Gandhinagar Institute of Science (03)

Academic Regulation & Curriculum

for

Bachelor of Science (06)

in

Chemistry (14)

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:

PO-1: Develop a strong foundation in organic, inorganic, physical, and analytical chemistry.

PO-2: Train students in laboratory techniques, chemical analysis, and instrumentation methods.

PO-3: Provide knowledge of chemical principles, industrial applications, and environmental aspects of chemistry.

PO-4: Introduce modern tools and technologies such as spectroscopy, chromatography, computational chemistry, AI tools, and data analytics in chemical sciences.

PO-5: Enhance research aptitude, scientific innovation, and problem-solving abilities.

PO-6: Promote sustainable and green chemistry practices for environmental protection and societal development.

PO-7: Develop professional, managerial, and communication skills required in chemical industries, research laboratories, and academia.

PO-8: Develop ethical values, scientific temperament, and professional standards required for careers in chemistry, research, quality control, and regulatory compliance at national and international levels.

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 B.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 Higher Secondary Education (10+2) with 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: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : First Year Bachelor of Science - Semester II **Effective From Academic Year:** 2025-26 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks
				L	T	P	Total	University	Continuous	University	Continuous	
10140203	Major	General Chemistry - I	4	3	-	2	5	50	50	25	25	150
10140204	Major	General Chemistry - II	4	3	-	2	5	50	50	25	25	150
10170203	Minor	Nutritional Pattern in Microorganisms	4	3	-	2	5	50	50	25	25	150
10160204	Multi / Interdisciplinary	Agriculture Business Management	4	4	-	-	4	50	50	-	-	100
AEC015	Ability Enhancement Course	Personality Development for Effective Leadership	2	2	-	-	2	25	25	-	-	50
SEC019	Skill Enhancement Course	Social Media and Management	2	2	-		2	25	25	-	-	50
IKS0201	IKS	Indian Ancient History and Cultural Heritage	2	1	-	2	3	-	25	25	-	50
			22	18		8	26	-	-	-	-	700
Note (If any):	**Exit 1: Award of UG certificate in Major course with 44 credits with additional 4 credits of Summer Intership In core spesific NSQF defined course OR continue with Major and Minor course for next NCrF credit level.**											

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : First Year Bachelor of Science - Semester I **Effective From Academic Year:** 2025-26 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
10140103	Major	Fundamental Chemistry - I	4	3	-	2	5	50	50	25	25	150
10140104	Major	Fundamental Chemistry - II	4	3	-	2	5	50	50	25	25	150
10170103	Minor	Introductory Microbiology	4	3	-	2	5	50	50	25	25	150
10170105	Multi / Interdisciplinary	Astrology I	4	4	-	-	4	50	50	-	-	100
AEC016	Ability Enhancement Course	Practical English	2	2	-	-	2	25	25	-	-	50
SEC006	Skill Enhancement Course	Data analysis using spreadsheet	2	-	-	4	4	-	-	25	25	50
VAC004	Value Added Course	Basic Life Support	2	2	-	-	2	25	25	-	-	50
			22	17	0	10	27	-	-	-	-	700
Note (If any):												

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : Second Year Bachelor of Science - Semester III **Effective From Academic Year:** 2025-26 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
10140305	Major	Inorganic Chemistry-I	4	3	-	2	5	50	50	25	25	150
10140306	Major	Organic Chemistry-I	4	3	-	2	5	50	50	25	25	150
10140307	Major	Physical Chemistry-I	4	3	-	2	5	50	50	25	25	150
10170308	Multi / Interdisciplinary	Astrology II	4	4	-	-	4	50	50	-	-	100
AEC010	Ability Enhancement Course	Functional Grammar and Composition	2	2	-	-	2	25	25	-	-	50
SEC021	Skill Enhancement Course	Visual Arts	2	-	-	4	4	-	-	25	25	50
VAC024	Value Added Course	Yoga and Meditation for Wellness	2	2	-	-	2	25	25	-	-	50
			22	17	0	10	27					700
Note (If												

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : Second Year Bachelor of Science - Semester IV **Effective From Academic Year:** 2025-26 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
10140405	Major	Inorganic Chemistry-II	4	3	-	2	5	50	50	25	25	150
10140406	Major	Organic Chemistry-II	4	3	-	2	5	50	50	25	25	150
10140407	Major	Physical Chemistry-II	4	3	-	2	5	50	50	25	25	150
10320401	Minor	Natural Resources & Management	4	3	-	2	5	50	50	25	25	150
AEC003	Ability Enhancement Course	Conversational Hindi	2	2	-	-	2	25	25	-	-	50
SEC023	Skill Enhancement Course	Organic Farming	2	2	-		2	25	25			50
IKS0401	IKS	Indian Ancient Science and Philosophy	2	2	-	-	2		25	25	-	50
			22	18		8	26					750
Note (If any):	Exit 2: Award of UG Diploma in Major course with 88 credits with additional 4 credits of Summer Internship in core specific NSQF defined course OR continue with Major and Minor course for next NCrF credit level											

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : Third Year Bachelor of Science - Semester V **Effective From Academic Year:** 2025-26 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
20140501	Major	Inorganic Organic Chemistry - I	4	4	-		4	50	50			100
20140502	Major	Physical Analytical Chemistry - I	4	4	-		4	50	50			100
20140503	Major	Chemistry Practical - V	4		-	8	8	-	-	50	50	100
20140504	Minor	Analytical Techniques - I	4	4	-	-	4	50	50	-	-	100
10140507	Minor	IKS - Chemistry	4	3	-	2	5	50	50	25	25	150
SEC022	Skill Enhancement Course	Public Speaking	2	2	-		2	25	25	-		50
			22	17		10	27					600
Note (If												

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : Third Year Bachelor of Science - Semester VI **Effective From Academic Year:** 2025-26 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
20140601	Major	Inorganic Organic Chemistry - II	4	4	-		4	50	50			100
20140602	Major	Physical Analytical Chemistry - II	4		-		4	50	50			100
20140603	Major	Chemistry Practical - VI	4		-	8	8	-	-	50	50	100
20140604	Minor	Analytical Techniques - II	4	4	-		4	50	50	-	-	100
	Ability Enhancement Course		2	2			2	25	25	-	-	50
	Internship	Internship in Major specific course	4	-	-	-	-	-	-	-	-	150
			22	10		8	22					600
Note (If	**Award of UG Degree in Major course with 132 credits and Internship in core discipline OR continue with Major and Minor course for next NCrF credit level.**											

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : Forth Year Bachelor of Science - Semester VII **Effective From Academic Year:** 2023-24 (As per NEP 2020)

Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
10140701	Major	Medicinal Chemistry	4	4	-		4	50	50			100
10140702	Major	Organometallic Chemistry	4	4	-		4	50	50			100
10140703	Major	Chemistry Practical - VII	4		-	8	8			50	50	100
10140704	Minor	Polymer Chemistry	4	4	-		4	50	50			100
	Research Project/On-the-Job	On the Job Training (OJT) (For UG Honors Degree) /	6	-	-	12	12			75	75	150
			22	12		20	32					550
Note (If any):												

Gandhinagar Institute of Science

Program Name: Bachelor of Science (Chemistry) **Program Code: 014**

Semester / Year : Forth Year Bachelor of Science - Semester VIII **Effective From Academic Year:** 2023-24 (As per NEP 2020)

Subject Code	Course Type		Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
				L	T	P	Total	University	Continuous	University	Continuous	
10140801	Major	Molecular Spectroscopy	4	4	-		4	50	50			100
10140802	Major	Biochemistry	4	4	-		4	50	50			100
10140803	Major	Chemistry Practical - VIII	4		-	8	8			50	50	100
10140804	Minor	Nano Technology	4	4	-		4	50	50			100
	Research Project/On-the-Job	On the Job Training (OJT) (For UG Honors Degree) /	6	-	-	12	12			75	75	150
			22	12		20	32					550
Note (If	**Award of UG Honours with Research Degree in Major course with total 176 credits.**											

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:

- Educational Institutes
- Industries
- Research & Development institutes
- Infrastructure Companies

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 B.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 (B.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

B.Sc. Chemistry

Semester-1

Subject Code: 10140103	**Subject Title:** Fundamental Chemistry-1 (Theory)
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) They will gain proficiency in logical deduction skills through written problems and laboratory work.

(2) They will identify problems and generate hypotheses, develop and implement experimental methods to test their hypotheses, and analyze and interpret the resulting data.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	70	30	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Fundamentals of Organic Chemistry** **Basic Concepts of Organic Chemistry,** Tetravalent carbon atom, Hybridization, Functional groups, Nomenclature of organic molecules, Types of bonds, Fission of bond, Inductive effect, Electrometric effect, Resonance Effect, Hyper conjugation.	10	23%
2	**Fundamentals of Inorganic Chemistry** **Periodic table and properties**: Periodic Table, Ionization Energy, Electron affinity, Atomic Size and Electronegativity. **Chemical Bonds:** The Lewis Theory, Sidgwick- Powell Theory, Valence Shell Electron Pair Repulsion (VSEPR) Theory, Valence Bond Theory (VBT), Hybridization, Molecular Orbital Theory (MOT).	11	27%
3	**Fundamentals of Physical Chemistry** **Chemical thermodynamics**: System and surroundings, heat and work, internal energy, first law of thermodynamics, entropy and enthalpy, temperature dependence of entropy and enthalpy, exothermic and endothermic reactions, Hess's law, Gibbs free energy, second law of thermodynamics, heat capacities, reversible and irreversible systems.	11	27%
4	**Fundamentals of Stereochemistry** Definition, Importance, Geometrical isomerism, cis-trans and E/Z nomenclature Optical isomerism – optical activity, plane polarized light, enantiomers, chirality, specific molar rotation.	10	23%

	Stereoisomerism with two chiral centers: Diastereomers, Mesoisomers, Resolution of racemic modification. **Projection diagrams of stereoisomers:** Fischer, Newman and Sawhorse projections.		

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

- Foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries as well as stereochemistry.
- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- Explore new areas of research in both chemistry and allied fields of science and technology.
- Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- Explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- Function as a member of an interdisciplinary problem-solving team.

List of Text Books:

1. Physical Chemistry for the life sciences by Peter Atkins, Oxford University Press.
2. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.
3. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
4. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

List of Reference Books:

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press.
3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. James E. Huheey *et al*.: Inorganic Chemistry: Principles of Structure and reactivity.
5. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.

List of Suggested Experiments

1. Titrimetric Analysis:
   i. Calibration and handling of apparatus.
   ii. Preparation of solutions of titrants of different Molarity/Normality.

2. Acid-Base Titrations: Principles of acid-base titrations to be discussed.
   i. Estimation of sodium carbonate using standardized HCl.
   ii. Estimation of carbonate and hydroxide present together in a mixture.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-1

Subject Code: 10140104	**Subject Title:** Fundamental Chemistry-2 (Theory)
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) They will gain proficiency in logical deduction skills through written problems and laboratory work.

(2) They will identify problems and generate hypotheses, develop and implement experimental methods to test their hypotheses, and analyze and interpret the resulting data.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	70	30	25	5	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Atomic Structure** Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Shapes of s, p, and d orbitals, Relative energies of orbitals. Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.	10	23%
2	**Fundamentals of Inorganic Chemistry** **Acids and Bases**: Arrhenius theory of Acids and Bases, The Lowry – Bronsted Concept, Strength of Acids and Bases, The Lewis concept, The pH Scale, Self-Ionization of Water.	11	27%
3	**Fundamentals of Physical Chemistry:** **Solids in liquids (sols):** properties - kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. **Liquids in liquids (emulsions):** types of emulsions, preparation, Emulsifier. **Liquids in solids (gels):** classification, preparation and properties, inhibition, general applications of Colloids.	11	27%
4	**Analytical Objectives, Data Handling and Good Laboratory Practice (GLP)** Scope of analytical science and its literature, qualitative and quantitative analysis, ways to express accuracy and precision, types of errors and their causes; GLP- standard operating procedures, quality assurance and quality control, validation of analytical methods.	10	23%

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

- Foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries as well as stereochemistry.
- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- Explore new areas of research in both chemistry and allied fields of science and technology.
- Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- Explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- Function as a member of an interdisciplinary problem-solving team.

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1. Physical Chemistry for the life sciences by Peter Atkins, Oxford University Press.
2. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.
3. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
4. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

List of Reference Books:

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press.
3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. James E. Huheey *et al*.: Inorganic Chemistry: Principles of Structure and reactivity.
5. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.
6. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
7. Ahluwalia, V.K.; Dhingra, S. (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.
8. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi

List of Suggested Experiments

1. Estimation of carbonate and bicarbonate present together in a mixture.
2. Estimation of free alkali present in soaps/detergents
3. Determination of Viscosity and density of unknown test sample using Ostwald viscometer.
4. Identify positive and negative ions from unknown salts.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-1

Subject Code: 10170103	**Subject Title: Introductory Microbiology**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidates must have studied core subjects like Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) To explain the History, Scopes, Branches and Basics of microbiology.
(2) To explain the habitats and impart the knowledge regarding the pure culture techniques.
(3) Clear the concepts of cultivating various microorganisms on different types of media.
(4) To explore the preservation techniques for maintaining routine cultures.
(5) To impart information regarding various national and international culture collection centers.
(6) To train the students in staining techniques and clear the concepts of Microscopy.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**History and Scope of Microbiology:** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Role of microorganisms in fermentation, Germ theory of disease. Development of various microbiological techniques and golden era of microbiology. Development in the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.	15	33%
	Branches and Scopes in Microbiology		
2	**Habitats of Microorganisms:** Soil, Water, Air and others. **Pure culture Techniques and Cultivation:** Pure culture Techniques: Definition of Pure culture and Axenic culture, Mix culture, Methods for Pure culture techniques: Striking, Spreading, Serial Dilutions, Pour Plate methods. Cultivation of Anaerobic Bacteria. **Culture Media:** Principles of Media Formulation, Media Ingredients, Types of Media: Natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media, Sterilization. **Culture Collection Centers.** **Preservation Techniques:** Preservation of industrially important organism: Principle, methods and quality control.	15	34%
3	**Techniques used to study microorganisms:** **Microscopy:** Principles of Microscopy, magnification and resolving power, Light microscopy: Simple and compound microscope, bright field and dark field microscopy, Principles and applications of phase contrast, fluorescent and Electron microscopy. **Staining:** **Dyes and stains:** Definition, acidic, basic dyes and leuco compounds. **Smear:** Fixation, use of mordents, intensifiers and decolorizers Mechanism of staining. **Types of staining:** Simple and differential staining.	15	33%

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

1. Comprehend historical developments/branches and scopes in the field of Microbiology.
2. Comprehend various habitats of microorganisms.
3. Prepare Media in Laboratory and learn the basic skills of isolation and cultivation of microorganisms in laboratory.
4. Preserve Microbial cultures on various media.
5. Explain principles and working pattern of Microscopes.
6. Learn aspects of staining techniques, various dyes and smear preparation.

List of Text Books:

1. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-I. 2nd edn. Himalaya Publishing House.
2. Dr. C. B. Powar and Dr. H. F. Daginawala, (2010), General Microbiology Volume-II. 2nd edn. Himalaya Publishing House.
3. Pelczar Jr, M J, Chan E C S, Krieg N R, (2023), Microbiology: An Application-Based Approach, 5th edn. McGraw-Hill Book Company, NY.

List of Reference Books:

1. Atlas R M, (2015), Principles of Microbiology, 2nd Edition, McGraw Hill education, Mumbai.
2. Ingraham J. L. and Ingraham C. A. Introduction to Microbiology: Thomson Brooks/Cole.
3. Microbiology: an introduction- Tortora, G.J., Funke, B.R. and Case, C.L.
4. Stanier, R.Y., Ingraham J. L., Wheelis, M. L. (1999). General Microbiology,5th Edition, Palgrave Macmillan.

Open e-Resource:

- Swayam Portal: General Microbiology - Course (swayam2.ac.in)
- OpenStax: Microbiology – OpenStax
- https://microbenotes.com/

https://www.microbiologybook.org

List of Suggested Experiments

1. Awareness and knowledge of Lab apparatus. Dos and Don'ts-Criteria to be followed – Lab Discipline – Biosafety, Washing, Cleaning and preparation of glassware for sterilization. Disposal of laboratory waste and cultures. Preparation of standard solutions. Good Laboratory Practices. Good Documentation Practices.
2. Study of principles and working of laboratory instruments: Light microscope, Autoclave, Hot air oven, Incubator, Water-bath, Laminar Air Flow chamber, Rotary shaker, pH meter, Spectrophotometer/Colorimeter, Centrifuge, Refrigerator, Colony counter.
3. Basic Microbe handling techniques:
    a. How to inoculate Needles and wire loops
    b. Preparing suspensions
    c. Inoculating/transferring cultures
    d. Handling petri plates
    e. Incubating petri dishes, slants and broths
    f. Preparing smear
    g. Preparing serial dilutions
4. Study of Hay infusion.
5. Staining of Bacteria: Simple staining:
   Positive staining, Negative staining.
   Differential staining:
   Gram staining.
6. Preparation of Nutrient media: Nutrient agar and Nutrient broth.
7. pH adjustment of media by use of pH strip and pH meter.
8. Isolation and cultivation methods for bacteria from water, soil, curd and surface of table.
   Cultivation methods for bacteria:
    a. Broth culture
    b. Agar slope/slant culture
    c. Agar plate method
        i. Streak plate method
        ii. Pour plate method
        iii. Spread plate method
        iv. Serial Dilution method
    d. Cultivation of Anaerobic Bacteria.
9. Preservation Techniques:
    a. Periodic sub culturing and storage at refrigeration temperature
    b. Preservation in soil (fungi/Azotobacter)
10. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-1

Subject Code: 10170105	**Subject Title:** Astrology-1
Pre-requisite:	

Course Objective:

1. **To introduce the basic principles, origin, development, and key texts of astrology.**
2. **To understand the astrological view of the universe and its applications in various fields.**

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Astrology** Introduction Origin Development of Astrology	10	23%
2	**Elements of Astrology** Siddantha Samhitha Hora	11	27%
3	**Concept of Universe** Word Solar family Earth	11	27%
4	**Applications of Astrology** Social Environmental Health and Education	10	23%

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

1. Understand the origin, development, and core elements of astrology, including key texts like Siddantha, Samhitha, and Hora.
2. Describe the astrological universe and the roles of the solar family and Earth.
3. Identify and analyze essential astrology components and terminology.
4. Evaluate astrology's applications in social, environmental, health, and education fields.

Textbooks

1. "Brihat Samhita" by Varahamihira
2. "Surya Siddhanta" (Translation by Ebenezer Burgess or modern Indian authors)
3. "Brihat Parashara Hora Shastra" by Maharishi Parashara
4. "Essentials of Astrology" by Komilla Sutton

Reference Books

1. "Light on Life: An Introduction to the Astrology of India" by Hart de Fouw & Robert Svoboda
2. "Astrology and Science" by B.V. Raman
3. "Phaladeepika" by Mantreswara
4. "Indian Astrology" by B.V. Raman

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-2

Subject Code: 10140203	**Subject Title:** General Chemistry-1 (Theory)
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) The main objective of the course is to develop the basic understanding of the chemistry.

(2) Students will gain the advance theories and methodologies to solving the problems in classroom and laboratory.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	70	30	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Periodic Properties of Element** Periodicity of Elements: Brief discussion of the following properties of elements, with reference to s- & p-block and the trends shown: (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic and ionic radii	11	27%
2	**Fundamental of Organic Reactions** Intramolecular forces (dipol-dipol interaction, Vander Waals forces) Electromeric effect, Inductive effect, Resonance effect, Hyper conjugation.	11	27%
3	**Liquid States** Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapor pressure, surface tension, coefficient of viscosity, friccohesity, their determination. Effect of various pollutants and solutes on surface tension and viscosity of water as a valuable resource. Explanation of cleansing action of detergents.	10	23%
4	**Basic concepts of Qualitative and Quantitative Analysis** Introduction, Solubility product principle, Common ion effect, Separation of cations of each groups and separation of anions (acid radicals), Introduction of volumetric titration based on normality and morality of the solution, Conditions for volumetric analysis and types of titrimetric analysis.	10	23%

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

- This course will help to develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.

- Fundamental understanding of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.
- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.
- Recognize the significance of chemistry in society and utilize this to guide ethical behavior in matters involving chemists, such as knowledge of chemical handling safety, environmental concerns, and important societal issues involving energy, health, and medicine.
- Justify the importance of chemistry in solving social, economic, and environmental issues.
- Participate in multidisciplinary teams to solve problems.

List of text books:

1. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
2. Physical Chemistry for the life sciences by Peter Atkins, Oxford University Press.
3. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.

List of Reference Books:

1. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press.
3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. James E. Huheey *et al*.: Inorganic Chemistry: Principles of Structure and reactivity.
5. Cotton and Wilkinson. Advanced Inorganic Chemistry 3rd Ed. Wiley.

List of Suggested Experiments

1. Iodo/Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).

(ii) Estimation of antimony in tartar-emetic iodimetrically

2. Paper chromatographic separation of following metal ions:

(i) Ni (II) and Co (II)

3. Inorganic preparations
4. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-2

Subject Code: 10140204	**Subject Title:** General Chemistry-2 (Theory)
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) The main objective of the course is to develop the basic understanding of the chemistry.

(2) Students will gain the advance theories and methodologies to solving the problems in classroom and laboratory.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	70	30	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Atomic Structure** Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Electronic Configuration, Shapes of s, p, and d orbitals, Relative energies of orbitals. Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.	11	27%
2	**Alkanes** (Saturated Hydrocarbons) Introduction, IUPAC nomenclature, Reduction of R-X, Wurtz's reaction, Hydrolysis of R-Mg-X, Decarboxylation of acid, Kolbe's electrolytic process, Free radical mechanism (Chlorination of Methane).	11	27%
3	**Gaseous state** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.	10	23%
4	**Acid Base Titration** Theory of acid-base titration, Ways of locating the end point of an acid-base titration, Titration of strong acid with strong base, Titration of weak acid with strong base, Titration of weak base with strong acid, Titration of weak base with weak acid, Factors determining the exact form of a pH curve.	10	23%

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

- This course will help to develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.

- Fundamental understanding of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.
- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.
- Recognize the significance of chemistry in society and utilize this to guide ethical behavior in matters involving chemists, such as knowledge of chemical handling safety, environmental concerns, and important societal issues involving energy, health, and medicine.
- Justify the importance of chemistry in solving social, economic, and environmental issues.
- Participate in multidisciplinary teams to solve problems.

List of text books:

1. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
2. Physical Chemistry for the life sciences by Peter Atkins, Oxford University Press.
3. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.

List of Reference Books:

1. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. P.W. Atkins: Physical Chemistry, Oxford University Press.
3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. James E. Huheey *et al*.: Inorganic Chemistry: Principles of Structure and reactivity.
5. Cotton and Wilkinson. Advanced Inorganic Chemistry 3rd Ed. Wiley.

List of Suggested Experiments

1. Organic Preparations

   Acetylation of one of the following compounds:

   i. Amines (aniline, o-, m-, p- toluidines and o-, m-, panisidine)

   ii. Phenols (β -naphthol, vanillin, salicylic acid) using conventional method.

2. Potentiometry:

   i. Dibasic acid vs. strong base

   ii. Potassium dichromate vs. Mohr's salt.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-2

Subject Code: 10170203	**Subject Title: Nutritional Pattern in Microorganisms**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Chemistry and Biology at their Higher Secondary level and he/she may have complete Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

(1) To make the students to understand the physiology of microbes in detail.

(2) To make students aware about the nutritional pattern of microbes and their mode of nutrition uptake.

(3) To make students learn about basics of enzymes and other biomolecules.

(4) To teach student Microbial Growth pattern.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	02	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Microbial Nutrition and Growth supporting conditions:** **Culture media: Types of culture media:** Routine and specialized media; Selective media, differential media, enriched media, enrichment media, enumeration media, assay media and maintenance media. **Modes of nutritional uptake: a.** Entry of nutrition in the cell, passive diffusion, facilitated diffusion and active transport **b.** Utilization of nutrients that cannot enter the cell**.** **Classification** of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydro static pressure.	15	33%

2	**Microbial growth:** **Methods of reproduction in bacteria and new cell formation:** **Microbial Growth:** a. Introduction to growth rate, generation time b. Criteria for growth measurement: Cell mass and cell number, methods of c. their measurement d. Normal growth curve of bacteria e. Continuous growth and synchronous growth.	15	33%
3	**Enzymes:** **General introduction: a.** Physical and chemical properties **b.** Structure of enzymes: Prosthetic group, apoenzyme, coenzymes, cofactors **c.** Localization of enzymes: Extra cellular and intra-cellular **d.** Nomenclature and classification of enzymes, lUB system of enzyme classification. **Enzyme action: a.** Active sites of enzymes **b.** Mechanism of enzyme action **c.** Factors affecting enzyme activity **d.** Inhibition of enzyme activity: Competitive and non-competitive.	15	34%

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

1. Understand the concept of Nutrition of the Bacteria and develop an understanding of growth and various parameters affecting to the growth also get the information about how bacterial cell uptake nutrition from the media, Students will understand Classification of bacteria on the basis of different parameters.
2. Students will Gain knowledge about the properties of enzymes and how it works& what is the structure of enzyme, Role of enzymes in Microbial cell also students can learn about what factors will affect the optimum activity of enzymes and how enzymes can inhibit their over acting activity
3. Also, by this paper learning students will aware profoundly about how bacteria and other Microbial cell can reproduce, how new cell formation process will occur, what is growth, how growth can be measured, how was the life cycle of bacteria, what are different types of growth.
4. Basic understanding of bio-molecules and their role in metabolism.

List of Text Books:

- Microbial physiology (4th ed.) Moat, A.G., Foster, J, W., and Spector, M. P. Wiley, Liss. New York; 2002.
- Pelczar Jr, M J, Chan E C S, Krieg N R, (2023), Microbiology: An Application Based Approach, 5th edn. McGraw-Hill Book Company, NY.

List of Reference Books:

- Bacterial Metabolism. (2nd ed.) Gerhardt, G. Springer, 1986.
- Bacterial Physiology and Metabolism. Sokatch, J. R. (2014). Academic Press, New York.

- Biochemistry and Physiology of microorganisms (3rd ed.) David White. Oxford University Press; 2007.
- Black J G, (2015) Microbiology: Principles and Explorations, 9th edn, John Wiley and Sons, Inc. NY.
- Brock's Biology Microorganisms (14th ed.) Madigan, M.T., Martinko, J. M., Bender, K.S., Buckley, D.H., Stahl, D. A., Benjamin Cummings.
- Ingraham J L, and Ingraham, C L, (2000) Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore.
- Lehninger's Principles of Biochemistry. (8th ed.) Nelson, D.L. & Cox, M. M. W. H. Freeman & Co. NY; 2021.

Open e-Resource:

- https://www.onlinebiologynotes.com/
- https://microbiologynotes.org/
- https://www.easybiologyclass.com/
- https://microbiologyinfo.com/
- https://thebiologynotes.com/

List of Suggested Experiments

1. **Study of different types of media:**
   A. Selective media: Rose Bengal agar medium B. Differential medium: MacConkey's agar medium, EMB agar medium, Triple sugar iron agar medium C. Enrichment media: Selenite broth D. Enriched media: Blood agar medium, Glucose yeast extract agar medium E. Natural media: Soil extract agar medium.

2. Qualitative analysis of biomolecules:

A. Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed's test, Bial's test
B. Protein: Biuret test, Ehrlich's test, Glyoxilic acid test and Xanthoproteic test.

3. Study of effect of Environmental factors on growth of bacteria:

A. Study the effect of heavy metal on the growth of bacteria.
B. Study the effect of temperature on the growth of the bacteria.
C. Study the effect of pH on the growth of the bacteria.
D. Study the effect of osmotic pressure on the growth of the bacteria.
E. Study the effect of UV light on the growth of the bacteria.

4. Study of Biochemical reactions:

A. Based on Carbon source i. Oxidative and fermentative breakdown of glucose ii. Fermentation of Sugars: Glucose, Xylose, Mannitol, Lactose, Maltose and Sucrose iii. Glucose breaks down products: Methyl red test and Voges Proskauer's test iv. Citrate utilization test v. Starch utilization test vi. Lipid utilization test.
B. Based on Nitrogen source i. Indole production test ii. H_2S production

test iii. Urea utilization test iv. Casein hydrolysis test v. Gelatin Hydrolysis test vi. Deamination test vii. Ammonia production test viii. Nitrate reduction test.

C. Other tests i. Catalase test ii. Dehydrogenase test iii. Oxidase test.

5. Methylene Blue Reduction Test of milk samples (MBRT).
6. Isolation and characterization of spoilage microorganisms from vegetable/fruit/milk-milk products.
7. Preparation of Yoghurt/curd/probiotic curd/probiotic lassi using pure culture.
8. Standard plate count from vegetables and fruit juices, milk-milk products, soft drink (Any available in Market).

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-2

Subject Code: 10170205	**Subject Title: Agriculture Business Management**
Pre-requisite: Candidate must have achieved regular 10+2 degree from any recognized Board.	

Course Objective: (1) To expose learners to the environment in which the agri-business is conducted.

(2) Focus will be on understanding micro and macro environmental forces and their impact on agri-business.

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	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	Agri-business: Meaning, definition, history and scope of agri-business (Input, Farm Product Sectors). Importance of agri-business in the Indian economy. Changing dimension of agricultural business. Agri-business Management-distinctive features, nature and components.	15	25%
2	Structure of Agriculture - Linkages among sub-sectors of the Agribusiness sector; economic reforms and Indian agriculture; impact of liberalization, privatization and Globalization on Agri business sector. Emerging trends in production, processing, marketing and exports; policy controls and Regulations relating to the industrial sector with specific reference to agro-industries.	15	25%

3	Role of agriculture in Indian economy; problems and policy changes relating to farm Supplies, farm production, agro processing, agricultural marketing, agricultural finance etc. in the country. Demand and Supply: Definition, Meaning, Laws, Factor affecting, Types, Determinants. Elasticity: Definition, Types Natural Resource Economics.	15	25%
4	Agricultural Economics: Meaning, Definition, Scope and Importance of Agricultural Economics Basic Concepts: Goods, Services, Utility, Value, Price, Wealth, and Welfare, Consumption Wants: Meaning, Characteristics, Classification of Wants, Importance.	15	25%

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

1. Understand the fundamentals of management with reference to agribusiness.
2. Acquaint with various functional areas of agribusiness.
3. Study the managerial functions and its applications with reference to agribusiness.
4. Learn the concepts and process of Planning and Organizing.
5. Provides knowledge about the Staffing, Directing and Control.

List of Reference Books:

1. Freddie L. Barnard, Jay T. Akridge, Frank J. Dooley, Agribusiness Management (Environmental and Agricultural Economics), 2010.
2. John B. Penson, Oral Capps, C. Parr Rosson, Richard T. Woodward, Introduction to Agricultural Economics, Pearson, 2019.
3. W.J. Obst, R. Graham & G. Christie, Financial Management in Agribusiness, Scientific Publishers, 2010.

Gandhinagar Institute of Science
B.sc Chemistry
Semester-2

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

B.Sc. Chemistry

Semester-3

Subject Code: 10140305	**Subject Title: Inorganic Chemistry-1**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) To develop the advance knowledge and understandings of the inorganic chemistry.

(2) Students will gain the advance theories and methodologies to solving the problems in classroom and laboratory.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Coordination Compounds:** Application of valence bond theory to some complexes; Shortcomings of valance bond theory; Crystal Field Theory; Crystal Field Splitting in Octahedral complexes; Crystal Field Stabilization Energy (CFSE); Crystal Field Splitting in Tetrahedral Complexes; Jahn- Teller Effect.	10	23%
2	**Chemistry of s-Block Elements:** Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water. Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, Solutions of alkali metals in liquid ammonia and their properties.	11	27%
3	**Chemical Bonding** Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.	11	27%
4	**Covalent Bond** Bent's rule, Resonance and resonance energy. Ionic character in covalent compounds: Bond moment and dipole moment. Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules, N2, O2, C2, B2, F2, CO, NO, and their ions	10	23%

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

- This course will help to develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.
- Fundamental understanding of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.

- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.

List of Text Books:

1. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. James E. Huheey *et al*.: Inorganic Chemistry: Principles of Structure and reactivity.

List of Reference Books:

6. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.
7. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
8. Puri, Sharma, Kalia, "Principles of Inorganic Chemistry", Milestone Publishers & Distributors, New Delhi, 3rd Edition, 2006

List of Suggested Experiments (Max. 12)

2. Titrimetric Analysis:
   iii. Calibration and handling of apparatus.
   iv. Preparation of solutions of titrants of different Molarity/Normality.

2. Acid-Base Titrations: Principles of acid-base titrations to be discussed.
   iii. Estimation of sodium carbonate using standardized HCl.
   iv. Estimation of carbonate and hydroxide present together in a mixture.

3. Inorganic Preparations

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-3

Subject Code: 10140306	**Subject Title:** Organic Chemistry-1
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) They will gain proficiency in logical deduction skills through written problems and laboratory work.

(2) They will identify problems and generate hypotheses, develop and implement experimental methods to test their hypotheses, and analyze and interpret the resulting data.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Reaction Mechanism** Fission of Co-Valant bond, Types of reagents. Types of organic reaction with mechanism. Substitution reactions (Nucleophilic & Electrophilic) Addition reactions (Nucleophilic & Electrophilic) Elimination reactions (E1 & E2)	10	23%
2	**Alkenes and Alkynes:** Introduction, Preparations (dehydration, dehalogenation, dehydrohalogenation), Reactions with H**2**, X**2**, HX, HOCl, H**2**SO**4,** and Hydroboration; Oxidation reactions: (i) with cold alkaline KMnO**4** (Baeyer's reagent), (ii) Oxidative cleavage with acidified or hot KMnO**4,** (iii) Ozonolysis (O**3)**; Polymerization; Reactions of terminal Acetylenes: (i) Addition of water, (ii) Na / liquid NH3.	11	27%
3	**Chemistry of Halogenated Hydrocarbons:** Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution vs. elimination.	11	27%
4	**Aryl halides:** Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds.	10	23%

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

- Foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries as well as stereochemistry.

- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- Clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- Explore new areas of research in both chemistry and allied fields of science and technology.
- Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- Explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- Function as a member of an interdisciplinary problem-solving team.

List of Text Books:

5. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
6. Chandra, R.; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.

List of Reference Books:

1. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Eliel, E. L.; Wilen, S. H. (1994) Stereochemistry of Organic Compounds; Wiley: London.
3. Singh, S.P.; Prakash, O. (2017), Reaction Mechanism in organic chemistry, Laxmi Publications.
4. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

List of Suggested Experiments (Max. 12)

5. Estimation of carbonate and bicarbonate present together in a mixture.
6. Estimation of free alkali present in soaps/detergents
7. Determination of Viscosity and density of unknown test sample using Ostwald viscometer.
8. Organic Preparation (any one of the following):

(a) Bromination of acetanilide/aniline/phenol
(b) Nitration of nitrobenzene/toluene

9. Purification of organic compounds by crystallization using the following solvents:

(a) Water
(b) Alcohol
(c) Alcohol-Water

10. Determination of the melting points of prepared organic compounds.
11. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-3

Subject Code: 10140307	**Subject Title:** Physical Chemistry-1
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) The main objective of the course is to develop the basic understanding of the chemistry.

(2) Students will gain the advance theories and methodologies to solving the problems in classroom and laboratory.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Chemical Energetics:** Review of thermodynamics and the laws of thermodynamics, important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution, Kirchhoff's equation,	11	27%
2	**Ionic Equilibrium:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids.	11	27%
3	**Electrochemistry Basics**: Introduction, Electrical Resistance and Electrical Conductance, Measurement of Electrolytic Conductance, Specific Conductivity, Equivalent Conductivity and Molar Conductivity, Numerical Problems on Specific, Equivalent and Molar Conductivities, Effect of Dilution on Specific Conductance and Equivalent Conductance	10	23%
4	**Surface chemistry:** Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Qualitative discussion of BET.	10	23%

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

- Understanding the basics and advanced concepts of the state of matter, such as gaseous, liquid, and solid states
- Understanding the basics of acids and bases, and calculating the pH of various acidic and basic solutions
- Understanding the concept of buffer solutions and preparing buffer solutions as required

- Deriving mathematical expressions to define the physical properties of solids, liquids, and gases
- Deriving equations to calculate the pH of acids, bases, and buffer solutions
- Participate in multidisciplinary teams to solve problems.

List of text books

4. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.
5. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.

List of Reference Books

6. P.W. Atkins: Physical Chemistry, Oxford University Press.
7. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
8. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
9. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.

List of Suggested Experiments (Max. 12)

1. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.
2. Preparation of stock solutions.
3. Detection of pH of the given solutions.
4. Preparation of buffer solutions of different pH values
    (a) Sodium acetate-acetic acid
    (b) Ammonium chloride-ammonium hydroxide

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-3

Subject Code: 10170308	**Subject Title:** Astrology-II
Pre-requisite:	

Course Objective:

1. **To study the traits and scientific aspects of planets, signs, houses, and aspects with critical thinking.**
2. **To build skills in natal chart reading using concepts from prediction, psychology, and neuroscience.**

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		**Total**
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Planets** Introduction Characteristics Scientific aspects	10	23%
2	**The Zodiac: Understanding the 12 Signs** Introduction Characteristics Relative analysis with Science	11	27%
3	**Houses and Aspects** Introduction Characteristics Critical Thinking & Skepticism	11	27%
4	**Reading a Natal Chart** Introduction Characteristics Prediction, Psychology and Neuroscience	10	23%

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

- Understand the traits and scientific aspects of planets, signs, houses, and aspects.
- Analyze zodiac signs from both traditional and scientific viewpoints.
- Use critical thinking to evaluate houses and other astrological concepts.
- Interpret natal charts using astrology, psychology, and neuroscience.

Textbooks

1. "Planets in Transit" by Robert Hand
2. "The Only Astrology Book You'll Ever Need" by Joanna Martine Woolfolk
3. "Astrology for the Soul" by Jan Spiller

Reference Books

1. "Cosmos and Psyche" by Richard Tarnas
2. "Aspects in Astrology" by Sue Tompkins
3. "The Inner Sky" by Steven Forrest
4. "Psychological Astrology: A Synthesis of Jungian Psychology and Astrology" by Karen Hamaker-Zondag
5. "Houses: Temples of the Sky" by Deborah Houlding

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-4

Subject Code: 10140405	**Subject Title:** Inorganic Chemistry-2
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) The main objective of the course is to develop the basic understanding of the chemistry.

(2) Students will gain the advance theories and methodologies to solving the problems in classroom and laboratory.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Structure, bonding and properties:** Acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following: Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH3 where E = N, P, As, Sb, Bi), Group 16 and Group 17. Oxides: oxides of phosphorus, sulphur and chlorine Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids of sulphur Halides: halides of silicon and phosphorus	11	27%
2	**Lanthanides** Lanthanide electronic configuration, Oxidation state, Lanthanide contraction, Effect of lanthanide contraction, Separation method (1) Solvent extraction methods (2) Ion Exchange Method	11	27%
3	**Actinides:** Electron configuration, Oxidation states, Magnetic properties, Color and absorption spectra of actinide ions, actinide contraction, Nuclear synthesis of trans uranic elements, Chain reaction, importance of Uranium, Comparison with lanthanide.	10	23%
4	**Chemical Forces:** van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.	10	23%

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

- This course will help to develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.
- Fundamental understanding of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.

- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.
- Recognize the significance of chemistry in society and utilize this to guide ethical behavior in matters involving chemists, such as knowledge of chemical handling safety, environmental concerns, and important societal issues involving energy, health, and medicine.
- Justify the importance of chemistry in solving social, economic, and environmental issues.
- Participate in multidisciplinary teams to solve problems.

List of text books

4. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India.
5. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.

List of Reference Books

6. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
7. Cotton and Wilkinson. Advanced Inorganic Chemistry 3rd Ed. Wiley.
8. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
9. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.

List of Suggested Experiments (Max. 12)

1. **Iodo / Iodimetric Titrations**
   - (i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodometrically).
   - (ii) Estimation of antimony in tartar-emetic iodimetrically
   - (iii) Estimation of Iodine Content in iodized salt
2. **Complexometric titrations using disodium salt of EDTA**
   - (i) Estimation of Mg2+,Zn2+
   - (ii) Estimation of Ca2+ by substitution method
   - (iii) Estimation of Calcium content in milk.
3. **Inorganic Preparations**

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-4

Subject Code: 10140406	**Subject Title:** Organic Chemistry-2
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective: (1) They will gain proficiency in logical deduction skills through written problems and laboratory work.

(2) They will identify problems and generate hypotheses, develop and implement experimental methods to test their hypotheses, and analyze and interpret the resulting data.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Alcohol:** Preparation, Pinacol-Pinacolone rearrangement. Phenols: Preparation and properties; Acidity and affecting factors, Ring substitutionreactions, Reimer– Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements and their mechanism.	10	23%
2	**Carbonyl Compounds:** Nucleophilic additions, Nucleophilic addition-elimination reactions, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, Friedel-Crafts reaction.	11	27%
3	**Carboxylic acids:** General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength, hydroxy acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides	11	27%
4	**Carbohydrates** Saccharides, structure of Glucose, Fructose, (+) maltose, (+) cellobiose, (+) lactose and (+) sucrose. Synthesis of carbohydrates, Physical and Chemical Properties of Carbohydrates.	10	23%

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

- Understanding major concepts and different aspects of organic chemistry.
- Understanding and defining various topics of organic chemistry in broader sense like: basic principles, reaction mechanism, stereochemistry, nomenclature, estimation and purification of organic compounds.
- Understanding an overview of application of organic chemistry.

- Applying chromatographic method of separation and qualitative analysis functional groups in organic compounds.
- Evaluating distribution co-efficient of a compounds between two immiscible solvents.
- Function as a member of an interdisciplinary problem-solving team.

List of Text Books:

1. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
2. Chandra, R.; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.

List of Reference Books:

1. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Eliel, E. L.; Wilen, S. H. (1994) Stereochemistry of Organic Compounds; Wiley: London.
3. Singh, S.P.; Prakash, O. (2017), Reaction Mechanism in organic chemistry, Laxmi Publications.
4. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

List of Suggested Experiments (Max. 12)

Short organic preparation and their purification: Use 0.5-1.0g of the organic compound.

Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product.

Preparation of organic compounds

1. Glucosazone from dextrose or fructose
2. Tribromoaniline from aniline.
3. β-Naphthylbenzoate
4. m-Dinitrobenzene from nitrobenzene
5. Phthalic anhydride from phthalic acid by sublimation
6. Acetanilide from aniline
7. p-Bromoacetanilide from acetanilide
8. Iodoform from acetone

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-4

Subject Code: 10140407	**Subject Title:** Physical Chemistry-2
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) To impart practical knowledge of equilibrium and electrochemical aspects of dilute solutions.

(2) To explore the chemistry of the three phases (solid, liquid and gases) of material and kinetic aspects of chemical reactions.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
03	-	2	04	50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Distribution Law**: Nernst Distribution Law—Introduction, Thermodynamic Derivation of Distribution Law, Modification in Distribution Law in Case of Change in Molecular State, Applications of Distribution Law, Utility of Distribution Law in the Process of Extraction, Determination of Degree of Hydrolysis from Distribution Law.	11	27%
2	**Chemical Equilibrium:** Introduction, Law of Mass Action, Applications of Equilibrium Constant, Partial Molar Quantities, Free-Energy Change as a Criterion of Spontaneity, VanT Hoff Equation for Temperature Dependence of Equilibrium Constant (Van't Hoff Reaction Isochore), Le-Chatelier's Principle, Clausius-Clapeyron Equation, Hammett Equation	11	27%
3	**Electrochemistry Basic:** Arrhenius Theory of Ionisation Ostwald Dilution Law, Variation of Conductivity with Concentration of Strong Electrolytes (Debye-Huckel-Onsagar Equation), Kohlrausch's Law, Anomalous Behaviour of Strong Electrolytes Debye-Huckel Theory, Migration of Ions and Transport Number, Hittorf's Theoretical Device—Change in Concentration,	10	23%
4	**Nuclear Chemistry**: Isotopes, Fundamental Particles of the Nucleus, Natural Radioactivity, Artificial Disintegration or Transmutation of Elements, Q Value of Nuclear Reactions, Nuclear Fission, Nuclear Fusion, racer and Tracer Technique Applications of Tracer (Radio Isotopes) Technique, Design of Nuclear Reactor, Soddy's Group-Displacement Law	10	23%

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

- Explain Nernst Distribution Law and its applications in extraction and hydrolysis.
- Understand principles of chemical equilibrium and factors affecting equilibrium.
- Describe basic concepts of electrochemistry including ionization, conductivity, and transport number.

- Explain fundamentals of nuclear chemistry and applications of radioisotopes.

List of text books

1. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.
2. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.

List of Reference Books

1. P.W. Atkins: Physical Chemistry, Oxford University Press.
2. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
3. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
4. Essential of Physical Chemistry by Bahl, Bahl, and Tuli, S. Chand and Co.

List of Suggested Experiments (Max. 12)

1. To determine specific refraction and molar refraction of liquid A, B and its Mixture.
2. To study the adsorption of an organic acid by Animal Charcoal. (Acetic acid /Oxalic acid).
3. To determine the conductivity of the given stock solution.
4. To determine the strength of acid by titrimetric method.
5. To determine absolute viscosities of liquid A, B and their mixture.

GANDHINAGAR INSTITUTE OF SCIENCE
B.Sc. Chemistry
Semester-4

Subject Code: 10320401	Subject Title: Natural Resources & Management
Prerequisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidates must have studied core subjects like Chemistry and Biology at their Higher Secondary level and he/she may have completed a Certificate Course (First Year, B.Sc.) with Basic Microbiology and Chemistry subjects.	

Course Objective:

1. To introduce the students about basic knowledge of Natural resources, their significance, availability, and conservation.

2. The course also includes the methodology and technical aspects to provide comprehensive knowledge of the subject.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	Theory		Practical		Total
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
03	-	02	04	50	50	25	25	150

Sr. No.	Topic	Total Hours	Weight %
1	**Introduction to Natural Resources and Management**. Introduction and importance of natural resources. Scopes of natural resource management. Renewal and non renewal resources. Trends and drivers of resource use (demography, ecological settings, economic growth, patterns of	10	25 %

	developments, etc.). Causes and consequences of resource depletion. Principles, Issues and approaches (community based, adaptive and integrated). Concept and evolution of sustainable development. Importance of legal, policy and governance in natural resource management. Organizational structure and stakeholders in NRM and livelihood.		
2	**Water resources**: Introduction of water resources. Description of hydrological cycle. Description of major sources of water for human. Use, causes and impacts of water resource depletion. Resource base, surface water, ground water, requirement. Policies (Water resource Act 1992, Water resource rule 1994), Strategy (Water Resources Strategy Nepal 2002) and Management practices (rain water harvesting, watershed management; multipurpose water resource management programs, etc.). **Fishery**: Fishery resources of Gujarat and their utilization (Fresh water and Marine), Fisheries of the important species/groups (Mackerel, Sardine, Bombay duck, Pomfrets, Hilsa, Mullet, Major Carps, game fishes and exotic fishes).	**12**	**25%**
3	**Land Resources**: Concept of land resource and land use, land use types, land use classification. Causes, types and effects of land degradation. Land use and land reform policy, land use planning, land resource management practice (mechanical, biological methods, fertility management). Importance of mountain as natural resources, degradation and its management. Mountain and tourism. Forest types and characteristics of India. Timber, fuel wood, fodder, NTFP, etc. Forest management- management policy, strategy and programs of India. Policy, programs and implementation of rules.	**11**	**25%**
4	**Mineral Resources**: Mineral resources, types (metallic and non-metallic minerals) and distribution of mineral resources,	**11**	**25 %**

	importance of mineral resources. Rapid depletion, wastage, environmental pollution. Policy, strategy and practice (reuse, recycle, sustainable extraction, etc). Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies		

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

CO 1. This course is designed to enable students to acquire understanding of the structure of Natural resources, their conservation and management.

CO 2. To introduce to the students various conceptual and analytical perspectives (drawn from different academic disciplines) to look at environmental problems

CO 3. It helps them to get knowledge of various Land resources

CO 4. The awareness of the Mineral resources will help them for further work.

References

- **Agarwal, K.**M., Sikdar, P.K., Deb., S.C. 2005. A Text Book of Environment. Macmillan India Limited.
- Klee, G.A. 1991. Conservation of Natural Resources. New Jersey: Prentice Hall Publ. Co.
- Miller, G.T. (Jr.) and Spoolman, S.T. 2010. Living in the Environment. Brooks/Cole. Belmont, California, USA: Wardsworth Publishing Company.
- Nalini, K.S. 1993. Environmental Resources and Management. Anmol Publishers.
- Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. Resources of the Earth: Origin, Use, and Environmental Impacts (2nd edition). Prentice Hall, New Jersey.
- Freeman, A.M. 2001. Measures of value and Resources: Resources for the Future. Washington DC.
- Freeman, A.M. 2003. Millennium Ecosystem Assessment: Conceptual Framework. Island Press.
- Ginley, D.S. & Cahen, D. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press.

List of Suggested Practical

1. Water analysis: chemical Properties (pH, Acidity, Alkalinity, Hardness, Chloride, Nitrate, Sulphate).
2. Study of plant fossil forms from different geological periods.
3. Preparation of Herbarium.
4. Estimation of Halides in water sample by Potentiometer.
5. Study of Plant and animal Specimens.
6. Study of plant chordate (Minimum Size, Minimum Number, Frequency, Density).
7. Study of species diversity index of vegetation.
8. Study of Phytoplankton and Macrophytes from water bodies.

Gandhinagar Institute of Science
B.sc Chemistry
Semester- IV

Subject Code: IKS0401	Subject Title: Indian ancient Science and Philosophy

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	**Ancient Science And Technology In India:** Development of science in ancient India (Astronomy, Mathematics, Medicine, Metallurgy, Chemistry) **Scientists of Ancient India and their contribution:** Mathematics & astronomy (Baudhayan, Aryabhatta, Brahmgupta, Bhaskaracharya, Mahaviracharya) Science (Kanad, Varahamihira, Nagarjuna) Medical science in ancient india (Susruta, Charak, Yoga & Patanjali)	15	1
2	**Indian Philosophical Systems:** Characteristics of Indian Philosophy, Pramanas, General Introduction to Indian Philosophical systems, i.e. Orthodox and Heterodox. Tenet of Nyaya philosophy, Principles of Vaisesika. Indian preaching on dharma, artha and Society- Bhagavadgita, Arthasastra, Gurukula systems, Nalanda, Takṣasila,	15	1

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

- Develop the ability to critically examine ancient sciences of India and narratives to understand the science and technology in ancient India.
- Develop a comprehensive understanding of the key characteristics of Indian philosophical systems.

List of Text Books:

1. An advanced history of India by B.C Majumdar & others, 1967, Macmillan
2. Ancient India by R.C. Majumdar, 1977, Motilal Banarsidas
3. History of Ancient India by Ram Shankar Tripati, 1942, Motilal Banarsidas
4. History and culture of India to 1000 A.D. by H.V. Srinivasamurthy, 1980, S.Chand & Co.
5. Advance history of India by K.A. NIlakanta Sastry & C.S. Srinivasachari, 1980, Allied Publications.
6. Ashoka, V.A. Smith, 1970, Oxford University Press.
7. Society, Religion & Art of Kushana India, Kanchan Chakraberti, 1930, Bagchi & Co.,
8. Ancient India by Romila Thapar, 2002, Oxford University Press, Delhi
9. Understanding Harappan civilization by Shereen Ratnagarh, Tulika Publication, Delhi

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-5

Subject Code: 20140501	**Subject Title: Inorganic and Organic Chemistry-I**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To impart fundamental knowledge of ceramic materials, their classifications, manufacturing processes, and industrial applications including glazing and types of cement.
2. To develop an understanding of glass and silicate industries, and the chemistry of heterocyclic and aromatic compounds including their structural and reactive behavior.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents

Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Ceramics** Brief introduction to types of ceramics. glazing of ceramics. Cement: Manufacture of Portland cement and the setting process, Different types of cements: quick setting cements, eco-friendly cement (slag cement), pozzolana cement.	10	23%
2	**Silicate Industries Glass** Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass.	11	27%
3	**Heterocyclic Compounds** Introduction, structure of Pyrrole, Furan and Thiophene, Furan and Thiophene, reactivity and orientation of electrophilic substitution reactions (ESR) in five membered heterocycles.	11	27%
4	**Aromatic Hydrocarbons** Concept of Aromaticity, Huckel's rule, aromatic character of arenes, cyclic carbocations and carbanions with suitable examples and heterocyclic compounds with suitable examples. halogenation, nitration, sulphonation, Friedel Crafts alkylation/ acylation.	10	23%

Course Outcome: Students will be able to

1. Describe the types, properties, and glazing methods of ceramics and explain the manufacturing process and setting of various types of cement.
2. Explain the glassy state, classification of glasses, and analyze the composition, manufacture, and uses of various industrial glasses like borosilicate, soda lime, and lead glass.
3. Illustrate the structures of five-membered heterocyclic compounds like pyrrole, furan, and thiophene and predict their behavior in electrophilic substitution reactions.
4. Apply the concept of aromaticity and Huckel's rule to aromatic hydrocarbons and heterocycles, and explain their typical electrophilic substitution reactions such as halogenation, nitration, and Friedel–Crafts reactions.

List of Text Books

3. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley
4. Smart, L. E.; Moore, E. A. (2012), Solid State Chemistry An Introduction, CRC Press Taylor & Francis.

List of Reference Books:

9. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.
10. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
11. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010),Shriver and Atkins Inorganic Chemistry, W. H. Freeman and Company.
12. Kent, J. A. (ed) (1997),Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-5

Subject Code: 20140502	**Subject Title: Physical and Analytical Chemistry-I**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To provide a deep understanding of the fundamental principles and quantitative treatment of conductance, chemical kinetics, and error analysis in chemical measurements.
2. To equip students with practical and theoretical knowledge of separation techniques such as solvent extraction and chromatography, along with statistical tools for data evaluation.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Conductance** Quantitative aspects of Faraday's laws of electrolysis, Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Walden's rule.	10	23%
2	**Chemical Kinetics** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods for determination of rate laws, kinetics of complex reactions.	11	27%
3	**Errors in chemical analysis** Types of errors, Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty. Statistical tests of data (the F test, the t test, Q test for bad data, the method of least squares).	11	27%
4	**Solvent extraction** Distribution law, Determination of distribution ratio Batch extraction, continuous extraction, discontinuous extraction, counter current extraction, Determination of Rf value of amino acids using paper chromatography.	10	23%

Course Outcome: Students will be able to

1. Explain the principles of electrolytic conductance and apply Kohlrausch's law and Walden's rule to evaluate ionic behavior in solution.
2. Derive and apply rate laws for chemical reactions of different orders and interpret the kinetics of simple and complex reactions using experimental methods.
3. Identify and categorize errors in chemical analysis and apply statistical tests (F, t, Q) to assess data accuracy, precision, and reliability.
4. Demonstrate the principles and applications of solvent extraction and chromatographic techniques, including determination of distribution ratios and Rf values.

List of Text Books:

7. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
8. Chandra, R.; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.

List of Reference Books:

5. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Eliel, E. L.; Wilen, S. H. (1994) Stereochemistry of Organic Compounds; Wiley: London.
7. Singh, S.P.; Prakash, O. (2017), Reaction Mechanism in organic chemistry, Laxmi Publications.
8. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-5

Subject Code: 20140503	**Subject Title: Practical Chemistry-V**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) To develop advanced knowledge and understanding of inorganic, organic and physical chemistry.

(2) Students will gain advanced theories and methodologies to solve the problems in classroom and laboratory.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	08	04	-	-	50	50	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	• Organic Preparations (Any five) • Inorganic Preparations (Any Five) • Titrimetric analysis • Water analysis • Soil analysis • Conductance of given sample • Preparation of stock solutions • Distillation of solvents	08	100%

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

- Develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.
- Understand of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.
- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.

- Investigate novel chemistry-related and related scientific and technological domains.

List of Text Books

5. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley
6. Smart, L. E.; Moore, E. A. (2012), Solid State Chemistry an Introduction, CRC Press Taylor & Francis.

List of Reference Books:

13. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.
14. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
15. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, W. H. Freeman and Company.
16. Kent, J. A. (ed) (1997),Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry **MINOR-1**

Semester-5

Subject Code: 20140504	**Subject Title: Analytical Techniques-I**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To introduce students to fundamental concepts of chemical accuracy, precision, and statistical evaluation of data for analytical chemistry.
2. To develop practical understanding of separation techniques like chromatography and solvent extraction, and to apply chemical concentration calculations in analytical contexts.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Errors in chemical analysis** Types of errors, Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty. Statistical tests of data (the F test, the t test, Q test for bad data, the method of least squares).	11	27%
2	**Solvent extraction** Distribution law, Determination of distribution ratio Batch extraction, continuous extraction, discontinuous extraction, counter current extraction, Determination of Rf value of amino acids using paper chromatography.	11	27%
3	**Fundamental Chromatography** Classification of chromatographic methods: Principle of differential migration, description of the chromatographic process, distribution coefficients, modes of chromatography, performing column chromatography.	10	23%
4	**Chemical concentrations** Mole, molar mass, Calculations in grams and moles, Solutions and their concentrations: a) Molar concentration b) Percent concentration c) Parts per million/billion (ppm, ppb)	10	23%

Course Outcome: Students will be able to

1. Distinguish between different types of errors in chemical analysis and apply statistical tools such as F, t, Q tests, and least squares for accurate data interpretation.
2. Explain the principles and procedures of solvent extraction methods and determine distribution ratios and Rf values using techniques like paper chromatography.
3. Classify chromatographic techniques and describe their mechanisms based on differential migration and distribution coefficients, including column chromatography applications.
4. Perform accurate chemical concentration calculations in various units (molarity, percent, ppm, ppb) and relate them to practical laboratory applications.

List of text books

1. Seamus P.J. Higson: Analytical Chemistry.
2. Douglas A. Skoog and Donald M. West: Fundamentals of Analytical Chemistry.

List of Reference Books

1. Adion A. Gordus: Schaum's Outline of Analytical Chemistry, Tata McGraw-Hill.
2. Gary D. Christian: Analytical Chemistry.
3. Freifelder and Kealy: Analytical Chemistry.
4. Daniel C Harris: Exploring Chemical Analysis.
5. Daniel C Harris: Quantitative Chemical Analysis.

Gandhinagar Institute of Science

B.Sc. Chemistry

Semester-5 **MINOR-II**

Discipline-Specific IKS

Subject Code: 10140507	**Subject Title: IKS-Chemistry**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 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**	4	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	-	2		50	50	25	25	150

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Chemistry and Indian Philosophy:** Theory of chemical combination in ancient India, Use of chemistry to understand vedic knowledge Introducing ayurveda the science of health and disease Theory of dynamic contact (Vistambha) Conception of molecular motion (parispanda) Evolution of different forms of matter (Pacikaraṇa) from the Vedantic, view, role of heat, fire and time in transformation. Elemental theory Panchmahabhuta.	13	23%
2	**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	12	27%
3	**Antient Chemistry and Metallurgy:** From alchemy to chemistry	10	27%

	Glass Making, Paints and Dyes, Perfumes and Cosmetics, Paper and Ink Making Concept of Nanoparticles Zinc distillation as mentioned in Rasarṇava and rasaratnasamukaya Processing of gold, silver, copper, iron, tin, mercury, lead, and zinc as mentioned in the Indian texts in the ancient and medieval period Evaluation of chemical apparatus		
4	**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.	10	23%

Course Outcomes:

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.

CO2: Analyze classical Indian philosophical concepts (e.g., *Pañcīkaraṇa*, *Parispanda*, *Viṣṭambha*) in relation to theories of matter, motion, and transformation.

CO3: Examine the development of ancient Indian metallurgy, including techniques for extraction, purification, and alloy preparation, and assess their scientific relevance.

CO4: Interpret the principles of "Hindu Chemistry" as documented in classical texts, and evaluate their influence on the evolution of chemistry and alchemy.

Practical Sessions/Experiential Learning

Unit 1:

- Preparation of reports on the survey, the science of health and disease (Ayurveda).
- Preparation of reports on the antimicrobial, antioxidant and anticancer properties of Indian traditional medicinal plants (Any ten)

Unit 2:

- Presentation on the life and work of prominent Indian chemists (any two).
- Preparation of reports on the early technique of extraction and distillation.

Unit 3:

- Preparation of reports on the early technique of glass making and perfume synthesis.
- Preparation of reports on the ancient processing of gold, silver, copper & comparison with recent processes for the same.

Unit 4:

- Preparation of reports on the ancient ritualism and chemical transformation in tantric tradition.

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

B.Sc. Chemistry

Semester-6

Subject Code: 20140601	**Subject Title: Inorganic and Organic Chemistry-II**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To impart theoretical knowledge of coordination and organometallic compounds including bonding models, structure, properties, and applications.
2. To build foundational understanding of biologically important molecules such as amino acids, peptides, proteins, carbohydrates, and lipids with respect to their structure, properties, and significance.

. **Teaching Scheme (Hours per week)**			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Coordination compounds** Crystal field theory (CFT) with reference to octahedral, distorted octahedral (Jahn Tellar distortion), tetrahedral and square planar complexes, explanation of colour and magnetic properties of magnetic complexes, limitations of crystal field theory	11	27%
2	**Organometallic Chemistry** Introduction, classification of organotransition metal complexes, 18 electron rule with respect to [Fe(CO)5], [Ni(CO)5], [Mn(CO)5]+, ferrocene, structure and bonding in metal olefins (Zeise's Salt).	11	27%
3	**Amino Acids, Peptides and Proteins** Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, isoelectric point and electrophoresis; Study of peptides: determination of their primary structure-end group analysis.	10	23%
4	**Carbohydrates and lipids** Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose; Disaccharides – Structure elucidation of maltose, lactose and sucrose.	10	23%

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

1. Explain crystal field theory in various geometries and interpret the colour, magnetic properties, and limitations of coordination complexes.
2. Apply the 18-electron rule and describe the structure and bonding in organometallic compounds like [$Fe(CO)_5$], ferrocene, and Zeise's salt.
3. Describe the synthesis, ionic nature, and behavior of α-amino acids and peptides, including the concept of zwitterions, isoelectric points, and peptide sequence determination.
4. Analyze the structure and classification of carbohydrates and lipids, determine ring size and configuration of monosaccharides, and explain the structural features of disaccharides like maltose, lactose, and sucrose.

List of text books

6. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India.
7. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education.

List of Reference Books

10. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
11. Cotton and Wilkinson. Advanced Inorganic Chemistry 3rd Ed. Wiley.
12. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
13. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-6

Subject Code: 20140602	**Subject Title: Physical and Analytical Chemistry-II**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To develop an understanding of various types of catalysis including enzyme and acid-base catalysis, with focus on mechanisms and specificity.
2. To introduce students to fundamental principles of photochemistry and chromatographic separation techniques, highlighting their theoretical and practical significance.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Catalysis** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.	10	23%
2	**Photochemistry** Characteristics of electromagnetic radiation, Jablonski Diagram. Lambert-Beer's law and its limitations, physical significance of absorption coefficients. photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes,	11	27%
3	**Chromatography** Instrumentation and working methodology and applications of HPLC & GC (Gas Chromatography), types of columns, packed columns, Capillary columns.	11	27%
4	**Atomic Absorption Spectrometry & ICP (Inductive coupled Plasma)** Introduction, Basic Principles, Instrumentation Applications:	10	23%

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

1. Explain the types, specificity, and mechanisms of catalysis including surface and enzyme catalysis using the Michaelis-Menten model and acid-base catalysis.
2. Interpret photochemical processes using Jablonski diagrams, apply Lambert-Beer's law, and describe phenomena such as photosensitization and quenching in biochemical contexts.
3. Describe the principles and types of chromatographic methods based on differential migration and distribution coefficients.
4. Perform and evaluate chromatographic separations such as column chromatography and understand the selection of suitable chromatographic modes for specific applications.

List of Text Books:

3. R.T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
4. Chandra, R.; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.

List of Reference Books:

5. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Eliel, E. L.; Wilen, S. H. (1994) Stereochemistry of Organic Compounds; Wiley: London.
7. Singh, S.P.; Prakash, O. (2017), Reaction Mechanism in organic chemistry, Laxmi Publications.
8. Stereochemistry Conformation and Mechanism 7th Edition by P.S. Kalsi; New Age International (P) Ltd.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-6

Subject Code: 2040603	**Subject Title: Practical Chemistry-VI**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) To provide hands-on experience with classical volumetric analysis, buffer systems, organic synthesis, and purification techniques.

(2) To enable students to experimentally determine key thermodynamic and colligative properties and develop precise laboratory skills for analytical and synthetic chemistry.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
00	-	08	04	-	-	50	50	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	1. Oxidation-Reduction Titrimetry: a. Principles of oxidation-reduction titrations (electrode potentials) to be discussed. b. Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution c. Estimation of oxalic acid and sodium oxalate in a given mixture. d. Estimation of Fe(II) with K2Cr2O7 using internal indicator (diphenylamine, N-phenylanthranilic acid) and discussion of external indicator. 2. Preparation of buffer solutions of different pH values a. Sodium acetate-acetic acid b. Ammonium chloride-ammonium hydroxide 3. Organic Preparation (any one of the following): a. Bromination of acetanilide/aniline/phenol b. Nitration of nitrobenzene/toluene 4. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol	12	100%

	c. Alcohol-Water 5. Determination of the melting points of prepared organic compounds. 6. Determination of enthalpy of hydration of salt. 7. To study the effect of concentration of solute on elevation of boiling point of water. 8. To study the elevation in boiling point on adding same concentrations of electrolyte and nonelectrolyte to a specific volume of water.		

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

1. Perform oxidation-reduction titrations to estimate Fe(II), oxalic acid, and sodium oxalate using $KMnO_4$ and $K_2Cr_2O_7$ with internal and external indicators.
2. Prepare buffer solutions of desired pH using weak acid–conjugate base and weak base–conjugate acid combinations and understand their role in maintaining pH.
3. Synthesize simple organic compounds through bromination or nitration reactions and purify them using appropriate crystallization techniques.
4. Experimentally determine melting points, enthalpy of hydration, and observe elevation in boiling point due to concentration and type of solute, understanding colligative behavior.

List of text books

1. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
2. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
3. Ahluwalia, V.K.; Dhingra, S. (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.
4. Kapoor, K.L. (2019), A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education. 3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry **MINOR**

Semester-6

Subject Code: 20140604	**Subject Title: Analytical Techniques - II**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To introduce students to the fundamental principles, instrumentation, and types of transitions involved in UV-Visible and FTIR spectroscopy.
2. To enable students to interpret spectra for qualitative and quantitative analysis and understand real-world applications in material science, pharmaceuticals, and environmental studies.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**UV-Visible spectroscopy** Basic Principles – Electromagnetic spectrum, electronic transitions, and Beer-Lambert law. Instrumentation – Components of UV-Vis spectrophotometers (light source, monochromator, detectors). Types of Transitions – $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$, and charge-transfer transitions in organic and inorganic compounds. Quantitative and Qualitative Analysis – Determination of concentration and structural information. Applications – Use in polymer characterization, drug analysis, and environmental monitoring.	11	27%
2	**FTIR spectroscopy** Fundamentals of IR Spectroscopy – Molecular vibrations, IR absorption principles, and selection rules. FTIR Instrumentation – Components such as interferometer, detectors, and sample preparation techniques. Interpretation of Spectra – Functional group identification and fingerprint region analysis. Quantitative and Qualitative Analysis – Concentration measurements and compound identification. Applications – Use in polymer analysis, material verification, and quality control.	11	27%
3	**Voltametry** Basic Principles – Introduction to electrochemical cells, redox reactions, and electrode processes. Types of Voltammetry – Overview of cyclic, linear sweep, and pulse voltammetry techniques. Instrumentation – Electrodes (working, reference, counter), voltammetric cells, and potentiostats. Data Interpretation – Analysis of current-voltage curves and	10	23%

	determination of redox potentials. Applications – Use in trace metal analysis, sensor development, and environmental monitoring.		
4	**Thermal analysis** Introduction to Thermal Analysis – Overview and importance in material characterization. Thermogravimetric Analysis (TGA) – Principles, instrumentation, and interpretation of weight loss data. Differential Scanning Calorimetry (DSC) – Concepts of heat flow, phase transitions, and glass transition temperature. Differential Thermal Analysis (DTA) – Working principles and comparison with DSC. Applications – Use in polymer degradation, thermal stability studies, and quality control.	10	23%

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

1. Explain the principles of UV-Vis spectroscopy, including Beer-Lambert law and electronic transitions such as $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$, and charge transfer.
2. Describe the working and components of UV-Vis and FTIR spectrophotometers and evaluate spectra for determining concentration and molecular structure.
3. Interpret FTIR spectra to identify functional groups and analyze fingerprint regions for compound identification and structural elucidation.
4. Apply UV-Vis and FTIR techniques for practical applications such as drug analysis, polymer characterization, material verification, and environmental monitoring.

List of text books

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry: An Introduction, 5th edition, Saunders college publishing, Philadelphia, 1990.
2. U.N. Dash, Analytical Chemistry: Theory and Practice, Sultan Chand and sons Educational Publishers, New Delhi, 1995.
3. R.A. Day Jr. A.L. Underwood, Quantitatives Analysis, 5th edition, Prentice Hall of India Private Ltd., New Delhi, 1988.
4. R. Gopalan, Analytical Chemistry, S. Chand and Co., New Delh.

List of Reference Books

1. Elementary Organic Spectroscopy: Principles and Chemical Applications, S. Chand and company Ltd., Ram Nagar, New Delhi, 1990.
2. V.K. Srivastava, K.K. Srivastava, Introduction to Chromatography: Theory and Practice, S. Chand and company, New Delhi, 1987.
3. R.M. Roberts, J.C. Gilbert, L.B. Rodewald, A.S. Wingrove, Modern Experimental Organic Chemistry, 4th edition, Holt Saunders international editions.
4. A.K. Srivastava, P.C. Jain, Chemical Analysis: An Instrumental Approach for B.Sc. Hons. and M.Sc. Classes, S. Chand and company Ltd., Ram Nagar, New Delhi.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-6

Subject Code: 20140605	**Subject Title: Internship**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
	-	8	04	50	50	-	-	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Internship (Industry or Institute)**	60	100%

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

1. Demonstrate the ability to integrate and apply academic knowledge in a real-world industrial or institutional environment.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-7

Subject Code: 10140701	**Subject Title: Medicinal Chemistry**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

3. To introduce the fundamental concepts, terminology, and classification of drugs in medicinal chemistry.
4. To provide understanding of pharmacokinetics, pharmacodynamics, drug design, and basic drug delivery systems.

. Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents

Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Introduction of Medicinal Chemistry**, Terminology: Drug, pharmacy, pharmacognocy, pharmacology, pharmacokinetics, pharmacodynamics, Toxicity, pharmacopeia, antimetabolite, bacteria, virus, fungi, vaccine Pharmacokinetics: Drug absorption, drug distribution, drug Metabolism (general pathway of drug metabolism: Oxidative, reductive and hydrolytic reactions)	10	23%
2	**Drug Design**: Concepts drug design, Approaches to lead discovery, SAR, Combinatorial chemistry, Drug excretion, Drug Administration. Classification of Drugs (based on Structure & Pharmacological effect), Concept of Pro Drug, Soft Drug and Hard Drug.	11	27%
3	**Pharmacodynamics:** Principles and mechanisms of drug action, Types of receptors and drug receptor interactions (protein receptors, DNA receptors with examples of Agonists and Antagonists), Dose-response relationships (drug potency and efficacy).	11	27%
4	**Drug delivery systems:** Fundamental of novel drug delivery: Rationale of sustained release, controlled release dosage forms. Oral controlled drug delivery systems, mucosal drug delivery systems, ocular drug delivery systems, parenteral drug delivery systems, and transdermal drug delivery systems.	10	23%

Course Outcome: Students will be able to

1. Understand basic concepts of medicinal chemistry and important drug-related terminology.

2. Explain pharmacokinetics including absorption, distribution, metabolism, excretion, and drug administration.
3. Describe drug design approaches, SAR, and concepts of prodrug, soft drug, and hard drug.
4. Understand pharmacodynamics, receptor interactions, dose–response relationships, and basic drug delivery systems.

List of Text/ Reference Books

- Medicinal chemistry-Burgers (Vol: I-VI)
- Principles of medicinal chemistry-William O Foye
- Comprehensive medicinal chemistry- Corwin and Hansch
- Textbook of medicinal chemistry- Vol-I & II-Surendra N Pandey
- Principles of medicinal chemistry- S SKadam, K R Mahadik and K G Bothara
- Introductory medicinal chemistry- Kennewell and Taylor
- Wilson and Giswold`sText book of Organic medicinal and Pharmaceutical chemistryJaimes N Delgado and William A Remere
- Fundamentals of microbiology- Forpischer
- Genetics of antibiotics producing microorganisms- G Sermouti
- Organic Synthesis: The Disconnection Approach: Stuart Warren
- Organic Chemistry: Clayden, Greeves, Warren and Wo
- Designing Organic Synthesis: Stuart Warren.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-7

Subject Code: 10140702	**Subject Title: Organometallic Chemistry**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To introduce the fundamental concepts, synthesis, and bonding in organometallic compounds.
2. To understand the applications of organometallic compounds in catalysis, industry, and analytical estimation

. Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents

Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Fundamentals of Organometallic Chemistry and Metal–Carbon Bonding** The conceptual of organometallic chemistry with emphasis on the formation and characteristics of metal–carbon bonds. Definition, classification, and historical evolution of organometallic compounds, highlighting their importance in modern chemical research	10	23%
2	**Synthetic Strategies and Reactivity of Organometallic Compounds** Method used for the preparation of organometallic compounds and the mechanistic pathways involved in their transformations. Various approaches for forming metal–carbon bonds, including reactions of metals with organic halides and ligand exchange processes, are explored in detail	11	27%
3	**Organometallic Catalysis and Industrial Transformations** the chemistry of transition-metal complexes used in polymerization reactions, including the development of Ziegler–Natta catalysts and their influence on modern polymer production. Advanced catalytic processes such as cross-coupling reactions are introduced to demonstrate organometallic chemistry contributes to the synthesis of pharmaceuticals and fine chemicals	11	27%

4	**Emerging Research Areas in Organometallic Chemistry** Classical and analytical techniques for estimation of organometallic compounds and their applications in research and industrial chemistry. estimation of metal ions obtained from organometallic compounds, including gravimetric and volumetric techniques.	10	23%

Course Outcome: Students will be able to

1. Understand the basic concepts of organometallic chemistry and metal–carbon bonding.
2. Describe the synthesis and reactivity of organometallic compounds.
3. Explain the role of organometallic catalysts in polymerization and cross-coupling reactions.
4. Apply analytical methods for estimation of organometallic compounds and metal ions.

List of Text/ Reference Books

1. Advanced Inorganic Chemistry, Cotton Wilkinson, WSE Wiley.
2. Inorganic Chemistry, J.E.Huhey, Harpes &Row.
3. Principle and Application of Organo transition Metal Chemistry, Collman & Hegsdus, University Science Books.
4. The Organometallic Chemistry of the Transition Metals, R.H.Crabtree, John Wiley.
5. Organometallic Chemistry, R.C.Mehrotraand A. Singh, New Age International.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-7

Subject Code: 10140703	**Subject Title: Practical Chemistry-VII**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) To develop advanced knowledge and understanding of inorganic, organic and physical chemistry.

(2) Students will gain advanced theories and methodologies to solve the problems in classroom and laboratory.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	08	04	-	-	50	50	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	1. Preparation of Aspirin and determination of its melting point. 2. Determination of COD of effluent sample. 3. Qualitative Test for Proteins (Biuret Test). 4. Phase diagram: Phenol – Water System. 5. Estimation of Na^+ & K^+ individually & in binary mixture by survismeter as green method. 6. Identification of common drugs by simple chemical tests. 7. Paper chromatographic separation of metal ions (Pb^{2+}, Ag^+ and Hg^{2+}). 8. Determination of Cu(II) with ammonia by spectrophotometric titration. 9. Synthesis of Aromatic Compounds (at least 5). 10. Estimation of detergents and their washing action by survismeter. 11. Determination of pH of pharmaceutical solutions using pH paper or pH meter. 12. Column chromatographic separation and estimation of unknown organic compound.	08	100%

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

- Develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.

- Understand of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.
- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.

List of Text Books

7. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley
8. Smart, L. E.; Moore, E. A. (2012), Solid State Chemistry an Introduction, CRC Press Taylor & Francis.

List of Reference Books:

17. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.
18. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
19. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, W. H. Freeman and Company.
20. Kent, J. A. (ed) (1997),Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry **MINOR**

Semester-7

Subject Code: 10140704	**Subject Title: Polymer Chemistry**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

3. To provide a deep understanding of the fundamental principles and quantitative treatment of conductance, chemical kinetics, and error analysis in chemical measurements.
4. To equip students with practical and theoretical knowledge of separation techniques such as solvent extraction and chromatography, along with statistical tools for data evaluation.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		**Total**
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	
04	-	-	04	50	50			100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Types of polymerizations:** Addition polymerization, Condensation polymerization, Copolymerization and their mechanism. Differences between Addition and Condensation polymerization; Classification of Polymers based on source, structure and applications	10	23%
2	Synthesis, properties and applications of some commercially important polymers: HDPE, LDPE, PVC, Teflon. Rubber, Vulcanization of rubber, Compounding of Rubber, Synthetic Rubber: Styrene rubber, Nitrile rubber, Butyl Rubber.	11	27%
3	**Conducting Polymers:** Classification, Factors affecting conductivity, Preparation and application; Molecular weight of polymers: Polyamides (Nylon-6 & Nylon-6,6), Polycarbonates, Polyurethane and Teflon. Resins: Urea-formaldehyde resin, Epoxy resin.	11	27%
4	**Production of bulk polymers:** PE, PP, PVC, SBR, Polyester, Nylons etc. by different processes, their differences wrt conventional chemical manufacturing Specialty polymers: Conducting polymers, Block copolymers, Polymer composites, special discussion on polyurethanes, Elastomers, spandex, etc.	10	23%

Course Outcome: Students will be able to

5. Understand physical state of polymers
6. Develop fundamental knowledge of thermal transitions of temperature
7. Understand structure-property relationship of polymers
8. Apply mathematical formulae to depict polymer solution properties

List of Text/ Reference Books:

1. Polymer Chemistry, S. Koltzenburg, M.Maskos, O. Nuyken, Springer
2. Introduction to Polymer Chemistry, 4th Edition, Charles E. Carraher Jr., CRC Press
3. A textbook of polymer chemistry, M.S. Bhatnagar, S Chand Publication
4. Polymer Chemistry, Alka L Gupta, Pragati Publication
5. Basic Principles of Polymer Chemistry, Archana Garg, Atlantic Publication
6. Wiley Engineering Chemistry, Second Edition, Wiley India.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-8

Subject Code: 10140801	**Subject Title: Molecular Spectroscopy**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To introduce the fundamental principles and instrumentation of major spectroscopic techniques such as UV–Visible, IR, Mass, NMR, ESR, and Microwave spectroscopy used for molecular analysis.
2. To develop the ability to interpret spectroscopic data and apply spectral techniques for the identification and structural elucidation of organic molecules.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents

Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**UV-Vis spectroscopy (electronic spectroscopy**): General electronic transitions, max & max, chromophores & auxochromes, bathochromic & hypsochromic shifts. Woodward rules for the calculation of max, and solvent effect **Infrared Spectroscopy (vibrational Spectroscopy)** Introduction, Basic Principles, Instrumentation, normal mode of vibrations, force constant, P, Q, R branches, Overtone	10	23%
2	**Mass Spectroscopy** Basic principles, instrumentation; Ion production: Soft ionization methods: Low energy electron ejection; Chemical ionization; Fast-atom bombardment (FAB), Plasma desorption (PD) and Matrix Assisted Laser Desorption/ionization (MALDI); Electrospray ionization (ESI); Mass spectrum: Unit mass molecular ion and isotope peaks; Fragmentation of pattern for common organic compounds;	11	27%
3	**Nuclear Magnetic Resonance Spectroscopy** Introduction, Magnetic properties of nuclei-Resonance condition, nuclear spin, population of nuclear spin levels and NMR isotopes, relaxation methods, Instrumentation handling; classical approach and FT-NMR. chemical shift, factors influencing chemical shifts, Pascals triangle-low and high resolution.	11	27%
4	**Electron Spin Resonance Spectroscopy:** Basic principles of ESR, the g value hyperfine structure, of ESR and its	10	23%

	applications to the study of free radicals and Mc Connell relationship. **Microwave Spectroscopy (Rotational Spectroscopy**): Fundamentals and Basic principles, and applications.		

Course Outcome: Students will be able to

1. Explain the fundamental principles of spectroscopic techniques including UV–Visible, IR, Mass, NMR, ESR, and Microwave spectroscopy used in molecular analysis.
2. Interpret electronic, vibrational, and rotational transitions in molecules, including concepts such as chromophores, auxochromes, spectral shifts, Woodward rules, and vibrational modes.
3. Describe the instrumentation and working principles of major spectroscopic techniques such as IR, NMR, ESR, and Mass spectrometry.
4. Analyze and interpret spectral data including molecular ion peaks, fragmentation patterns, chemical shifts, hyperfine splitting, and other spectral features for structural elucidation of compounds

List of Text/ Reference Books

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. Physical Chemistry by P.W. Atkins. ELBS 1986.
7. Introduction to molecular spectroscopy by G. M. Barrow.
8. Molecular spectroscopy by I.N. Levis, Wiley interscience.
9. Nuclear Magnetic Resonance by J.D. Roberts, McGraw Hill.
10. Introduction to magnetic resonance by A. Carrington and A.D. McLachlan. Harper and Row.
11. Electron Spin Resonance, Elementary theory and practical applications by J.E. Wets and J.R. Buoulton, Mc Grew Hill.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-8

Subject Code: 10140802	**Subject Title: Biochemistry**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

a. To understand the structure, classification, and functions of major biomolecules including proteins, carbohydrates, lipids, vitamins, and nucleic acids.
b. To develop knowledge of the structural organization, properties, and analytical methods used for the study of biomolecules and their biological roles.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents

Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Protein chemistry:** Amino acids: Properties, structures, functions and classification of common amino acids. Uncommon amino acids. Peptides and proteins: Peptides bond formation, types of peptides, and lengths of peptides chain, conjugated proteins and their classification. Protein structure: Levels of organization of protein structures – primary, secondary, tertiary and quaternary structures. The three-dimensional structure of proteins, determination of sequence of amino acids in peptides or protein.	10	23%
2	**Carbohydrate chemistry:** Nomenclature of carbohydrates, Types of carbohydrates: (a) Monosaccharides & disaccharides (b) Polysaccharides (c) Glycoconjugates Carbohydrate as informational molecules – the sugar code, An outline of methods of carbohydrate analysis. Vitamins: (Water soluble and fat-soluble vitamins): Structure and functions of: (a) Water soluble Vitamins – Vitamins B1, B2, B6, B12, Folic acid, Pantothenic acid, Niacin and Biotin. (b) Fat soluble Vitamins – Vitamins A, D, E and K	11	27%
3	**Nucleic acid structures:** (a)DNA: Watson – Crick Model, Three-dimensional forms of DNA (Comparison of A, B and Z form of DNA) Unusual DNA structures – palindromes, mirror repeats, inverted repeats, hairpin (or cruciform), Hoagsteen pairing, triplex DNA's, G tetraplex DNA, H - DNA. (b) RNA: monocistronic and polycistronic RNA, base – paired helical structure in RNA. (c) Denaturation and renaturation of double stranded DNA and RNA, DNA hybridization, DNA sequencing	11	27%

	by Sanger method. Chemical synthesis of DNA (Automated)-Principle and major steps involved. Ribozymes- types and therapeutic applications		
4	**Lipid chemistry:** Storage lipids: fatty acids – nomenclature structure and properties of some naturally occurring fatty acids, Triacylglycerols and their functions as storage lipids. **Structural lipids in cell membranes**: Glycerophospholipids, galactolipids, sulfolipids, sphingolipids, and sterols. Lipids as signals, cofactors and pigments. Phosphatidyl inositol and sphingosine derivatives as intracellular signals Eicosanoids, Prostaglandins, Thromboxanes, Leukotrienes, Vitamins: A, D, E and K. An outline of method of the extraction, separation and identification of cellular lipids.	10	23%

Course Outcome: Students will be able to

1. Explain the structure, classification, and properties of amino acids, peptides, proteins, and carbohydrates.
2. Describe the structural organization of proteins and nucleic acids, including different levels of protein structure and DNA/RNA models.
3. Illustrate the structure and biological functions of vitamins and lipids, including their roles in metabolism and cell membranes.
4. Understand basic biochemical techniques used for the analysis, sequencing, synthesis, and identification of biomolecules such as proteins, carbohydrates, nucleic acids, and lipids.

List of Text/ Reference Books

- "Principles of Microbiology", by Atlas R.M., 1st edition, 1995,Mosby–YearBook Inc.
- St.Louis, Missouri.
- Biochemistry by Jeremy Berg, John Tymoczko and LubertStryer, Fifth Edition, Freeman
- Company.
- Fundamentals of Biochemistry by Debajyothi Das 11/e, 2002.
- Fundamentals of biochemistry- Life at the molecular level By: Voet, Voet and Pratt,
- Second edition, 2006.
- Harper's Biochemistry by Robert.KK.Murray 26/e, 2003.
- Human Biochemistry by James.M.Orten&Oho.W.Neuhaus, 10/e, 1983.
- Lehninger Principles of Biochemistry by David Nelson and Michael Cox, Fifth Edition
- Freeman Company. (2005).

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry

Semester-8

Subject Code: 10140803	**Subject Title: Practical Chemistry-VIII**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

(1) To develop advanced knowledge and understanding of inorganic, organic and physical chemistry.

(2) Students will gain advanced theories and methodologies to solve the problems in classroom and laboratory.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
-	-	08	04	-	-	50	50	100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	Assay of aspirin tablet by potentiometry. a. TLC separation of sugars and amino acids. b. Determination of Acid Value of a Polymer Resin. c. Interpretation of Organic Molecule by IR Spectroscopy. d. Estimation of Glucose by Benedict's Method. e. Analysis of oils. f. Qualitative analysis of mixtures containing at least six radicals including ions of two rare elements g. (Cations: W, Tl, Mo, Ce, Ti, Th, Zr, U, V, Be, Li; h. Anions: $Cr_2O_7^{2-}$, CO_3^{2-}, PO_4^{3-}, AsO_4^{3-}, AsO_3^{3-}, BO_3^{3-}, CH_3COO^-, $C_2O_4^{2-}$, SiO_4^{4-}). i. Determination of purity of vanillin by conductometry. j. Preparation of Inorganic Complexes. k. Separation and identification of components of organic compounds (at least 5). l. Study of antacid activity by acid–base titration method.	08	100%

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

- Develop a solid foundation in the principles and applications of modern chemical and scientific ideas in the field of chemistry.

- Understand of plan, conduct, and accurately record and analyze scientific experiments as well as their outcomes.
- Capable to applying analytical reasoning, critical thinking, and problem-solving skills to scientific issues.
- Effectively convey scientific findings to both scientists and the general audience in oral, written, and electronic mediums.
- Investigate novel chemistry-related and related scientific and technological domains.

List of Text Books

9. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley
10. Smart, L. E.; Moore, E. A. (2012), Solid State Chemistry an Introduction, CRC Press Taylor & Francis.

List of Reference Books:

21. Ashutosh Kar Advanced Inorganic Chemistry Vol: I and II CBS Publishers.
22. Advanced Inorganic Chemistry Volume-I, Satyaprakash, GD Tuli, SK Basu, RD Madan.
23. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, W. H. Freeman and Company.
24. Kent, J. A. (ed) (1997),Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

GANDHINAGAR INSTITUTE OF SCIENCE

B.Sc. Chemistry **MINOR**

Semester-8

Subject Code: 10140804	**Subject Title: Nano Technology**
Pre-requisite: Candidate must have achieved regular degree in the 10+2 system from any recognized Board. Candidate must have studied core subjects like Mathematics, Physics, Chemistry and Biology at their Higher Secondary level.	

Course Objective:

1. To provide a strong foundation in nanoscience and nanotechnology by equipping students with interdisciplinary knowledge of nanoscale materials.
2. To develop practical skills and research competencies through hands-on experience in synthesis.

Teaching Scheme (Hours per week)			**Credit**	**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**		**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
04	-	-	04	50	50			100

Subject Contents			
Sr. No	**Topics**	**Total Hours**	**Weight (%)**
1	**Introduction and preparation** Introduction to Nanomaterials, magnetic and chemical properties of Nanomaterials, Preparation of Nanoparticles: Chemical Approaches: Chemical reduction; Aerosol spray; Gas condensation; Laser vaporization and vapour deposition; Sputtering.	10	23%
2	**Nanostructured materials** Quantum dots, wells & wires; Carbon Nanotubes (CNTs): Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs), Graphenes, Fullerenes, Metal/Oxide nanoparticles (NPs), Nanorods, Nanotubes and Nanofibres, Semiconductor quantum dots	11	27%
3	**Characterization techniques for Nanomaterials-I** Particle size Analyser (Laser scattering), Optical Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunnel Microscopy (STM).	11	27%
4	**Application of Nanomaterials** Applications Solar energy conversion and catalysis, Polymers with a special architecture, Liquid crystalline systems, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Chemical and biosensors, Nanomedicine and Nanobiotechnology.	10	23%

Course Outcome: Students will be able to

- Understand the basic principles, history, and interdisciplinary nature of nanoscience and nanotechnology.
- Explain the quantum mechanical, chemical, and physical properties of nanomaterials.
- Demonstrate knowledge of various synthesis methods, including top-down and bottom-up approaches.
- Utilize modern characterization techniques such as SEM, TEM, XRD, STM, and Raman spectroscopy

List of Text/ Reference Books:

1. Introduction to Nanotechnology: Charles P. Poole, Jr. and Frank J. Owens; Wiley Student Edition, 2008
2. Nanostructures and Nanomaterials: Synthesis, Properties and Applications: G. Cao, ICP, London, 2004.
3. Nano biotechnology, Concepts, Applications and perspectives: C. M. Niemeyer and C. A. Mirkin, WILEY-VCH, Verlag GmbH & Co, 2004.
4. Nanotechnology - Molecularly Designed Materials: G. M. Chow and K. E. Gonslaves; (American chemical society)

Annexure 2.

A. Ability Enhancement Courses (AEC)

Sl. No	Course Name	Course Code
1	Business Communication – Blended with ICSI	AEC001
2	Communication and Presentation for Technical Professionals (IEEE)	AEC002
3	Conversational Hindi (Modern Indian Language)	AEC003
4	Corporate Grooming and Business Etiquettes	AEC004
5	Digital Privacy: Understanding and Operational Framework (IEEE)	AEC005
6	Digital Transformation: Game Changing Opportunities (IEEE)	AEC006
7	Economics & Business Environment Blended with ICSI	AEC007
8	Freelancing and Content Writing	AEC008
9	French	AEC009
10	Functional Grammar and Composition	AEC010
11	German	AEC011
12	Gujarati	AEC012
13	Marathi	AEC013
14	Mass Communication and Journalistic Writing	AEC014
15	Personality Development for Effective Leadership	AEC015
16	Practical English	AEC016
17	Punjabi	AEC017
18	Spanish	AEC018
19	Radio Jocky	AEC019
20	Ethics for Engineers, Patents, Copyrights and IPR	AEC020
21	Digital Privacy: Understanding and Operational Framework	AEC021
22	Environmental Studies	AEC022

B. Skill Enhancement Courses (SEC)

Sl. No	Course Name	Course Code
1	Animation & Graphics Design	SEC001
2	Aptitude and Logical Reasoning Blended with ICSI	SEC002
3	AutoCAD and Basic Drafting	SEC003
4	Business Administration	SEC004
5	Current Affairs and Quantitative Aptitude Blended with ICSI	SEC005
6	Data Analysis using Spreadsheet	SEC006
7	Digital Marketing	SEC007
8	Eco-Engineering: Designing for the Future	SEC008
9	Engineering Mastery: Tools and Techniques	SEC009
10	Event Management	SEC010
11	ICT Skills for Leadership	SEC011
12	Innovation & Entrepreneurship	SEC012
13	Interpersonal Skills – Blended with ICSI	SEC013
14	Introduction of Cyber Security (IEEE)	SEC014
15	Office Automation Tools	SEC015
16	Performing Arts (Dance, Music, Drama)	SEC016
17	Personal Financial Planning	SEC017
18	Practical Workshop Training	SEC018
19	Social Media Management	SEC019
20	Tally Accounting	SEC020
21	Visual Arts	SEC021
22	Public Speaking	SEC022

C. Value Addition Courses (VAC)

Sl. No.	Course Name	Course Code
1	Anti-ragging – Blended with IEEE	VAC001
2	Art of Living for Wellness	VAC002
3	Awareness of Cyber Crime and Ethical Hacking	VAC003
4	Basic Life Support (BLS)	VAC004
5	Community Development	VAC005
6	Economics & Social Development	VAC006
7	Emotional Intelligence	VAC007
8	Environmental Studies	VAC008
9	Ethics and Values in Ancient Indian Tradition	VAC009
10	Gandhian Studies	VAC010
11	Indian Economy and Planning	VAC011
12	Indian Geography and Environmental Ecology	VAC012
13	Indian History and Cultural Heritage	VAC013
14	Integrated Personality Development Course	VAC014
15	Life Lessons from Bhagvad Gita	VAC015
16	Life Skills	VAC016
17	National Cadet Corps (NCC)	VAC017
18	National Service Scheme (NSS)	VAC018
19	Prevention of Sexual Harassment	VAC019
20	Psychology	VAC020
21	Stress and Time Management	VAC021
22	Sustainable Development and Environmental Studies	VAC022
23	Universal Human Values	VAC023
24	Yoga and Meditation for Wellness	VAC024