	-	1		-	25/ Project	25/ Project	-	50

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Ancient Chemical Scientist and their contribution:** Nagarjuna- Ras Ratnakar, Kakshaputtantra, Arogya Manjari, Yog Saar, Yoasthak Sushrutha: Susrutasamhita Kanada: Atomic theory, Vaishesika Sutras Charaka: Charak Samhita Vaagbhatt- Rasratna Samuchchay Govindacharya- Rasarnava Yashodhar- Ras Prakash Sudhakar Ramchandra- Rasendra Chintamani Somdev- Rasendra Chudamani	08	60
2	**Hindu Chemistry:** Alchemical Concepts in the Vedas The Ayurvedic Era The Tantric Influence on Alchemical Thought The Latro-Chemical Period Arab Contributions and Their Debt to Indian Alchemical Knowledge Symbolism, ritualism and chemical transformation in tantric tradition.	07	40%

By the end of this course, students will be able to:

CO1: Describe key contributions of ancient Indian chemical scientists such as Nagarjuna, Kanada, Charaka, and others to early chemical and medicinal knowledge.
(Knowledge, Understanding)

CO42: Interpret the principles of "Hindu Chemistry" as documented in classical texts, and evaluate their influence on the evolution of chemistry and alchemy.
(Understanding, Critical Thinking)

CO3: Integrate knowledge of Ayurveda and Vedic science with chemical understanding to explore holistic approaches to health, materials, and environmental harmony. *(Synthesis, Application)*

Practical learning:

Project/ assignment/ Report writing

List of Text Books:

11. https://vajiramandravi.com/upsc-exam/science-and- technology-in-ancient-india/
12. https://asutoshcollege.in/new-web/couse-syllabus-indian-knowledge-system.html.
13. Ancient India by R.C. Majumdar, 1977, Motilal Banarasi Das.
14. https://cuet.iitk.ac.in/sathee-cuet/student-corner/ncert-books/class-11/knowledge-traditions-and-practices-of-india/chapter-07-introducing-ayurveda-the-science-of-health-and-disease/.
15. https://www.puranavedas.com/.
16. Lothal and Indus Civilizations by S.R.Rao, 1972, Asia Publishers, Madras.
17. A History of Hindu Chemistry, Praphulla Chandra Ray D.Sc.

Gandhinagar Institute of Science
Master of Science - Chemistry
Semester-IV

Subject Code: 10230401	Subject Title: Research Methodology
Pre-requisite: Student must have achieved Graduate degree in Chemistry with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Research Methodology:** Research Defined: Understanding the Meaning of Research, Research Goals: Exploring Objectives and Motivations, Diverse Research Types and Approaches, Significance of Research and Its Place in Scientific Methods, Navigating the Research Process, Identifying Criteria for High-Quality Research.	15	25%
2	**Defining the Research Problem & Research Design:** Deciphering the Research Problem, Selecting and Framing Research Questions, The Importance of Problem Definition, Techniques for Articulating Research Problems. Unpacking Research Design: Meaning and Necessity, Features of an Effective Research Design, Core Concepts and Types of Research Design, Basics of Experimental Design Principles, Design a Research Plan.	15	25%
3	**Testing of Hypothesis:** Understanding Hypothesis Testing: Concepts and Flow, Evaluating the Power of a Hypothesis Test, Parametric Tests: Hypothesis Testing for Means and Proportions, Comparing Variances and Correlation Coefficients, Recognizing Limitations in Hypothesis Testing.	15	25%

4	**Methods of Data Collection:** Collecting Primary Data: Observation, Interviews, Questionnaires and More, Gathering Secondary Data and Selecting the Appropriate Method, Insights into Case Study Methodology, Guidelines for Developing Effective Questionnaires, Comparing Surveys and Experiments. **Processing and Analysis of Data:** Data Processing Fundamentals and Challenges, Analyzing Data Elements, Statistical Tools in Research, Measures of Central Tendency and Dispersion, Exploring Relationships and Regression Analysis.	15	25%

Course Outcome: After completion of this course, student will be able to

1. Demonstrate the ability to choose methods appropriate to research aims and objectives.
2. Understand the limitations of particular research methods.
3. Develop skills in qualitative and quantitative data analysis and presentation.
4. Develop advanced critical thinking skills.

References:

1. Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
2. Das, S. K., 1986, An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for for Beginners, (2nd.ed.), Singapore, Pearson Education.
4. Bhattachraya, D.K., 2006, Research Methodology, (2nd.ed.), New Delhi, Excel Books.
5. Panneerselvam R., 2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
6. Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
7. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
8. Katz J.M., 2009, Form Research to Manuscript: A guide to scientific writing, USA, Springer Science

Gandhinagar Institute of Science
Master of Science - Chemistry
Semester-IV

Course Objective:

- Students improve their ability to present scientific information clearly and effectively to an audience, using appropriate language, visuals, and presentation techniques.
- Confidence in Public Speaking: Regular presentations help students become more comfortable and confident when speaking in front of groups, an important skill for professional and academic settings.
- Critical Thinking and Question Handling: Presenting in a seminar setting often involves answering questions from peers and faculty. This experience helps students think critically and respond thoughtfully to inquiries and feedback.
- Exposure to Diverse Perspectives: Seminar presentations provide opportunities for students to engage with a variety of topics and viewpoints, broadening their understanding of different areas within chemistry and fostering interdisciplinary thinking.

Subject Code: 10230402	**Subject Title: Seminar/ Assignment**
Pre-requisite: Student must have achieved Graduate degree in Chemistry with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Teaching Scheme (Hrs)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-		2	-	-	-	100	100

Gandhinagar Institute of Science
Master of Science - Chemistry
Semester-IV

Subject Code: 10230403	Subject Title: Research Project/Dissertation/ Industrial training
Pre-requisite: Student must have achieved Graduate degree in Chemistry with minimum three years on regular basis, from any UGC recognized university. Student should have basic knowledge and technical skill for the concern subject.	

Course Objective:

- Students will develop and refine their ability to conduct independent research, including designing experiments, collecting and analyzing data, and interpreting results.
- By focusing on a particular topic or problem in chemistry, students will gain specialized knowledge and expertise, enhancing their understanding of the field.
- The dissertation process requires students to identify research questions, formulate hypotheses, and address challenges, fostering strong critical thinking and problem-solving skills.
- Students will enhance their ability to communicate complex scientific concepts, both in writing and orally, through the preparation of the dissertation document and presentations.
- Completing a dissertation equips students with experience and qualifications that are valuable for pursuing careers in industry, academia, or further studies, such as a PhD program.

Teaching Scheme (Hrs)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
-	-	32	16	-	-	200	100	300

GANDHINAGAR INSTITUTE OF SCIENCE M.Sc. CHEMISTRY SEMESTER-III

Subject Code: 10240306	**Subject Title:** Analysis of Materials
Pre-requisite: Student must have achieved Graduate degree in science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) Understand and explain the fundamental properties of materials, including echanical, thermal, electrical, and optical properties.

(2) Identify the relationship between material structure and its properties.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents

Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Analysis of water** Analysis of water- Dissolved solids, Acidity, Alkalinity, Estimation of dissolved chloride, fluoride, calcium, magnesium, manganese, zinc, dissolved oxygen, BOD, COD.	15	25%
2	**Water treatment** Drinking water treatment - Estimation of temporary and permanent hardness, dispersed and colloidal impurities from water, Coagulation of water, Sterilisation and disinfection of water, Sewage Water Treatment- Properties of sewage water, Decomposition of sewage.	15	25%
3	**Agricultural Analysis** Soil Analysis- Determination of soil moisture, pH, conductivity, total organic matter, nitrogen, phosphorus, potassium, sulfur, manganese, Determination of moisture by Karl Fischer titration methods. Determination of Ammonical nitrogen and Ammonical nitrate nitrogen.	15	25%
4	**Food additives** Food adulteration, common adulterants in food, Contamination of food stuffs. Microscopic Chemical and Instrumental Analysis of food additives- Preservatives, Food colorants, Antioxidants, Sweeteners, stabilizers, Thickeners, Clarifying and Bleaching agents.	15	25%

Course Outcome: After completion of this course, students:

1. Describe the fundamental properties of materials and how they relate to their internal structure.
2. Apply various material characterization techniques to analyze material properties and structures.
3. Use phase diagrams to predict phase changes and transformations in materials.
4. Perform and interpret results from mechanical tests to determine material properties.
5. Conduct thermal analysis to evaluate the thermal properties and stability of materials.
6. Examine and interpret microstructures using optical and electron microscopy.

List of Textbooks

1. Standard Methods for Examination of water & waste wate APHA- AWWA- WPCE
2. Text book of water and waste water engineering

by H. K. Hussen. List of References

1. Water supply & sanitary engineering by Birdie.
2. Practical methods in ecology & Environmental science by R. K. Trivedi, P. K. Goel, C. L. Trisal.
3. Manual of water & waste water analysis, NEERI, Nagpur.
4. Haard, N.F. and Salunke, D.K . 1975, Post harvest biology and handling of fruits and vegetables, AVI, Westport.
5. Jacob John P., 2012. A Handbook on Post Harvest Management of Fruits and Vegetab

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY
SEMESTER-III

Subject Code: 10240307	Subject Title: Analytical Spectroscopy
Pre-requisite: Student must have achieved Graduate degree in science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop Analytical skills analyzing, and interpreting information to make inferences and reach conclusions.

(2) To make student more advanced to learn the techniques analytical research using a variety of methods

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Atomic absorption spectroscopy** Introduction, Instrumentation, principal application and detection limit sensitivity and disadvantage, detectors.	15	25%
2	**NMR Spectroscopy** Introduction, Instrumentation, principal application and techniques of NMR principal application Chemical shifts and coupling constant, Shielding and deshielding effect, internal standard.	15	25%
3	**UV-Visible Spectroscopy** Introduction, principal and application, instrumentation and part of spectroscopy **FTIR Spectroscopy** Introduction, principal instrumentations, theory of FTIR, advantage, disadvantage and application	15	25%
4	**LC-MS** Introduction, principal, instrumentations, advantage, disadvantage and application. **DLS** Introduction, principal, instrumentations, advantage, disadvantage and application.	15	25%

Course Outcome: After completion of this course, students:

- Students will be able to understand the concepts and principles of basic analytical chemistry.

- Will have thorough knowledge of different spectroscopic techniques, Chromatography techniques.
- Will have insights of use of some instruments in analytical chemistry.
- Will be able to troubleshoot the errors in the analytical experiments.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Textbooks:

1. Molecular Structure and Spectroscopy" by Arulhas
2. Fundamentals of Molecular Spectroscopy" by P S Sindhu
3. Spectroscopic Methods in Organic Chemistry" by D H Williams and I Fleming
4. fundamentals of molecular spectroscopy By C.N. Banwelll

List of References:

1. Principles of instrumental analysis, D.A. Skoog and J.L,Loary ,W.B ,Saunder
2. Spectroscopy of Organic Compounds" by P S Kalsi
3. Atomic and Molecular Spectroscopy by Rita Kakkar, Cambridge India, 2017, Paperback,

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY
SEMESTER-III

Subject Code: 10240308	**Subject Title:** Food Analysis
Pre-requisite: Student must have achieved Graduate degree in science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop Analytical skills analyzing, and interpreting information to make inferences and reach conclusions.

(2) To make student more advanced to learn the techniques analytical research using a variety of methods

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Food morphology** Types of microorganism associated with food, microbiological standards, sources of microorganism in food, some important food spoilage microorganisms, fermentation- definition and types, microorganisms used in food fermentation, dairy fermentation, fermented foods	15	25%
2	**Bio molecules** carbohydrates, proteins, lipids and nucleic acids, their classification, structure, bio synthesis, metabolism and calorific value. Enzymes- classification, kinetics, factors controlling enzyme activities, enzymes used during food processing,	15	25%
3	**Food Technology** Food preservatives, analysis of preservatives, general methods of food preservation and food processing, food packaging, importance of post-harvest technology of fruits and vegetables.	15	25%
4	**Minerals** important minerals and their functions in human body. Plant alkaloids and their uses. Animal and plant toxins. Toxic substances and their metabolism-pesticides, metals, food additives etc.	15	25%

Course Outcome: After completion of this course, students:

- Students will be able to understand the concepts and principles of basic food analysis.
- Will have thorough knowledge of different terms of food science

- Will have knowledge of food contents.
- Will be able to find out contaminates in Food.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Textbooks

1. Analytical Chemistry, H. Kaur, Pragmatic Prakashan.
2. Food Microbiology Paperback4 May 2000Martin R Adams
3. Food microbiology by M.R. Adams, M.O. Moss *The Royal Society of Chemistry*
4. Fundamental Food Microbiology By Bibek Ray, Arun Bhunia

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List of References:

1. Food Laws and Standards: An Introduction Dr. S. P. Bansal
2. Food Safety and Standards Act: A Practical Commentary Rahul Bajaj
3. Food Analysis Laboratory Manual S. Suzanne Nielsen Semih Otles and Lutfi Tutar
4. Food Packaging: Principles and Practice Gordon L. Robertson

GANDHINAGAR INSTITUTE OF SCIENCE
M.Sc. CHEMISTRY
SEMESTER-III

Subject Code: 10240309	**Subject Title:** Analytical Methods
Pre-requisite: Student must have achieved Graduate degree in science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop Analytical skills analyzing and interpreting information to make inferences and reach conclusions.

(2) To make student more advanced to learn the techniques analytical research using a variety of methods

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Chromatographic methods** Principal, Separation techniques, Type of Chromatography, column chromatography, paper chromatography, TLC, HPTLC, and determination of Rf values, Applications of chromatography,	15	25%
2	**Gravimetric methods of analysis** principal, types of gravimetric analysis, advantage and disadvantage and applications. **Volumetric analysis:** principal, titration, type and procedure for volumetric analysis	15	25%
3	**Titration** Definition, procedure, chemical analysis, types of titration, titration curve, titration method, **Distillation** Definition, distillation unit, procedure, principle, application and mechanism.	15	25%
4	**Potentiometry** Principal instrumentation types of potentiometric titration and its application pH measurements determination of pH instrumentation and applications and type of pH Electrodes.	15	25%

Course Outcome: After completion of this course, students:

- Students will be able to understand the concepts of basic practical chemistry.
- Will have thorough knowledge of potentiometric AAS instruments.
- Will have insights of use of volumetric and gravimetric methods.
- Will be able to analyze and interpret the data obtained using instrumentation.
- Course will help to understand the applications of instruments in chemistry.

List of Textbooks:

1. Introduction to Modern Liquid Chromatography L.R Synder
2. Modern Practice of Gas Chromatography Eugene
3. Preparative Chromatography H.Schmidt- Traub
4. Advances in Chromatography, Volume 57 Nelu Green Berg

List of References:

1. Ion Chromatography, First Edition Principles and Applications (Kindle Edition) By P.R. Haddad
2. Affinity Chromatography Template Chromatography of Nucleic Acids and Proteins (Kindle Edition) By Herbert Schott
3. Process Chromatography A Guide to Validation (Kindle Edition) by G.K Sofer.
4. Douglous Skoog
5. Vogel's for Quantitative analysis.

GANDHINAGAR INSTITUTE OF SCIENCE

M.Sc. CHEMISTRY

SEMESTER-3

Subject Code: 20240310	**Subject Title:** Practical Analytical Chemistry
Pre-requisite: Student must have achieved Graduate degree in science and chemistry should be one of the major subject with minimum 45%.	

Course Objective: (1) To develop the knowledge of basic chemistry tools and instrumentation.

(2) Encouraging for advanced hands-on training in chemistry laboratory with appropriate instrumentation technology.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	12	06	70	30	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	1. Analysis of compounds using analytical and instrumental methods. 2. Identification and Separation of unknown organic compounds using analytical tools. 3. Determination of total hardness (Ca2+ and Mg2+) of water samples 4. Determination of chloride (Cl-) present in water samples 5. Determination of dissolved oxygen (DO) of drinking water and sewage water. 6. Determination of alkalinity of a coloured effluent using pH metric titration. 7. Determination of purity of commercial HCl using pH metric titration. 8. Determination of purity of commercial H2SO4 using pH metric titration. 9. Determination of Fe (III) using potassium thiocyanate 10. Hands on training on basic instrumentation.	60	100%

Course Outcome: After completion of this course, students:

- To acquire knowledge on the qualitative analysis of separation of binary mixture of organic compounds and purification techniques.
- To understand separation by TLC methods, separation and purification by column chromatographic methods.
- To develop knowledge on functional group identification using IR spectra.
- To prepare various organic compounds involving different reactive intermediates, study of reaction mechanism, characterization of products by various spectral techniques.

List of Text Books:

1. A Text Book of Quantitative Inorganic Analysis (3rd Edition) – A. I. Vogel
2. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS

List of Reference Books:

1. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications
2. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
3. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall