KL
(DEEMED TO BE UNIVERSITY)

STUDENT handbook 2023-2024

MSc. Chemistry

Department of Chemistry

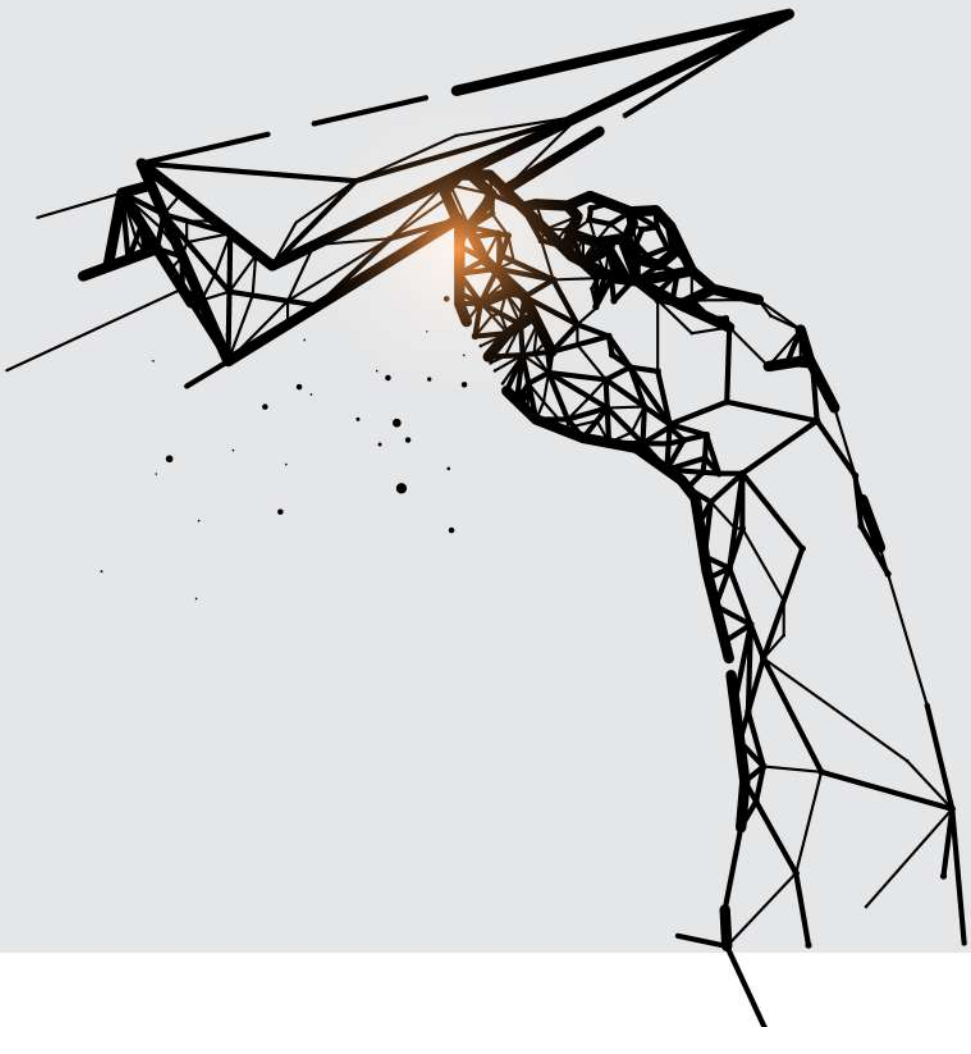
www.kluniversity.in

VISION

To be a globally renowned university.

MISSION

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.




CATEGORY 1
UNIVERSITY
BY MHRD, Govt. of India
KL ACCREDITED BY
NAAC WITH A++
GRADE
nirf 2023
NATIONAL INSTITUTIONAL RANKING FRAMEWORK
RANKED 28
AMONG ALL
UNIVERSITIES
43 YEARS OF
EDUCATIONAL
LEADERSHIP

Koneru Satyanarayana,
Chancellor

Sri Koneru Satyanarayana, BE, FIE, FIETE, MIEEE graduated in Electronics and Communication Engineering in the year 1977. Along with Sri Koneru Lakshmaiah, he is the co-founder of the Institute which was established in the year 1980. He is an educationist of eminence and also an industrialist of great repute. He runs a number of industries in and around Vijayawada.

Dr. K. S. Jagannatha Rao
Pro-Chancellor

Prof. K. S. Jagannatha Rao was one of the leading scientists in neuroscience research in globe. He was the Director on Institute for Scientific Research and Technological Advances (INDICASAT AIP), Republic Panama and contributed lot in building innovation in higher education and research in Panama since 2010. He played a key role in building PRISM (Panamanian Research Institutes of Science and Medicine) in Latin America. Dr. Rao has his research area on Brain Research and established Alzheimer's Centre and published 165 papers in leading Biochemistry and Neuroscience Journals, supervised 19 Ph.D students. He is also adjunct faculty of Biomedical Informatics of UTHS, Houston, and Advisory Board Member of UT- El Paso Minority Health NIH program, USA and Adjunct Faculty, Methodist Research Institute, Houston, USA. He was elected Member of Panamanian Association for the Advancement of Science (APANAC) - Considered as National Science Academy of Panama. He received his undergraduate and Ph.D degrees from Sri Venkateswara University, Tirupati. Later, joined in Central Food Technological Research Institute, Mysore. He received Sir C. V. Raman Award by Karnataka State Council of Science and Technology, 2003.

Prof. G P S Varma
Vice-Chancellor

Prof. G P S Varma, Vice-Chancellor, KLEF, is one of the most widely experienced leaders in Indian higher education, known for his commitment to expanding student opportunity, catalyzing academic innovation, and encouraging university's civic engagement and service to society. He adorned the position of Chairman, ISTE (Indian Society for Technical Education)- AP State, TSEMCET Test Committee Member-2021 nominated By Telangana State Govt, APEAMCET Admission Committee Member in 2016 by Andhra Pradesh State Council of Higher Education, Govt. of Andhra Pradesh. He has been a very farsighted Peer Team Visit Member for National Assessment and Accreditation Council (NAAC), Expert Committee Member for University Grants Commission (UGC) Autonomous Visits. He has been an Advisory Council Member for (CEGR) Centre for Education Growth, and Research India International Centre, New Delhi, and Board Member for Big-Data Analytics Forum.

Dr. Venkatram Nidumolu

Pro-Vice Chancellor

Dr. A. V. S. Prasad, M.E and Ph.D from JNTU, Hyderabad is a professor in Civil Engineering. He has a rich experience of 33 years in academics which includes 26 years in administration at various cadres ranging from Head of Department, Dean, Principal, Director and Pro-Vice Chancellor. He has served as Director of Audisankara group of institutions and Narayana Group of Institutions for 18 years and was instrumental in getting these institutions accredited by NAAC, NBA, Autonomous and gained many laurels from the State Government, JNTU etc. He has served as Pro-Vice Chancellor of KL University for 3 years.

He has extensive knowledge of administrative system, maintaining statutory norms of bodies like AICTE, UGC etc and has a good understanding of NBA, NAAC procedures and norms. He served as Member, Chairman of Board of Studies at JNTU(A), KLCE(Autonomous) and KL University.

Dr. Venkatram Nidumolu

Pro-Vice Chancellor

Dr. Venkatram Nidumolu, Pro-Vice Chancellor is High performing, strategic thinking professional with more than 15years of administration experience and 20 years of teaching experience in KLEFand 30 years overall experience in the higher education sector. He graduated in B.Tech (ECE) from Acharya Nagarjuna University, pursued M.S degree from BITS, PILANI in software Systems. He received Ph.D award from Acharya Nagarjuna University. He held the positions like HOD, Joint Register, Principal, and Dean-Academics before becoming Pro-Vice Chancellor. He was core member of all NBA, NAAC, & other accreditations since 2004 and he has good experience in handling of quality issues and assessment related practices.

Acronyms

S. No	Acronyms	Full Form
1	KLEF	Koneru Lakshmaiah Education Foundation
2	CET	Common Entrance Test
3	KLEEE	KLEF Engineering Entrance Examination
4	JEE	Joint Entrance Examination
5	BT	Biotechnology
6	CE	Civil Engineering
7	CS	Computer Science &Engineering
8	EC	Electronics & Communication Engineering
9	EE	Electrical & Electronics Engineering
10	CM	Computer Engineering
11	ME	Mechanical Engineering
12	AD	Artificial Intelligence & Data Science
13	CI	Computer Science & Information Technology
14	CGPA	Cumulative Grade Point Average
15	SGPA	Semester Grade Point Average
16	LTPS	Lecture, Tutorial Practical, Skill
17	SEE	Semester-End Examinations
18	SIE	Semester-In Examinations
19	OJET	On-the-job Engineering Training
20	IRP	Industrial Relations and Placements
21	PS	Practice-School
22	OPAC	Online Public Access Catalog
23	QCM	Quality Circle Meeting
24	MOOC	Massive Open Online Course
25	MOU	Memorandum of Understanding
26	OD	On Duty
27	(A,B]	Between A and B excluding value A and including value B
28	COE	Controller of Examinations
29	VLSI	Very Large-Scale Integration
30	MTech	Master of Technology
31	COA	Council of Architecture
32	JEE	Joint Entrance Examination
33	NATA	National Aptitude in Architecture

34	PC	Professional Core
35	BSAE	Building Science and Applied Engineering
36	PE	Professional Elective
37	PAECC	Professional Ability Enhancement Compulsory Courses
38	SEC	Skill Enhancement Course
39	OE	Open Elective
40	CTIS	Cloud Technology and Information Security
41	DS	Data Science
42	IoT	Internet of Things
43	IPA	Intelligent Process Automation
44	PCI	Pharmacy Council of India
45	PY	Pharmacy
46	B. Com (H)	Bachelor of Commerce with Honors
47	ACCA	Association of Chartered Certified Accountants
48	HM	Hotel Management
49	BTK	Basic Training Kitchen
50	QTK	Quantitative Training Kitchen
51	ATK	Advanced Training Kitchen
52	MBA	Master of Business Administration
53	BBA	Bachelor of Business Administration
54	MSc (F&C)	Master of Science (Finance & Control)
55	BA	Bachelor of Arts
56	M.Sc.	Master of Science

Chapter 1

INTRODUCTION

The President of Koneru Lakshmaiah Education foundation, Er. Koneru Satyanarayana, along with Late Sri. Koneru Lakshmaiah, founded the K L College of Engineering in the Academic year 1980-81. With the mighty vision and restless efforts of Er. Koneru Satyanarayana K L College of Engineering carved a niche for itself through excellence in engineering education, discipline and record numbers of placements and was the leading college in the state of AP. K L College of Engineering achieved NBA Accreditation for all its B.Tech. Programs in 2004 and later re-accredited in 2007. K L College of Engineering was transformed into an autonomous engineering college in the year 2006. In 2008 this college received a record grade of 3.76 on a 4 points scale with "A" Grade from NAAC; and in February 2009, the college, and Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A^{++}' with highest Grade of 3.57 CGPA on 4-point scale in 2018, through its founding society "Koneru Lakshmaiah Education Foundation" was recognized as Deemed to be University by the MHRD-Govt. of India, Under Section 3 of UGC Act 1956. This Deemed to be University is named as "KLEF".

Location

KLEF is situated in a spacious 100-acre campus on the banks of Buckingham Canal of river Krishna, eight kilometers from Vijayawada city. Built within a rural setting of lush green fields, the institute is a virtual paradise of pristine nature and idyllic beauty. The campus has been aptly named "Green Fields" and the splendid avenue of trees and gardens bear testimony to the importance of ecology and environment. The campus ambience is most befitting for scholastic pursuits. The University is situated in a built-up area of around 15, 00,000 S.Ft.

Vision

To be a globally renowned university.

Mission

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of the students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

Facilities

Central Library: E-Resources

The Central Library is the largest and holds materials to serve the whole University community. It has materials relevant to the Engineering, Science & Humanities courses offered by the University. The library system contains more than one lakh and fifty thousand books and periodicals on all subjects related to the teaching and research interests of the University staff and students. The library has over 36,000 electronic journal titles, academic databases and32.98 lakhs eBooks. Access is available on campus on student computers and remotely.

The Data Centre

A State-of-the-Art Data center with advanced servers provides a highly interactive learning environment with full-fledged hardware and software training facilities.

Physical Education- Sports Facilities

KLEF encourages students to explore their latent talents by providing good games and sports facilities.

The institute is equipped with the following-

Sport/Game	No. of Courts	Sport/Game	No. of Courts
Athletic track	1	Handball Court	1
Hockey Field	1	Netball Courts	2
Badminton Courts	4	Throw ball courts	2
Tennikoit Courts	2	Beach Volleyball Court	1
Cricket Field with Net practice	3	Football Field	1
Volleyball Courts	2	Basketball Courts	2
Tennis Courts	2	Kabaddi Courts	2
Kho Kho Court	1	Table Tennis	6
Soft Ball	1	Chess	20
Archery	1	Caroms	12

The University had a State-of- the - Art Indoor stadium of 30000 sq. Ft with:

- 4 wooden Shuttle Courts/ Basketball Court
- Yoga and Meditation Centre
- Dramatics
- 8 Table Tennis Tables
- Hobby Centre
- Gymnasium for Girls
- Gymnasium for Boys
- Multipurpose room with Chess, Caroms etc.
- Power lifting/Weightlifting

Accommodation- Hostels

- KLEF has separate hostels for boys and girls with well furnished rooms and modern amenities.
- The overall atmosphere is very conducive for the students to concentrate on their studies.
- A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.
- Generators have been provided as power backup. Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs, it keeps changing according to their tastes.
- Teaching staff will have to address the academic and personal problems of the students. Round-the-clock security, communication, dispensary facilities are also available.

Facilities in the hostels

- Protected drinking water
- State of the art kitchen, dining hall
- Newspapers, telephones, toilets, and bathrooms are well maintained.
- Every student in the hostel is provided with a cot, study table, chair, and a rack.
- Fan and light are also provided in each room.
- Gas & Steam based hygienic food preparation.
- Palatable regional, national, and international cuisines
- Cleanliness and Safety STD/ISD Facilities
- Medical Kits and First Aid Boxes Soft drinks, snacks, Fruits etc.
- Laundry Stationary shop

Hostel Rules and Regulations

- Students are hereby informed that while staying in the hostel, it is essential to be responsible for maintaining dignity by upholding discipline.
- They must be obedient to the hostel warden/floor in –charges. Valuable items like jewelry etc. should not be kept with students while staying in the hostel.
- It is student's own responsibility to safeguard her/his Laptops, Money by locking suitcases and bags.
- If any loss is found, management will not take any responsibility. Students must intimate to the hostel authorities before giving police complaints against losses.
- Students are not allowed to indulge in smoking; consumption of Alcohol, Narcotic drugs etc., and defaulters will be strictly viewed upon.
- Students are directed that after locking their rooms they must hand over the keys to security and can collect them on returning to the hostel.
- Students must switch off Fans, Lights, Geysers, A/C's etc., before leaving their rooms.
- Visitors are not allowed inside the hostel at any time; however, they are allowed into the visitor's hall with the prior permission of the warden.
- Only family members listed by the parents are allowed to contact the student. Visiting hours are up to 7.30 pm only and after 7.30 pm visitors are required to leave the premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm for morning shift students and 6.00pm for day shift students.
- Those students who are utilizing the computer lab, library etc., after the times specified must submit the permission slip to the security while entering the hostel.
- During public holiday outings, those who seek permission to leave the hostel will have to obtain written permission from the warden. Permission will be given only to those students who get permission from parents to leave the hostel during holidays/outings.
- Moving out of campus without permission is strictly prohibited. Strict study hours from 7.30 am to10.30 pm shall be maintained in the hostel.
- The hostellers must be in their allotted rooms during study hours. The general complaints of any kind should be noted in the complaint register, which is available at the hostel office.
- Registered complaints will only be entertained. Any health problem should be brought to the notice of Warden/Floor In – charge for necessary treatment.

Transportation

The institution runs 80 buses covering all the important points in Vijayawada City, Mangalagiri, Guntur & Tenali towns with a total seating capacity of 4000 students in two shifts. Transport is available 24 hrs, In case of any emergency in the institute /hostels. Transportation is available for conducting industrial tours and visits etc. Regular transport facility available up to 10PM.

Healthcare

A full-fledged health center with all the facilities is established to cater the needs of the students, staff, Faculty, and the public in the adopted villages. It consists of three doctors (Homoeopathy, Ayurvedic &Allopathy).

Cafeteria

KLEF has a spacious canteen with the latest equipment and hygienic environment which provides quality food and prompts service and caters to the needs of all the students and staff. A central cafeteria of 1500 Sq.m. is available on the campus. Mini cafes and fast-food centers are available in various blocks. The canteen is open from 6:30 a.m. to 8:30 p.m. There is a wide variety of North-Indian and South-Indian cuisine and the students enjoy the pleasure of eating during the breaks. Cool aqua water for drinking is available.

Placements

KLEF has meticulously planned to make all its outgoing students employed. The University had installed the infrastructure, employed well experienced faculty, designed and delivered programs that help to enhance the communication and soft skills which are required for making the students employable. An excellent system is in place that considers all the issues that make a student employable. The University has been successful for the last 7 years in employing all the students who have registered and eligible for placement through its offices located across the country. About 50 trained personnel work extensively to make the students ready for recruitment by the industry.

Counselling & Career Guidance

A special Counselling Cell consisting of professional student counsellors, psychologists, and Professors counsels/helps the students in preparing themselves to cope with studies, perform well in the tests & various competitions. This Cell provides its services to the students in getting the solutions for their personal problems and provides career guidance with the help of the Industrial Relations and Placements (IRP) department. A group of 20 students are allotted to each faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KLEF has a social service wing which is used to channelize the social service activities of the faculty, staff, and students. It has adopted 5 nearby villages and conducts activities like medical camps, literacy camps and educates the villagers regarding hygiene and health care on a regular basis.

NSS/NCC wings

NCC/NSS is a credit course designed with an intent to transform NCC/NSS activities into curricular activities from an extracurricular thereby providing credits to students involved in NCC/NSS along with other attended advantages to the students in the university.

Hobby Clubs

Wholly and solely managed by the students, contributed much to the cultural life of the campus and to the cultural evolution of the students. Few student bodies and clubs operate in the campus like music society, dance club, drama society, literary and debating club, English press club, drawing club, painting club, mime club, computer club etc. Students manage entire activities and budget of the organization for the entire semester in advance. Around 4000 students are active members of the Hobby Clubs.

Life Skills and Inner Engineering

KLEF feels that it is its responsibility to mold the students as good human beings, contributing to the country and to society by producing responsible citizens. Along with the regular programs every student admitted into KLEF undergoes a one-week special life skills /orientation program. Through this program, KLEF is producing the students with clarity of thoughts and charity at heart. Strict regularity, implicit obedience, courtesy in speech and conduct, cleanliness in dress. Life skills and inner engineering teach a student his/her obligation towards GOD, himself /herself his/her country and fellow human beings. Every student is encouraged to practice his/her own religious faith and be tolerant and respectful towards other religions.

Technical Festival

KLEF organizes various programs for the all-round development of the students. The technical festival and project exhibition is organized in the odd semester (October) every year to elicit the innovative ideas and technical skills of the students.

Cultural Festival

The cultural festival in the even semester (February) of every year is the best platform for the students to exhibit their talents and creativity. Through these festivals KLEF is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLEF festivals provide recreation to the student community.

Center for Innovation, Incubation and Entrepreneurship (CIIE)

KLEF being a pioneering institute supporting Academics and Research in Engineering, Science and Technology is endowed with the entire infrastructure and highly experienced faculty, has a Centre for Innovation, Incubation and Entrepreneurship (CIIE) that comprises of: Innovation Centre which aims to inculcate a spirit of innovation. Incubation Centre which aims to incubate innovations through prototype product development. Entrepreneurship Development Centre (EDC) which aims at fostering entrepreneurial skills among the students.

Department of Chemistry

Department of Chemistry is one of the vibrant departments of K L E F (Deemed to be University) with highly qualified and well experienced faculty whose areas of expertise and research include organic synthesis, Bio Sensors, Material Chemistry, Natural products, Medicinal Chemistry, Analytical, Bio Analytical, Inorganic, Physical, Environmental and Nanotechnology. The Department has infrastructural facilities in terms of well-equipped laboratories with modern instruments and well-furnished and spacious classrooms to appease the requirement of undergraduate & postgraduate students apart from Ph. D students. The department is recognized as DST-FIST Level 1 department by the Department of Science and Technology, Govt. of India, New Delhi. The department offers various courses at UG level, M. Sc Chemistry at PG level with Organic chemistry and Analytical Chemistry specializations, Ph.D. both part time and full time.

VISION

To impart quality higher education in all branches of Chemistry along with excellence in research to provide manpower to multi sectoral Industries, Research Institutions and Academia.

MISSION

To provide exceptional chemistry education, producing proficient and forward-thinking graduates, and facilitating synergistic collaboration between academia and industry. Striving to elevate the field of Chemistry, contribute to societal progress, and drive innovation for a brighter future.

Mission statements:

M1: Propagation of higher education in Chemistry and provide wider job opportunities.
M2: Prepare competitive and professional postgraduates and researchers, having sound knowledge of basics and applied chemistry for the betterment of society.
M3: Strengthen Industry - Academia relationship to catalyse innovation and growth in technology.

Facilities

Library

Chemistry department caters to the needs of the students and teachers with its huge and updated volume of books offline and online. The library has an extensive and quality collection of over 3000 books and volumes of journals magazines and newspapers. Remote access to online database is available at the library. We can comfortably accommodate the students on rolling basis.

Classrooms

Comfortable classrooms with adequate seating capacity are available at department of chemistry. The classrooms are well equipped for digital method of teaching. Projectors, speakers are pre-installed to give best mode of teaching.

Extension Activities

Rasayanika- Rasayanika- Chemistry Student Association serves as a liaison between postgraduate students and department faculty and staff. Our goal is to foster an inclusive and supportive environment within the department. Current forefronts of our organization include mediating student concerns, building on community outreach, and coordinating educational and fun events for the department! The primary objective of this association is one which enhances both the social and professional experiences of our students. The association accomplishes the objective by hosting guest lectures, group discussions, workshops, seminars, teachers' day etc. "Rasayanika" hopes to create an inviting space for all students to feel comfortable sharing their ideas, comments, questions, and concerns while also ensuring their voices are heard and respected.

Outreach
The Department of Chemistry strives to look beyond itself and work as a team to improve the local community. The Department of Chemistry shares KLEF's well-established tradition of excellence on all fronts – in the laboratory, in the classroom, and in the community at large. Pioneering discoveries and advancements in chemistry and incorporation of them into our educational programs contribute to the betterment of the world. None of these contributions would be possible without our students, Scholars, our faculty, and our staff.

CHAPTER 2

PROGRAMS LIST AND ELIGIBILITY CRITERIA

The disciplines in which the courses of study are available at Chemistry department are as follows –

Program	Duration	Eligibility	Percentage of Marks in the Qualifying Exam	Total Seats
M. Sc Chemistry with Organic Chemistry and Analytical Chemistry specialization	2 Years	bachelor's degree in science with Chemistry discipline Examination, from recognized institute/ University	50% marks or equivalent CGPA in Chemistry.	54
Ph. D	Minimum 3 years in case of Full Time and 4 years in case of Part Time	Post Graduation in any branch of Law	55% or equivalent CGPA in Chemistry.	As per availability of Guide

Admissions will be done on the basis of ranks obtained in the PG admission eligibility test i.e., KLUEEE (Entrance Examination conducted by KLEF)

CHAPTER 3

PROGRAM EDUCATIONAL OBJECTIVES (PEOs) AND PROGRAM OUTCOMES (POs)

PROGRAM EDUCATIONAL OBJECTIVES (PEO):

The Program Educational Objectives (PEOs) are as follows:

PEO	DESCRIPTION
1	To prepare students for successful practice in diverse fields of Chemical Sciences such as pharmaceutical, chemical, polymer / advanced material, energy, biotechnology, and environmental engineering and in the fields of Societal expectations on time.
2	To prepare students for advanced studies in Chemical sciences and its allied fields.
3	To ensure our students to achieve excellence and get selected for high-ranking industrial, academic, Government and other professional positions, as well as to inculcate leadership qualities.
4	To develop graduate's skills and awareness to become socially, ethically, and morally responsible individual in all the challenges they take over, in our communities and in the field of chemical Sciences.

PROGRAM OUTCOMES: (PO)

PO	DESCRIPTION
1	Ability to understand the scope and principle of Chemistry.
2	Ability to understand and implement complex chemical equations and chemical compositions.
3	Ability to analyse the outcomes of experiments on chemicals and their product.
4	Ability to understand the chemicals deeply and their effects on environment and health.
5	Ability to connect the latest developments in Chemistry with the knowledge attained during academics and come up with better ideas.
6	Awareness of the impact of Chemistry in all domains of the society including environment, manufacturing, and production, etc.
7	Use modern techniques, decent equipment's, and Chemistry software's.

PEO- PO Matrix

Matrix		Program Outcomes						
PEO	PEO- Description	1	2	3	4	5	6	7
1	To prepare students for successful practice in diverse fields of Chemical Sciences such as pharmaceutical, chemical, polymer / advanced material, energy, biotechnology, and environmental engineering and in the fields of Societal expectations on time.	✓	✓	✓	✓	✓	✓	✓
2	To prepare students for advanced studies in Chemical sciences and its allied fields.	✓	✓	✓	✓	✓	✓	✓
3	To ensure our students to achieve excellence and get selected for high-ranking industrial, academic, Government and other professional positions, as well as to inculcate leadership qualities.						✓	
4	To develop graduate's skills and awareness to become socially, ethically, and morally responsible individual in all the challenges they take over, in our communities and in the field of chemical Sciences.	✓	✓	✓	✓	✓	✓	✓

CHAPTER 4

ACADEMIC REGULATIONS

This document supplements the KLEF rules and regulations to assist all students. It is required that every individual must abide by these regulations. The regulations stated in this document are subject to change or can be relaxed/modified without prior notice at the discretion of the Hon'ble Vice Chancellor.

Terminology

- **Academic Council:** The Academic Council is the highest academic body of the University and is responsible for the maintenance of standards of instruction, education, and examination within the University. The Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.
- **Academic Year:** It is the period necessary to complete an actual course of study within a year. It comprises of two consecutive semesters i.e., Even and Odd semester.
- **Academic Pathways:** Students of all programs of study are given the opportunity to choose their career pathways viz. Employability, Innovation and Research. Each of these pathways prepares the students in a unique way, enabling them to achieve the heights of their career.
- **Academic Bank of Credits (ABC):** It helps the students to digitally store their academic credits from any higher education institute registered under ABC in order to award Certificate / Diploma / Degree / Honors based on the credits earned by the student. All the credits acquired by the students are stored digitally by registering into Academic Bank of Credits (ABC) portal. It also supports retaining the
- credits for a shelf period and continue their program study with multiple breakovers.
- **Audited Course:** It is a course of study which has zero credits and has a "Satisfactory" or an "Unsatisfactory" grade.
- **Backlog Course:** A course is considered to be a backlog if the student has obtained a failure grade (F).
- **Board of Studies:** Board of Studies (BOS) is an authority as defined in UGC regulations, constituted by Vice Chancellor for each of the department separately. They are responsible for curriculum design and update in respect of all the programs offered by a department.
- **Branch of Study:** It is a branch of knowledge, an area of study or a specific program (like Analytical Chemistry, Organic Chemistry etc.,)
- **Compulsory course:** Course required to be undertaken for the award of the degree as per the program.
- **Course:** A course is a subject offered by the University for learning in a particular semester.
- **Course Handout:** Course Handout is a document which gives a complete plan of the course. It contains the details of the course viz. Course title, Course code, Pre-requisite, Credit structure, team of instructors, Course objectives, Course rationale, Course Outcomes and the relevant syllabus, textbook(s) and reference books, Course delivery plan and session plan, evaluation method, chamber consultation hour, course notices and other course related aspects. In essence, course handout is an agreement between students (learners) and the instructor.

- **Course Outcomes:** The essential skills that need to be acquired by every student through a course.
- **Credit:** A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week or two hours per week of tutorials/ self-learning/ practical/ field work during a semester.
- **Credit Point:** It is the product of grade point and number of credits for a course.
- **Choice Based Credit System:** The institute adopts Choice Based Credit System (CBCS) on all the programs offered by it which enables the students to choose their courses, teachers and timings during their registration. This enables the students to decide on the courses to be done by them in a specific semester according to their interests in other activities.
- **Cumulative Grade Point Average (CGPA):** It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed upto two decimal places.
- **Curriculum:** Curriculum is a standards-based sequence of planned experiences where students practice and achieve proficiency in content and applied learning skills. Curriculum is the central guide for all educators as to what is essential for teaching and learning, so that every student has access to rigorous academic experiences.
- **Degree:** A student who fulfils all the Program requirements is eligible to receive a degree.
- **Degree with Specialization:** A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of Professional elective courses in a specialized area is eligible to receive a degree with specialization.
- **Department:** An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff and other resources.
- **Detention in a course:** Student who does not obtain minimum prescribed attendance in a course shall be detained in that course. Refer to Attendance & Detention Polo Policy
- **Dropping from the Semester:** A student who doesn't want to register for the semester should do so in writing in a prescribed format before commencement of the semester.
- **Elective Course:** A course that can be chosen from a set of courses. An elective can be Professional Elective, Open Elective, Management Elective and Humanities Elective.
- **Evaluation:** Evaluation is the process of judging the academic work done by the student in her/his courses. It is done through a combination of continuous in-semester assessment and semester end examinations.
- **ERP:** ERP (Enterprise Resource Planning) system is a comprehensive software solution designed to streamline and automate various administrative, academic, and financial processes within the University. It manages student information, including admissions, registration, enrollment, attendance, grades, and academic records.
- **Grade:** It is an index of the performance of the students in a said course. Grades are denoted by alphabets.
- **Grade Point:** It is a numerical weight allotted to each letter grade on a 10 - point scale.
- **Industrial Training:** Training program undergone by the student as per the academic requirement in any company/firm. It is a credited course.
- **Industrial Visit:** Visit to a company/firm as per the academic requirement.
- **In-Semester Evaluation**: Summative assessments used to evaluate student learning, acquired skills, and academic attainment during a course.

- **LMS:** LMS stands for Learning Management System. It is a platform used in the institution to manage and deliver courses. Students can access learning resources, participate in online discussions, submit assignments, take assessments, and communicate with their instructors and peers.
- **Make-up Test:** An additional test scheduled on a date other than the originally scheduled date.
- **Minor Degree:** A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of courses from another discipline is eligible to receive a minor degree in that discipline.
- **Open Elective:** This is a course of interdisciplinary nature. It is offered across the University for All Programs.
- **Pre-requisite:** A course, the knowledge of which is required for registration into higher level course.
- **Professional Core:** The courses that are essential constituents of each engineering discipline are categorized as Professional Core courses for that discipline.
- **Professional Elective**: A course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.
- **Program:** A set of courses offered by the Department. A student can opt and complete the stipulated minimum credits to qualify for the award of a degree in that Program.
- **Program Outcomes:** Program outcomes are statements that describe what students are expected to know or be able to do at the end of a program of study. They are often seen as the knowledge and skills students will have obtained by the time, they have received their intended degree.
- **Program Educational Objectives:** The broad career, professional, personal goals that every student will achieve through a strategic and sequential action plan.
- **Project:** Course that a student must undergo during his/her final year which involves the student to undertake a research or design, which is carefully planned to achieve a particular aim. It is a credit-based course.
- **Supplementary**: A student can reappear only in the semester end examination for the Theory component of a course, subject to the regulations contained herein.
- **Registration**: Process of enrolling into a set of courses in a semester/ term of the Program.
- **Re-Registration:** Student who are detained in courses due to attendance or marks criteria as per their regulation are given a chance to re-register for the same and complete it during the summer term.
- **Semester:** It is a period of study consisting of 16$\pm$1 weeks of academic work equivalent to normally 90 working days including examination and preparation holidays. The odd Semester starts normally in July and even semester in December.
- **Semester End Examinations:** It is an examination conducted at the end of a course of study.
- **Social Service:** An activity designed to promote social awareness and generate well-being; to improve the life and living conditions of the society.
- **Student Outcomes:** The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.
- **Summer term:** The term during which courses are offered from May to July. Summer term is not a student's right and will be offered at the discretion of the University.

- **Term Paper:** A 'term paper' is a research report written by students that evolves their course-based knowledge, accounting for a grade. Term paper is a written original research work discussing a topic in detail. It is a credit-based course.

Academic Instructions

▪ Student should communicate in English with faculty and other students while he/ she is in campus.
▪ Students are expected to wish/greet all officials of the KLEF with due respect.

▪ Students should be courteous and polite while communicating with all Faculty & staff.

▪ Students should maintain silence and/or speak in a polite way in and around the classrooms, library, laboratories, and offices of the Deans, Program Chairs, Senior Officials, faculty rooms and corridors of academic buildings.

▪ It must be noted that shouting, talking in loud voice or in chorus, using indecent, abusive and discourteous language anywhere within the institution premises are considered serious acts of indiscipline and are punishable.

▪ Students should not loiter during the free time in the university campus.

▪ Students should not issue any public or press statement, send letters to editors, government, public servants or notaries without prior permission and approval of the Registrar of KLEF in writing.
▪ Students should keep the status, dignity, prestige and reputation of KLEF high and not engage in anything that might directly or indirectly undermine the standing of the institution.

▪ Students must always adhere to a prescribed/decent dress code befitting the dignity of a technical/professional student within the campus.

▪ Ragging of any student is a serious act of indiscipline and has been totally banned by the Hon'ble Supreme Court of India.

▪ A student found involved in any form of ragging, verbal or physical, inside or outside the institutional campus, hostels, or buses shall be treated as per the anti-ragging rules of the KLEF.

▪ Students must not be involved in quarreling or fighting or any indecent verbal or physical activity among themselves, or with staff and faculty or visitors.

▪ Direct or indirect involvement in any such activity will be considered as serious breach of discipline and strict disciplinary action will be taken against the students that engage in such activities.

▪ Students are not allowed to sit on the steps, boundary walls on the higher floors of any building, or engage in gossiping, making noise or any other such activity.

Working Hours

The University operates between 7:10am to 5:20pm (in shifts) on all weekdays.

Class Environment

The institute is a community of learners. Students have a responsibility of creating and maintaining an environment that supports effective learning to receive effective instructions in classrooms and laboratories. KLEF expects students to conduct themselves in an orderly and cooperative manner by adhering to University Rules & Regulations.

Laboratory Environment

A conducive learning environment in the laboratory is essential and the students are advised to follow the guidelines mentioned below:

▪ Always listen carefully to the faculty especially for the safety precautions to take in the moot court or laboratories.

▪ Accidents resulting in injuries may occur if precautions are not taken.

▪ Eating in moot court hall or laboratories is strictly prohibited.

▪ Proper dress code is to be followed as prescribed by faculty.

▪ Students should familiarize themselves with the location of all the equipment which may be available.

▪ Follow evacuation procedures quickly and quietly, if needed.

▪ Students should always conduct themselves in a responsible and cautious manner. Risky behaviors such as pushing, running, jumping etc., are unwarranted.

▪ Only materials required to complete and record the experiment instructions, (e.g. pencils, books, memorials, paper, etc.) should be brought into the moot court hall or laboratory.

▪ Equipment must be carefully handled to prevent breakage or damage, otherwise appropriate penalties/disciplinary action may be levied/imposed.

▪ Lab station or moot court hall must be cleaned prior to leaving.

▪ Any accident, no matter how small or big, must be reported to the concerned faculty immediately.

Registration Process

For every course, the student must undertake the registration process prior to commencement of the coursework, based on the following conditions:

▪ Registration into a course will be permitted only for such courses, which are offered by KLEF in that semester.

▪ A student must clear the pre-requisite(s) if any, to register into a course.

▪ KLEF reserves the right to register.

▪ Registration for add/drop/change of a course will be permitted only within one week from the scheduled date of commencement of classes.

▪ Students can register up to a maximum of 32 credits of their choice in a semester to meet their Program requirements.

▪ Students, who wish to register for additional credits through Overloading or less credits through Under loading, must seek prior permission from Dean-Academics.

▪ Students who have opted for minor degree, honors degree, can register for a greater number of credits in a semester through Overloading (subjected to guidelines appropriate to compliance on eligibility).

▪ KLEF reserves the right to withdraw within one week of the commencement of the semester any elective course offered, if adequate number of students have not registered or for any other administrative reasons. In such cases, the students are permitted to register for any other elective course of their choice provided they have fulfilled the eligibility conditions.

▪ KLEF reserves the right to cancel the registration of a student from a course or a semester or debar from the degree on disciplinary / plagiarism grounds.

▪ A student is solely responsible to ensure that all conditions for proper registration are satisfied.

If, there is any clash in the timetable, it should be immediately brought to the notice of the Department PG coordinator for necessary corrective action. The registration may be cancelled for a course or the entire semester by KLEF if any irregularity is found at a later stage.

Student Course Registration Process

To complete the student registration, student login to new ERP portal with their valid login credentials. After login student should click on Academic Registrations Student Course Registration. Now Student can view the courses and sections in dropdown menus. Student can select the sections against the courses on their own choice as mentioned in the following screen shot. Student can view the timetable on top of the selection of each course and section. After completing the selection student need to click on Save to save the timetable. After duly verifying the timetable student needs to click on Submit to complete the Registration process. On successful completion of registration, a pop-up message, “Student Registration Successfully Completed” appears.

CHAPTER 5

PROGRAM CURRICULUM

For an academic program the curriculum is the basic framework that will stipulate the credits, category, course code, course title, course delivery (Lectures / Tutorials / Practice / Skill / Project/ Self Study / Capstone Design etc.), in the Choice Based Credit System. However, all such are essentially designed, implemented, and assessed in Outcome Based Education Framework.

Program Structure

a) Each Academic Year is divided into two semesters, each of, approximately, 18 weeks duration:

- Odd Semester (July – December).
- Even Semester (January – May)

b) All courses are categorized into three streams even, odd and dual semester courses.

c) Even semester courses are offered only during even semester i.e., January-May, Odd semester courses are offered only during odd semester i.e., July-December and dual semester courses are offered during both even & odd semesters.

d) A Program is a set of courses offered by the University that a student can opt and complete certain stipulated credits to qualify for the award of a degree.

e) A student can opt for dissertation either by means of research at the University (or) through Internship at an Industry; this is however allowed during 3rd (or) 4th semesters only.

Course work

a. Every course has a Lecture-Tutorial-Practice-Skill (L-T-P-S) component attached to it.

b. Based upon the L-T-P-S structure the credits are allotted to a course using the following criteria.

- Every Lecture / Tutorial hour is equivalent to one credit.
- Every Practical hour is equivalent to half credit.
- Every skill-based practice hour is equivalent to quarter credit.
- If the calculated value of credit is a fraction, it is rounded to the next integer.

Course Classification:

Any course offered under M. Sc program is classified as:

- **Induction Courses:** Student who gets admitted into M. Sc. program must complete a set of Induction courses for a minimum period of 3 weeks and obtain a “Satisfactory” result prior to registering into 1st Semester of the Program.
- **Bridge Courses:** Courses which are required to bridge the continuity among the Basic Sciences Courses / Engineering Sciences Courses / Professional Core Courses and are identified through gap analysis carried out using feedback obtained from various academic stakeholders are termed as Bridge Courses. These courses also do not yield any credits but require a “Satisfactory” result to register into the attached professional courses.

- **Humanities Arts & Social Science Courses (HAS):** Humanities, arts, and social sciences (HAS) courses are a broad field of study that encompasses the study of human culture and society. These courses focus on developing students' critical thinking, problem-solving, and communication skills. These skills are valuable in a variety of careers, and they can also help students become more engaged citizens.
- **Basic Science Courses (BSC):** Basic science courses are the foundation of all science education. They provide students with the knowledge and skills they need to understand the natural world. Basic science courses typically cover Mathematics, Physics, Chemistry, Biology etc., Basic science courses are essential for students who want to pursue careers in science, engineering, medicine, and other STEM fields.
- **Engineering Science Courses (ESC):** Engineering sciences courses are a subset of basic science courses that are specifically designed for engineering students. These courses provide students with the knowledge and skills they need to understand the physical principles that underlie engineering design and analysis.
- **Professional Core Courses (PCC):** Professional core courses are a set of courses that are essential for all engineering students. These courses provide students with the knowledge and skills they need to be successful in their chosen engineering discipline.
- **Professional Elective Courses (PEC):** Professional electives are a set of courses that are chosen by students to supplement their engineering education. Professional electives are a great way for students to customize their engineering education and prepare for their future careers. By choosing electives that are relevant to their interests and goals, students can gain the knowledge and skills they need to be successful in their chosen field.
- **Open Elective Courses (OEC):** Open electives are a set of courses that are not specifically related to engineering, but that can provide students with knowledge and skills that are valuable in a variety of fields. Open electives are a great way for students to broaden their horizons and explore their interests outside of engineering. By choosing electives that are relevant to their interests and goals, students can gain the knowledge and skills they need to be successful in a variety of fields.
  - **Skill Development Courses (SDC):** Skill development courses can provide students with the knowledge and skills they need to use specific software or hardware. This can be especially important for students who are interested in pursuing a career in a particular field.
  - **Project Research & Internships (PRI):** Project, Research and Internships can help students gain a better understanding of their chosen field by giving them the opportunity to apply their knowledge and skills to real-world problems. These can help students explore their interests by giving them the opportunity to work on projects that they are passionate about.
  - **Social Immersive Learning (SIL):** Social immersive learning is a type of experiential learning that allows students to learn by interacting with others in a simulated environment. This type of learning can be especially beneficial for M. Sc students because it can help them develop their soft skills, such as communication, teamwork, and problem-solving.
  - **Audit Courses (AUC):** Any course offered in the University that has no assessment of student performance and no grading. Though “Satisfactory” completion of audit courses doesn’t acquire any credit, but they are part of the graduation requirements.
  - **Value-Added Courses (VAC):** Courses leading to certification and those which are conducted exclusively for employability are referred to as value added courses. Though “Satisfactory” completion of value-added courses doesn’t acquire any credit, but they are part of the graduation requirements.

Course Precedence:
The following are the guidelines for registering into courses with pre-requisites.

- Every course may have one or more of its preceding course (s) as pre- requisite(s).
- To register for a course, the student must successfully be promoted in these course(s) earmarked as pre-requisite(s) for that course.

Summer Term Courses:

KLEF offers summer term courses during May and June. The following are the guidelines to register into courses offered in the Summer Semester.

- A student may register for course/s in each summer term by paying the stipulated fee.
- Students registering for more than one (1) summer course must ensure that there is no clash in the timetable.
- A student can register into a detained course or a not-registered course (course offered in regular semester, but student failed to register due to the non- compliance of pre-requisite condition but has paid the fee.) A student can also register for other than the above two mentioned categories of courses only if they are permitted for acceleration.
- In any case, a student can register only for a maximum of 12 credits during summer term.
- Attendance & Promotion policy for summer term is same as compared to the regular semester except for condonation policy. Condonation is not applicable for summer term courses.

CHAPTER 6

REQUIREMENTS FOR THE AWARD OF DEGREE

The student is awarded a M. Sc. Chemistry degree provided she/he

- Must successfully earn 80 credits, as stipulated in the program structure.
- Must have successfully obtained a minimum CGPA of 5.5 at the end of the program.
- Must obtain all PEC credits from courses of specific specialization domain.
- Must complete 1 SCI publication.
- Must obtain Satisfactory in all Non credited courses.
- Must complete one certification course.
- Must have finished all the above-mentioned requirements in less than twice the period mentioned in the Academic structure for each program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

Name of the Program			M. Sc Chemistry	
Course Category	No. of courses	No. of credits	Total credits	Minimum CGPA required
AUC	1	0	80	5.5
HAS	3	0		
PCC	7	39		
FCC	1	3		
PEC	4	18		
OEC	2	6		
PRI	3	20		
VAC	1	0		

A student having cleared all the courses and met all the requirements for the award of degree with

a. $5.5 \leq CGPA < 5.75$ will be awarded Pass class.
b. $5.75 \leq CGPA < 6.75$ will be awarded Second class.
c. $6.75 \leq CGPA < 7.75$ will be awarded First class.
d. $CGPA \geq 7.75$ will be awarded First class with Distinction provided the student has cleared all the courses in first attempt, and shouldn't have any history of betterment and must have fulfilled all the program requirements in two years duration.

CHAPTER 7

ATTENDANCE RULES & DETENTION POLICY

Attendance policy for promotion in a course:
The student must maintain minimum 85% of attendance to be promoted in a course and to appear for Sem End Examination. In case of medical exigencies, the student/parent should inform the principal within a week by submitting necessary proofs and in such cases the attendance can be condoned up to an extent of 10% by Principal on the recommendation of the committee established for condonation.

- Attendance in a course shall be counted from the date of commencement of the classwork only and not from the date of his/her registration.
- Attendance for the students who are transferred from other institutes and for new admissions, attendance must be considered from the date of his/her admission.
- In case of attendance falling marginally below 75% due to severe medical reasons or any other valid reasons, the Principal / Program chair may bring such cases, along with valid and adequate evidence to the notice of the Dean Academics. The condonation board formed by Vice-Chancellor under the chairman ship of Dean-Academics will consider any further relaxation in attendance from the minimum attendance percentage requirement condition after going through case by case.

Attendance based Marks: There are no specific marks attached to attendance as such, however, if the Course Coordinator of a course desires to award certain marks, for attendance in a course, She/he can do so based on following guidelines, which thereby must be clearly reflected in the respective course handouts which should duly be approved by the Dean Academics. For any course, not more than 5% marks can be allotted for attendance.

The distribution of marks for attendance is [85,88] =1 mark, [89,91]=2marks, [92,94]=3marks,[95,97]=4marks and [98,100]=5marks, below 85%, even in case of condonation,"0" marks. The marks, if allotted for attendance will have to be considered for all L-T-P-S components of a course cumulatively but not specifically for theory component for any course.

Attendance Waiver: Students maintaining a CGPA ≥ 9.00 and SGPA ≥ 9.00 in the latest completed semester get a waiver for attendance in the following semester. Students who thus utilize an attendance waiver will be awarded the marks allocated for attendance (if any) based on their performance in an advanced assignment specified by the course coordinator (emerging topics related to the course). S/he can appear in all assessments and evaluation components without being marked ineligible due to attendance-based regulations.

Attendance Condonation for Participation in KLEF / National / International Events: Only those students nominated / sponsored by the KLEF to represent in various forums like seminars / conferences / workshops / competitions or taking part in co- curricular / extra- curricular events will be given compensatory attendance provided the student applies in writing for such a leave in advance and obtain sanction from the Principal basing on the recommendations of the Head of the Department (HoD) for academic related requests; or from the Dean Student Affairs for extracurricular related requests. For participation in the KLEF's placement process the names of students will be forwarded by the placement cell in-charge to the respective Heads of the Departments. Students participating in KLEF/National/International events like technical fests,

workshops, conferences etc., will be condoned for 10% of total classes conducted for each course in the semester. This condonation is not applicable for summer term.

Course Based Detention Policy:

In any course, a student must maintain a minimum attendance as per the **attendance policy for promotion in a course**, to be eligible for appearing in the Sem-End examination. Failing to fulfill this condition, will deem such student to be detained in that course and become ineligible to take semester end exam.

Eligibility for appearing Sem – End Examination:
A Student registered for a course and maintained minimum attendance of 85% is eligible to write the Semester-End Examination for that course unless found ineligible due to one or more of the following reasons:

- Shortfall of attendance
- Detained
- Acts of indiscipline
- Withdrawal from a course

CHAPTER 8

ASSESSMENT & EVALUATION PROCESS

The assessment is conducted in formative and summative modes with a weightage of 60% for Semester-In evaluation and 40% for Semester-End Evaluation.
The distribution of weightage for various components of formative and summative modes are decided and notified by the course coordinator through the course handout after approval by the Dean Academics, prior to the beginning of the semester. Students are advised to refer the course handout to get more detailed information on assessment.

- Sem-In tests and the Semester-End Examinations will be conducted as per the Academic Calendar.
- Students may have to take more than one examination in a day during Sem-In exams, Semester-End Examinations /Supplementary examinations.
- Examinations may be conducted on consecutive days, beyond working hours and during holidays.

Semester-In Evaluation

The following are the guidelines for the Semester-In evaluation.

- The process of evaluation is continuous throughout the semester.
- The distribution of marks for Semester-In evaluation is 60% of aggregate marks of the courses.
- To maintain transparency in evaluation, answer scripts are shown to the students for verification, within one week of conduct of exam. If there is any discrepancy in evaluation, the student can request the course-coordinator to re-evaluate.
- The solution key and scheme of evaluation for all examinations are displayed by the Course-Coordinator in the appropriate web portal of the course, on the day of the conduct of examination.
- In case the student is unable to appear for any evaluation component owing to hospitalization, participation in extra/ co-curricular activities representing KLEF/ state/ country; the Dean Academics can permit to conduct of re- examination for such students.
- In case a student has missed any of the two in-semester evaluations, S/he is eligible for and will be provided with an opportunity of appearing for re- examination.

Semester End Examination

- The distribution of marks for Semester-End evaluation is 40% of aggregate marks of the course
- The pattern and duration of Sem End examination are decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academics.
- To maintain transparency in evaluation, answer scripts are shown to the students for verification. If there is any discrepancy in evaluation, the student can request the Controller of Examinations to re-evaluate.
- If a student earns ‘F’ grade in any of the courses of a semester, an instant supplementary exam (for only Semester End Exam component) will be provided within a fortnight of the declaration of the results.

Assessment of Project/Research-Based Subjects

All project or research-based subjects must have a defined time limit for completion. The specific time limits and schedule for monitoring and evaluating student performance will be announced each term. The final project report, after obtaining a plagiarism certificate, will be considered, and

evaluated by the panel of examiners. Student project reports must follow the guidelines prescribed by the Dean of Academics.

Absence in Assessment & Examination

If a student fails to take any formative assessment component (due to ill-health or any valid reason), no second chance will be given, and zero marks will be awarded for the same. In cases of excused absence, the instructor may provide an opportunity to the student to reappear in quizzes or assignments or any other internal assessment criteria based on the approval from the principal & the concerned Head of the Department in written. If a student fails to write Sem-In Exam-I or obtained less than 50% marks in Sem-In Exam-I, he must attend remedial classes and maintain a minimum 85% of attendance in remedial classes to be eligible for Make-up test for Sem-In exam-I. Further, the number of remedial classes to be conducted shall be 50% of regular classes held till the Sem-In exam-I. However, there is no make-up test for Sem-In Exam-II or for the Laboratory exams.

A student's absence for Sem-In exams under the following circumstances are only considered for makeup test.

- Pre-approved participation in University/State/National/International co- curricular and extra-curricular activities
- Ill health and medical emergencies for the student leading to hospitalization with certification by the doctor stating inability of student to attend Sem-In exams clearly within the necessary dates.
- Death of immediate family member

Remedial Classes & Remedial Exam

The following categories of students are recommended to attend Remedial classes:

- Students who did not attend or obtain a minimum of 60% marks in the Sem-In examination-1.
- Students for whom the learning objectives of CO1/CO2 are not attained in the Sem-In examination-1.
- Any other student may also be permitted to attend remedial classes as per the discretion of the principal.

The following are the guidelines to conduct remedial classes:

- Remedial classes are scheduled to be conducted usually one- or two- weeks after the conclusion of Sem-In exam-1.
- The number of remedial classes to be conducted shall be 50% of regular classes held until the Sem-In exam-I.
- Remedial classes MUST NOT be scheduled during regular class work hours.

The following are the guidelines for remedial exams:

- Students attending remedial classes must maintain attendance of minimum 80% in classes conducted under remedial classes, without fail for being eligible for attending remedial exam.
- After conduction of remedial test, the Sem-in exam-1 marks will be updated by considering the weightage of 75% of marks obtained by student in remedial exam, and 25 % of marks obtained by student in regular exam; with a CAP of 75% in overall marks.

Grading Process

At the end of all evaluation components based on the performance of the student, each student is awarded grade based on absolute/relative grading system. Relative grading is only applicable to a section of a course in which the number of registered students is greater than or equal to 25. Choice of grading system is decided by the Course-Coordinator with due approval of Dean Academics and is specified in the course handout.

Absolute Grading

The list of absolute grades and its connotation are given below:

Performance	Letter Grade	Grade Point	Percentage of marks
Outstanding	O	10	90-100
Excellent	A+	9	80-89
Very Good	A	8	70-79
Good	B+	7	60-69
Above Average	B	6	50-59
Average	C	5	46-49
Pass	P	4	40-45
Fail	F	0	0-39
Absent	AB	0	Absent

Relative Grading

The following table lists the grades and its connotation for relative grading:

Letter Grade	Grade Point	Grade Calculation
O	10	total marks >= 90% and total marks >= mean + 1.50σ
A+	9	μ+0.50σ <= total marks < μ+1.50σ
A	8	μ <= total marks < μ+0.50σ
B+	7	μ-0.50σ <= total marks < μ
B	6	μ-1.00σ <= total marks < μ-0.50σ
C	5	μ-1.25σ <= total marks < μ-1.00σ
P	4	μ-1.50σ <= total marks < μ-1.25σ or ≥40
F	0	total marks <μ-1.50σ or total marks <=39
AB	0	Absent

μ is the mean mark of the class excluding the marks of those students who scored ≥ 90% and ≤40% after rounding the percentages to the next highest integer. σ is the standard deviation of the marks.

SGPA & CGPA

The SGPA is the ratio of sum of the product of the number of credit s with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student, in a semester.

Where 'Ci' is the number of credits of the i^{th} course and *'Gi'* is the grade point scored by the student in the i^{th} course.

The CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a program, where 'Si' is the SGPA of the i^{th} semester and *'Ci'* is the total number of credits in that semester.

- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- CGPA can be converted to percentage of marks: 10 X CGPA -7.5

- A student appearing for a course having lab integrated with theory and in case obtains less than 40% in either of lab or theory component of semester end examination, and in such case the student must reappear for the component only in which he has secured less than 40%. Till successful attainment of minimum 40% of both components, the student remains in the F grade for that course.
- Audit/Certificate courses are graded as satisfactory (S) or non- satisfactory (NS) only.
- At the end of each semester, the KLEF issues a grade sheet indicating the SGPA and CGPA of the student. However, grade sheets will not be issued to the student if he/she has any outstanding dues.

Betterment

Any student may reappear for semester end examination for betterment only in the theory part of the course for improving the grade. In the case of reappearing for a course, the best of the two grades will be considered. A student cannot reappear for semester end examination in courses like Industrial Training, courses with their L-T/ST-P-S Structure like 0-0-X-X, Project, Practice School, and Term Paper.

CHAPTER 9

PROMOTION

A student admitted to a particular Branch of the B.Tech. Program will normally continue studying in that branch until the completion of the program.

Promotion Policy

To be eligible for provisional promotion for course registration in the next semester, a student must meet the following criterion: The student must promote in the course that serves as a prerequisite for the courses in the following semester.

Note: In case a student is unable to secure minimum P grade for a particular course even after three consecutive attempts, s/he must repeat the course by re-registration.

Re Evaluation

Students desirous of seeing their Semester-End Examination answer scripts have to apply online to the COE for the same within the timeframe as declared by the COE by paying the prescribed fee through ERP. Student applications must be forwarded by the Head of the Department and the Principal of the School and then re-evaluation fees are to be paid. The application along with the attached fee receipt must be submitted to the office of the COE.

There is no provision for re-evaluation in case of Lab/Practical/skilling exams,

student project, viva-voce exam or seminar/design/mini-project courses.

The final grades awarded to each course shall be announced by the COE and the same will be made available to students through the website/notice boards.

Academic Counselling Board (ACB)

Academic Counselling Board is constituted by the Dean Academics. This board shall comprise of the Chairman, Convener, Principal/Director, HOD and Professor/Associate Professor. A student will be put under Academic Counselling Board in the following circumstances:

- Has CGPA of less than 6.00.
- Has 'F' grade or 'Detained' in multiple courses.

The first level of Counselling such students will be done by the Mentor of the student and the HoD followed by the ACB and the list of students who have to undergo the ACB counselling be forwarded by the HoD to the Office of Dean Academics.

The students undergoing the Academic Counselling Board process may be allowed to register only for a few courses based on the recommendation of Academic Counselling Board.

Backlog Courses

A course is considered to be a backlog if the student has obtained 'F' grade and detained in the course.

Rustication

A student may be rusticated from the KLEF on disciplinary grounds, based on the recommendations of any empowered committee, by the Vice Chancellor.

Award of Medals

KLEF awards Gold and Silver medals to the top two candidates in each program after successful completion of their study. The medals are awarded based on their CGPA during the Annual Convocation with the following constraints:

a. The grade obtained through betterment/ supplementary will not be considered for this award.

b. S/he must have obtained first class with distinction for the award of Gold or Silver-medal.

Academic Bank of Credits:

ABC helps the students to digitally store their academic credits from any higher education institute registered under ABC in order to award Certificate/Diploma/Degree/Honors based on the credits earned by the student. All the credits acquired by the students are stored digitally by registering into Academic Bank of Credits (ABC) portal. It also supports retaining the credits for a shelf period and continuing their program study with multiple breakovers. Students may exit from their current program of study due to any unforeseen reasons or to focus on their chosen career path. In such cases, the student may break for a period of time (preferably not in the middle of an academic year) and may continue with the program of study at a later stage. Moreover, students must be able to complete their program by not exceeding the maximum duration of the program. If not, they may be issued with a Certificate, diploma, degree, or honors based on the credits acquired over the period of time for all the programs approved by UGC.

CHAPTER 10

STUDENT COUNSELLING AND FEEDBACK

Counselling

Student counselling / mentoring service ensures that every student gets to know the academic structure of the University and utilize maximum opportunities that the institute offers to fulfil their career and personal life goals. The objective of "Student counselling/Mentoring Service" is to provide friendly support to the students for their well-being during their stay in the campus and for their holistic development.

Counsellors offer individual counselling to help students resolve personal or interpersonal problems. They may also offer small group counselling to help students enhance listening and social skills, learn to empathize with others, and find social support through healthy peer relationships. Counsellors also provide support to faculty by assisting with classroom management techniques and the development of programs to improve quality or safety. When necessary, counsellors may also intervene in a disrupted learning environment.

However, the benefits of counsellor-student relationships are as follows:

Maintain academic standards and set goals for academic success.

Develop skills to improve organization, study habits, and time management.

Work through personal problems that may affect academics or relationships.

Improve social skills.

Cope with university or community-related violence, accidents.

Identify interests, strengths, and aptitudes through assessment.

Counselling Policy:

Student counselling takes great place in K L University. counselling is designed to facilitate student achievement, improve student behaviour, subject analysis levels, attendance, and help students develop socially, professionals with bachelor's, master's degrees or beyond. Faculty counsellors provide counselling and serve an educational role in K L University. We have Mentors, Academic, Career, Physiological, Co-Curricular & Extra Curricular activities counsellors in order to support students who are experiencing personal or academic challenges, help students choose careers and plan for university and intervene when students face behavioural, physical, or mental health challenges.

Feedback System

At KLEF, monitoring of feedback is a continuous process. Feedback is obtained from students and parents on various aspects. Feedback is taken through personal interaction with students, interaction with parents in addition to mid-semester and end-semester feedback.

The institution assesses the learning levels of the students, after admission and organizes special programs for advanced learners and slow learners.

Feedback Types:

In first year SWEAR analysis is done for every student in such a way it identifies their interests, pre-existing knowledge, aspects to improve technical and logical skills based on their career choice. The following are the different types of feedback taken at regular intervals:

(i). Student General Feedback (Twice in a Sem.)

(ii). Student Satisfaction Survey (Once in a Sem.)
(iii). Student Exit Feedback (Once in a Year)
(iv). Academic Peers Feedback on Curriculum (Once in a Sem.)
(v). Parents Feedback on Curriculum (Once in a Sem.)
(vi). Alumni Feedback on Curriculum (Once in a Sem.)
(vii). Industry Personnel Feedback on Curriculum (Once in a Sem.)
(viii). Student Feedback on Curriculum (Once in a Sem.)
(ix). Faculty Satisfaction Survey (Once in a Sem.)
(x). Parent Teacher Association (Once in a Sem.)

Feedback Procedure:

- General Feedback to be taken from the students on the aspects like Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation twice in every semester (Mid semester and End Semester Feedback) in a structured format floated by dean academics office.
- Student Satisfaction Survey (SSS) to all innovative methods and approaches should be recorded at appropriate intervals and the process should be refined based on that. Students should be sensitized on the process and methods and their understanding of the same should be assured.
- Exit survey feedback to be taken from the final year students on the aspects like entrance test, admission process, Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation, placements etc.
- Structured feedback for design and review of syllabus – semester wise / year wise is received from Students, Alumni, Peers, Parent, Industry Personnel.
- Satisfaction Survey to be taken from the existing faculty on Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation once in every semester in a structured format floated by dean academics office.
- Parent Teacher Association (PTA) to develop the potential of parents and to strengthen their relationship with their children through planning and conducting a variety of developmental and recreational activities.
- Online Feedback is collected from all the students once at the end of the semester using well designed questionnaire. Informal feedback will be collected in parallel from selected student representatives within 4-5 weeks of commencement of the semester by the Office of Dean Academics.
- HODs have to submit monthly /semester / Academic Year Feedback reports with necessary comments and proofs to Dean Academics office duly signed by concerned Principal/Director. Visit following link https://www.kluniversity.in/site/feedsys.html

CHAPTER 11

PROGRAM STRUCTURE

Course code	COURSE NAME	Short Name	Mode	Type	L	T	P	S	CR	CH	Pre-requisites
23UC5201	Professional Communication Skills	PCS	R	AUC	0	0	4	0	0	4	NIL
23CY5101	Symmetry & Molecular Spectroscopy	SMS	R	PCC	2	1	0	0	3	3	NIL
23CY5102	Chemical bonding & Coordination Chemistry	CBCC	R	PCC	3	0	4	0	6	7	NIL
23CY5103	Structural Organic & Stereo Chemistry	SOSC	R	PCC	3	0	4	0	6	7	NIL
23CY5104	Molecular Thermodynamics & Chemical Kinetics	MTCK	R	PCC	3	0	4	0	6	7	NIL
23CY5205	Reaction Mechanism & Organometallic Chemistry	ROMC	R	PCC	3	0	4	0	6	7	CBCC
23CY5206	Quantum, Surface & Electrochemistry	QSEC	R	PCC	3	0	4	0	6	7	MTCK
23CY5207	Biomolecules	BM	R	PCC	3	0	4	0	6	7	SOSC
23CY5121	Concepts of Organic Synthesis	COS	R	FCC	3	0	0	0	3	3	NIL
23CY5122	Separation Techniques	ST	R	FCC	3	0	0	0	3	3	NIL
23CY52E1	Biosensors and Diagnostic Devices	BDD	R	PEC	2	1	0	0	3	3	FCC
23CY61E2	Instrumental Methods of Chemical Analysis	IMCA	R	PEC	3	0	6	0	6	9	NIL
23CY61E3	Chromatographic Techniques & Method Validation	CTMV	R	PEC	2	1	0	0	3	3	NIL
23CY61E4	Applied Chemical Analysis	ACA	R	PEC	3	0	6	0	6	9	NIL
23CY52E5	Nano chemistry	NC	R	PEC	2	1	0	0	3	3	FCC
23CY61E6	Organic Synthesis	OS	R	PEC	3	0	6	0	6	9	NIL
23CY61E7	Organic Spectroscopy	OSP	R	PEC	2	1	0	0	3	3	NIL
23CY61E8	Natural Products and Heterocyclic Chemistry	NPHC	R	PEC	3	0	6	0	6	9	NIL
	OPEN ELECTIVE - 1	OE1	M	OEC	3	0	0	0	3	0	NIL

	OPEN ELECTIVE - 2	OE2	M	OEC	3	0	0	0	3	0	NIL
23IE5201	Essentials of Research Design	ERD	R	PRI	1	1	0	0	2	2	NIL
23IE6103	Term Paper	TP	R	PRI	0	0	4	0	2	4	NIL
23IE6205	Dissertation	MAP	R	PRI	0	0	32	0	16	32	NIL
23CC6201	VAC	VAC	R/M	VAC	2	0	0	0	0	0	NIL
	GRAND TOTAL				**42**	**3**	**78**	**0**	**80**	**114**	

LIST OF OPEN ELECTIVES OFFERED TO OTHER DEPARTMENTS

Open Elective Courses	SEM	Course code	Course Name	Short Name	Mode	Type	L	T	P	S	Cr	CH	PRE-REQUISITE
1	3	OECY0001	Energy: Waste to Wealth	OE1	R	OEC	3	0	0	0	3	0	NIL
2	4	OECY0002	Nanotechnology in energy, surface interface and environment	OE2	R	OEC	3	0	0	0	3	0	NIL

PCC - Professional Core related to Major area, PEC - Professional Elective Courses related to Specialization, PRI - Project, Research or Internship Courses, AUC - Audit Courses, VAC - Value Added Courses, OEC - Open Elective, FCC- Flexi core course which leads to specialization

Graduation requirements: Successful attainment of 86 credits, obtain all PEC credits from courses of specific specialization domain, complete 1 SCI publication and obtain Satisfactory in all 0 credit courses (AUC, VAC and PRI categories)

CHAPTER 12
ARTICULATION MATRIX

M. Sc CHEMISTRY
2023-2025
Programme Articulation Matrix (Mapping of Courses with POs)

S. No	Course Code	Course Name	Category	L	T	P	S	Cr	PR	PO						
										1	2	3	4	5	6	7
1	23CY5101	Symmetry & Molecular Spectroscopy	PCC	2	1	0	0	3	NIL	2	2	3				
2	23CY5102	Chemical bonding & Coordination Chemistry	PCC	3	0	4	0	6	NIL	2	3	2	3		2	
3	23CY5103	Structural Organic & Stereo Chemistry	PCC	3	0	4	0	6	NIL	2	3	3	3		2	3
4	23CY5104	Molecular Thermodynamics & Chemical Kinetics	PCC	3	0	4	0	6	NIL	2	2	3	3			
5	23CY5205	Reaction Mechanism & Organometallic Chemistry	PCC	3	0	4	0	6	CBCC	2		3			3	
6	23CY5206	Quantum, Surface & Electrochemistry	PCC	3	0	4	0	6	MTCK	2	2	3	2	3	3	
7	23CY5207	Biomolecules	PCC	3	0	4	0	6	SOSC	2					2	3
8	23CY5121	Concepts of Organic Synthesis	FCC	3	0	0	0	3	NIL	2	2	3				
9	23CY5122	Separation Techniques	FCC	3	0	0	0	3	NIL	2	2	2	3			
10	23CY52E1	Biosensors and Diagnostic Devices	PEC	2	1	0	0	3	ST	2	3			3	3	
11	23CY61E2	Instrumental Methods of Chemical Analysis	PEC	3	0	6	0	6	NIL	2	3			3	3	
12	23CY61E3	Chromatographic Techniques & Method Validation	PEC	2	1	0	0	3	NIL	2	2	3				
13	23CY61E4	Applied Chemical Analysis	PEC	3	0	6	0	6	NIL	2	2	2		3		
14	23CY52E5	Nano chemistry	PEC	2	1	0	0	3	COS	1	3	3	2	2		2
15	23CY61E6	Organic Synthesis	PEC	3	0	6	0	6	NIL	2	2	3	2			
16	23CY61E7	Organic Spectroscopy	PEC	2	1	0	0	3	NIL	2	3	3				
17	23CY61E8	Natural Products and Heterocyclic Chemistry	PEC	3	0	6	0	6	NIL	3		2	2	3		
18	23IE5201	Essentials of Research Design	PRI	1	1	0	0	2	NIL	2	2					
19	23UC5201	Professional Communication Skills	AUC	0	0	4	0	0	NIL					3		

K L E F												
DEPARTMENT OF CHEMISTRY												
2023-2025 M. Sc Course Outcomes vs Program Outcomes												
Course Articulation Matrix												
S No	**Course Code**	**Course Title**	**CO NO**	**Description of the Course Outcome**	**Program Outcomes**						
					1	**2**	**3**	**4**	**5**	**6**	**7**
1	23CY5101	Symmetry & Molecular Spectroscopy	CO1	Demonstrate symmetry elements, operations, and groups by representing them in matrices	2	3					
			CO2	Employ the basic principles of Spectroscopic methods	2	2	3				
			CO3	Explore the basic principles of Microwave, photoelectron ESR Spectroscopy	2	2	3				
			CO4	Illustrate the basic principles of Raman, Mossbauer, X-ray, Laser Spectroscopy	2	2	3				
2	23CY5102	Chemical Bonding & Coordination chemistry	CO1	Predict the shapes of molecules, illustrating the bonding models and applying them to simple molecules	2		2				
			CO2	Predict the shapes of molecules, illustrating the bonding models and applying them to simple molecules	1	2					
			CO3	Illustrate the bonding models, structures, reactivities, and applications of coordination complexes	2		2				
			CO4	Illustrate spectral and magnetic properties, color, and analytical applications of transition metal complexes		3	2	3			
			CO5	Perform chemical reactions to prepare inorganic complexes and analyse samples for quantitative determinations.						2	

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
3	23CY5103	Structural Organic & Stereochemistry	CO1	Illustrate the aromaticity of organic compounds	2	2			3		
			CO2	Apply the reaction intermediates in organic reaction mechanism.	2	3	3				
			CO3	Apply the theories of various energy diagrams in the organic reaction mechanism	2		2				3
			CO4	Interpret the symmetry of organic molecules	2			3	3		
			CO5	Derive the necessary pathways to identify the chemical composition in the given binary mixture and the synthesis of organic molecules.		3		2		3	
4	23CY5104	Molecular thermodynamics & Chemical kinetics	CO1	Utilize the concepts of Classical thermodynamics & laws of thermodynamics	2	2					
			CO2	Develop the applications of Surfactants and Macromolecules		2					
			CO3	Apply the concept of rate of change associated with chemical change		1	2	3			
			CO4	Utilize the concepts of photo chemistry & luminescence in theoretical methods for treating excited states.		2	3	1			
			CO5	An ability to analyze, generate experimental skills towards the industrial applications.	2	2					

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
5	23CY5121	Concepts of Organic Synthesis	CO1	Apply the nucleophillic addition reactions in synthesizing organic compounds	2	1					
			CO2	Use of various organic reagents to synthesize organic compounds			3				
			CO3	Apply various reaction pathways, addition to Carbon-Hetero Multiple Bonds to develop new and notable organic compounds.	2	2					
			CO4	Illustrate the synchronous reactions in organic reaction mechanisms.	2	2					
6	23CY5122	Separation Techniques	CO1	Describe the theory and principles of chromatographic separation.	2	3					
			CO2	Discuss principle of paper chromatography, different techniques, and its modification to thin layer chromatography for analytical applications		2					
			CO3	Describe the ION exchange & ION chromatography		1	2	3			
			CO4	Explain the Liquid-Liquid chromatographic techniques, instrumentation, and Applications.		1	2	3			
7	23IE5201	Essentials of Research Design	CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	2						
			CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection		2					
			CO3	Represent the data in tabular/Graphical form and prepare data for analysis		2					
			CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.		2					

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
8	23CY5205	Reaction mechanism and organometallic Chemistry	CO1	Analyze the various reaction mechanisms of coordination complexes	2		2				
			CO2	Predict the thermodynamics of complex formation and properties of acids and bases in aqueous medium	2		3				
			CO3	Demonstrate structure and bonding of d-block organometallic complexes	2		3				
			CO4	Determine structures of metal clusters and categorize the reactions of d-block organometallic complexes	2		3				
			CO5	Perform chemical reactions to prepare inorganic complexes and analyse samples for quantitative determinations.						3	
9	2CY5206	Quantum, Surface & Electrochemistry	CO1	Utilize the tools of quantum chemistry to analyze the structure and dynamics of molecules.	1	2					
			CO2	Make use of adsorption process and its mechanisms on the *surfaces*	2	2	3				
			CO3	Critically evaluate and apply electrochemical theories and models.	2	3	2				
			CO4	Analyze the stability of thermodynamic systems and apply theories of phase transitions.	2			2	3		
			CO5	An ability to analyze, generate experimental skills towards the industrial applications.		2				3	

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
10	23CY5207	Biomolecules	CO1	Interpret the structure, functions, and chemistry of carbohydrates with respect to their pharmacological activity	1					2	3
			CO2	Demonstrate the structure, function of amino acids and proteins and explain their metabolic pathways.	2					2	3
			CO3	Relate the structure of nucleic acids with their functionality and understand the central dogma of molecular biology.	2					2	3
			CO4	Illustrate the physicochemical properties and characterization of fats and oils.	2					3	3
			CO5	Apply the principles of chromatography, and qualitative analysis to isolate, separate and identify various biomolecules.	3					3	3
11	23CY52E5	Nano chemistry (Prof. Elective)	CO1	Describe a working knowledge of the basic concept of nanochemistry and changes of chemical and physical properties.	1	3			2		
			CO2	Analyse several synthetic methods for the fabrication of nano particles.	1	3	3				
			CO3	Apply the links between structure and catalytical activity of the nanomaterials.	1	3					2
			CO4	Illustrate the application and prospects of nanochemistry	2			2	2		

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
12	23CY52E1	Biosensors and Diagnostic Devices (Prof. Elective)	CO1	Demonstrate the working mechanism and applications of biosensors towards clinical diagnosis	1					2	
			CO2	Discuss the principle of various structural and morphological techniques and apply them for clinical quantitative analysis	2	3					
			CO3	Illustrate the working principles and fabrication of different biosensors	2	2					
			CO4	Discuss the principle of various diagnostic devices and apply them in clinical samples to understand working principles	2				3		
13	23UC5201	Professional Communication Skills	CO1	To develop and demonstrate principles of listening, speaking, reading, and writing in various functional contexts					3		
			CO2	To demonstrate different types of personal and professional skills and apply them for growth in professional zone.					3		
			CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic, Algebra & Geometry to improve problem solving ability.					3		
			CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.					3		

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
14	23CY61E2	Instrumental Methods of Chemical Analysis (Prof. Elective)	CO1	Demonstrate the working mechanism and applications of voltametric techniques towards pharmaceutical drug analysis and environmental monitoring	2					3	
			CO2	Discuss the principle of fluorescence spectroscopy and apply it for clinical quantitative analysis	2	3					
			CO3	Apply the basic principles of IR and Mass spectroscopy for the interpretation of organic molecules	3	2					
			CO4	Apply the basic principles of thermal and radiochemical methods of analysis for the determination of stability of compounds and quantitative estimations of radioactive elements	2				3		
			CO5	Apply the key concepts of instrumentation techniques to set a procedure for the analysis of target species of interest and analyze the obtained results	3				3		
15	23CY61E3	Chromatographic techniques and method validation (Prof. Elective)	CO1	Apply the principles and common applications of a Gas chromatographic techniques.	2	3					
			CO2	Apply Liquid-liquid partition chromatography principles to the development and validation of complex chemical methods.	1	2	3				
			CO3	Apply LC-MS principles to the development and validation of complex biochemical methods.	1	2	3				
			CO4	Interpret chromatograms and analyze and interpret retention times, peak shapes, and peak resolution.	2	2	3				

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
16	23CY61E4	Applied Chemical Analysis (Prof. Elective)	CO1	Understand the principles, methodology and adoptability various procedures for the analysis of Analysis of Iron, Manganese, Chromite, Phosphate and Aluminium Ores.	2	2					
			CO2	Discuss, explain, and illustrate the applications of the general methods of analysis for finished products such as Steel, dolomite, fire clay, four spar and magnesite.	2	2	3				
			CO3	Finding the adoptability by applying the general methods of analysis for Cement, Soaps, Oils, and paints analysis.	2	2	2				
			CO4	Explain and apply the various principles involved in the chemical and physicochemical analysis of Organic Functional Groups	2			2	3		
			CO5	Analysis of chemicals by instrumental methods		3				3	
17	23CY61E6	Organic Synthesis (Prof. Elective)	CO1	Apply appropriate reagents and reaction conditions to achieve selective carbon- carbon bond formation.		2		2			
			CO2	Use knowledge of reaction conditions, catalysts, and reagents to design and executive selective functionalization reactions of organoboranes and silanes.		1	3				
			CO3	Employ appropriate oxidizing and reducing agents and reaction conditions to achieve selective transformations.	2				2		
			CO4	Design synthetic route utilizing phase transfer catalysis, retro synthetic approach, polymerization mechanism to achieve challenging transformations.		2		2	3		
			CO5	Execute multi-step synthetic sequences to synthesize target molecules efficiently and demonstrate a deep understanding of reaction mechanisms and reaction optimization.		2	3				3

S No	Course Code	Course Title	CO NO	Description of the Course Outcome	Program Outcomes						
					1	2	3	4	5	6	7
18	23CY61E7	Organic spectroscopy (Prof. Elective)	CO1	Demonstrate UV-VISIBLE and Applications towards deduction of the structure of Molecule	2	2	3				
			CO2	Explore IR Spectroscopy and Applications towards deduction of the structure of Molecule	2	3					
			CO3	Depreciate NMR- Spectroscopy and Applications towards deduction of the structure of Molecule	2	2					
			CO4	Illustrate the Mass Spectroscopy and Applications towards deduction of the structure of Molecule	2	3					
19	23CY61E8	Natural Products & Heterocyclic Chemistry (Prof. Elective)	CO1	Illustrate the drug metabolic pathways, adverse effect and therapeutic value of alkaloids and steroids.	3			2	2		3
			CO2	Interpret the mechanistic pathways and mode of action of different class of medicinal compounds like terpenoids and vitamins.	3			2	2		3
			CO3	Explore chemical behaviour of aromatic heterocycles, use of heterocycles in functional group and ring transformations.	3		2	2	3		
			CO4	Illustrate the synthesis, reactions of Meso-ionic compounds and interpret the special feature of aliphatic heterocycles.	3		2	2	3		
			CO5	Isolate, analyse independent investigations of natural products, and use classical synthetic methods to synthesize heterocyclic compounds.	3		2				3

CHAPTER 13

SYLLABUS

Symmetry and molecular spectroscopy (SMS)

COURSE CODE	23CY5101	MODE	General	LTPS	2-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Demonstrate symmetry elements, operations, and groups by representing them in matrices	3	1,2
CO2	Employ the basic principles of Spectroscopic methods	3	1,2,3
CO3	Explore the basic principles of Microwave, photoelectron ESR Spectroscopy	3	1,2,3
CO4	Illustrate the basic principles of Raman, Mossbauer, X-ray, Laser Spectroscopy	3	1,2,3

Syllabus

Module 1	**Symmetry and Group Theory in Chemistry***:* Symmetry elements & operations, group, subgroup, Understanding Character Tables of Symmetry Groups, relation between order of a finite group and its subgroup. Point group of symmetry. Schon files symbols, representation of groups by Matrices (representation for Cn, Cnv, Cnh, Dn etc. groups to be worked out, explicitly). Chirality and molecular vibrations. The great orthogonality theorem (without proof) and its importance. Character tables and their use, Application of group theory in IR and Raman spectroscopy
Module 2	**Spectroscopic methods:** Introduction to spectroscopic methods (UV, IR, NMR, MS) - Electromagnetic spectrum, Quantization of Energy in the Hydrogen Atom, Quantization of Energy in poly-electronic atoms, Electronic states of diatomic and polyatomic molecules, Classification based on absorption-Emission- Importance-Characterization of electromagnetic radiation -Beer-Lambert's law-deviations from Beers Law, Franck-Condon principle. Dispersive spectrometers, Fourier Transform spectrometers, Signal to Noise Ratio, how spectra are obtained.
Module 3	**Microwave spectroscopy, Photoelectron Spectroscopy:** The motion of molecules-Degrees of freedom -Energy associated with the degrees of freedom Type of spectra-**Microwave spectroscopy**. –Principle-Classification molecules, rigid rotator model, -Microwave spectra of diatomic molecules and polyatomic molecules. **Photoelectron Spectroscopy:** Basic principles, Koopman's theorem. Photoelectron spectra of simple molecules, Electron spin chemical analysis (ESCA), Auger electron spectroscopy. **Electron Spin Resonance (ESR)-Spectroscopy-** Theory-ESR lines and intensity-g-values -factors affecting the ESR lines- Zero field splitting and Kramer's degeneracy. Applications of ESR

Module 4	**Raman spectroscopy:** Principle-Classical and quantum theories of Anharmonic perturbation, Raman effects, selection rules, mutual exclusion principle, Resonance Raman spectroscopy, coherent anti-stokes Raman Spectroscopy (CARS)-Application. **Mossbauer Spectroscopy**: Principle- Isomer Shifts – Quadrupole splitting and Magnetic hyperfine splitting – Selection Rules. Applications- **X-ray Diffraction**-Introduction-principle-Braggs law-Scherrer Formula-Applications. **Laser spectroscopy**- General principles of laser spectroscopy, features of lasers and population inversion. Examples of some common lasers –solid state, gas and dye lasers.

Textbooks:

Sl No	Title	Author(s)	Publisher	Year
1	Organic Spectroscopy	W. Kemp	MacMillan	1994
2	Modern Spectroscopy	J. Michael Hollas	Wiley	2013
3	Atomic and molecular Spectroscopy	S. Svanberg	Springer	2003
4	Basic atomic and molecular Spectroscopy	J. Micheal Hollas	Royal Society of Chemistry	2002
5	Introduction to Molecular Spectroscopy	G.M. Barrow	McGraw Hill, New York	1964
6	Fundamentals of Molecular spectroscopy	C. N. Banwell	McGraw Hill, New York	2000
7	Spectroscopy	B.P. Straughan and S. Walker	Chapman Hall, London	1976
8	Introduction to Photoelectron Spectroscopy	P.K.Ghosh	John Wiley New York	1989

Chemical Bonding and Coordination Chemistry (CBCC)

COURSE CODE	23CY5102	MODE	General	LTPS	3-0-4-0	PRE-REQUISITE	NIL	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Predict the shapes of molecules, illustrating the bonding models and applying them to simple molecules	3	1, 3
CO2	Predict the shapes of molecules, illustrating the bonding models and applying them to simple molecules	3	1, 2
CO3	Illustrate the bonding models, structures, reactivities, and applications of coordination complexes	3	1, 3
CO4	Illustrate spectral and magnetic properties, color, and analytical applications of transition metal complexes	3	2,3,4
CO5	Perform chemical reactions to prepare inorganic complexes and analyse samples for quantitative determinations.	4	6

Syllabus

Module 1	**Structure & Bonding**: Shapes of molecules (VSEPR Theory, Bent's rule), Valence Bond Theory, Molecular Orbital Theory in explaining the structures of simple molecules [homonuclear diatomic (H_2, H_2^+, He_2, He_2^{2+}, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2), heteronuclear diatomic (HF, CO).
Module 2	**Structure and bonding in boron clusters**: Preparation, structure and reactions of boranes, carboranes, metallocarboranes, boron–nitrogen ($H_3B_3N_3H_3$), Electron counting in boranes–Wades rules (Polyhedral skeletal electron pair theory).
Module 3	**Chemistry of transition metal compounds**: Limitations of VBT, Crystal field theory - crystal field splitting patterns in octahedral, tetrahedral, tetragonal, square planar, square pyramidal and trigonal bipyramidal geometries. Calculation of crystal field stabilization energies. Factors affecting crystal field splitting energies, Spectrochemical series, Jahn – Teller effect.
Module 4	**Electronic spectra of transition metal complexes**: Term symbols – Russell – Sanders coupling – derivation of term symbols for various configurations. Spectroscopic ground states. Selection rules, break-down of selection rules. Orgel and Tanabe-Sugano diagrams for d1 – d9 octahedral and tetrahedral transition metal complexes of 3d series – Calculation of Dq, B and β parameters.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Inorganic Chemistry	F.A. Cotton and G. Wilkinson	IV Edition, John Wiley and Sons, New York,	1980
2	Inorganic Chemistry	J.E. Huheey	III Edition, Harper International Edition,	1983
3	Theoretical Inorganic Chemistry	M.C. Day and J. Selbin	Affiliated East-West press Pvt. Ltd., New Delhi.	1997
4	Inorganic Chemistry	Shriver and Atkins	Oxford University Press,	2010
5	Concise Inorganic Chemistry	J. D. Lee	Oxford University Press; Fifth edition, Wiley India edition.	2008

Structural Organic & Stereo Chemistry (SOSC)

COURSE CODE	23CY5103	MODE	General	LTPS	3-0-4-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate the aromaticity of organic compounds	3	PO1, PO2, PO5
CO2	Apply the reaction intermediates in organic reaction mechanism.	3	PO1, PO2, PO3
CO3	Apply the theories of various energy diagrams in the organic reaction mechanism	3	PO3, PO1, PO7
CO4	Interpret the symmetry of organic molecules	3	PO1, PO4, PO5
CO5	Derive the necessary pathways to identify the chemical composition in the given binary mixture and the synthesis of organic molecules.	4	PO 2, 4, 6

Syllabus

Module 1	**Aromaticity and Aromatic electrophilic substitution:** Basic definition of aromaticity, Huckel's rule, intermediates and orientation, electrophiles, reactivity and selectivity, kinetic isotopic effects; Nitration, halogenation, sulfonation, Friedel-Crafts reaction, protonation; Nucleophilic aromatic substitution.
Module 2	**Reactive Intermediates:** Carbenes, Nitrenes, Radicals, Carbo-cations, ylides, benzyne; Substitution and Elimination reactions; Acid and base concept of organic compounds; Ideal synthesis; fundamentals of retrosynthesis; Functional **group transformations, umpolung and protecting groups.**
Module 3	**Reaction mechanisms:** Definition of reaction mechanism, transition state theory, Substituent effects, linear free energy relationships, Hammett equation and related modifications. Basic mechanistic concepts like kinetic vs thermodynamic control, Hammond postulate, Curtin-Hammett principle, isotope effects; Oxidation and Reduction reactions, Chemistry of cyclic and acyclic compounds.
Module 4	**Stereochemistry:** Introduction, optical isomerism and chirality, resolution, conformational analysis, stereo electronic effect, and stereochemical aspects.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Organic chemistry	Clayden J, Greeves N, Warren S. T. Pradeep,	Oxford university press	2012
2	advanced organic chemistry: reactions, mechanisms, and structure	Smith MB. March's Wang, X.; Bashir, S.; Liu, J.	John Wiley & Sons	2020
3	Advanced organic chemistry: part A: structure and mechanisms	Carey FA, Sundberg RJ	Springer Science & Business Media	2007
4	Organic reactions stereochemistry and mechanism	Kalsi PS.	New Age International	2007
5	Structure and Mechanism in Organic Chemistry	C. K. Inglod,	Cornell University Press.	1953

Molecular Thermodynamics & Chemical Kinetics (MTCK)

COURSE CODE	23CY5104	MODE	General	LTPS	3-0-4-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Utilize the concepts of Classical thermodynamics & laws of thermodynamics	3	1,2
CO2	Develop the applications of Surfactants and Macromolecules	3	2
CO3	Apply the concept of rate of change associated with chemical change	3	2,3,4
CO4	Utilize the concepts of photo chemistry & luminescence in theoretical methods for treating excited states.	3	2,3,4
CO5	An ability to analyze, generate experimental skills towards the industrial applications.	4	1,2

Syllabus

Module 1	**Thermodynamics:** Chemical equilibrium- effect of temperature on equilibrium constant-Van't Hoff equation. Partial molar quantity- different methods of determination of partial molar quantity. Chemical potential- Phase rule and its derivation, Gibbs-Duhem equation, Duhem- Margules equation, Classius-Clapeyron equation. Third law of thermodynamics- Determination of the absolute entropy- Apparent exceptions to Third law of thermodynamics.
Module 2	**Micelles and Macromolecules**: Surface active agents, classification of surface-active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization- micro emulsion, reverse micelles. ***Polymers***- Definition, types of polymers, electrically conducting, kinetics of polymerization. Molecular mass- Number and mass average molecular mass, molecular mass determination- Osmometry, viscometry, calculation of average dimensions of various structures.
Module 3	**Chemical Kinetics**: Theories of reaction rates- Collision theory- Limitations, Transition state theory. Effect of ionic strength-Primary and secondary salt effects. Effect of dielectric constant, effect of substituent, Hamett equation -limitations- Taft equation. Consecutive reactions, parallel reactions, opposing reactions (Uni molecular steps only, no derivation). Specific and general acid-base catalysis. Fast reactions- different methods of studying fast reactions- flow methods, relaxation methods- temperature jump and pressure jump methods.
Module 4	**Photochemistry:** Electronic transitions in molecules, Franck-Condon principle. Electronically, excited molecules- singlet and triplet states, spin-orbit interaction. Quantum yield and its determination. Actinometry. Derivation of fluorescence and phosphorescence quantum yields. Quenching effect- Stern Volmer equation. Photochemical equilibrium and delayed fluorescence- E type and P type. Photochemical primary processes, types of photochemical reactions-photo dissociation, addition, and isomerization reactions with examples.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Thermodynamics For Chemists	Samuel Glasstone	Ewp	2008
2	Chemical Kinetics	K J Laidler	Pearson Education India	2003
3	Photochemistry	R.P. Kundall And A. Gilbert	Mcgraw Hill.	2014
4	Physical Chemistry.	Ira N. Levine	Mcgraw Hill.	2008
5	Advanced Physical Chemistry	Gurdeep Raj	Krishna Prakashan Media P. Ltd	2016

Reaction mechanism and organometallic Chemistry (ROMC)

COURSE CODE	23CY5205	MODE	General	LTPS	3-0-4-0	PRE-REQUISITE	CBCC

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze the various reaction mechanisms of coordination complexes	3	1, 3
CO2	Predict the thermodynamics of complex formation and properties of acids and bases in aqueous medium	3	1, 3
CO3	Demonstrate structure and bonding of d-block organometallic complexes	3	1, 3
CO4	Determine structures of metal clusters and categorize the reactions of d-block organometallic complexes	3	1,3
CO5	Perform chemical reactions to prepare inorganic complexes and analyse samples for quantitative determinations.	4	6

Syllabus

Module 1	Reactivity of coordination complexes – inert and labile complexes –ligand substitution reactions in octahedral and square planar complexes –Trans effect– electron transfer reactions – inner and outer sphere electron transfer mechanisms.
Module 2	Thermodynamics of complex formation in aqueous medium – stepwise and overall formation constants –factors affecting formation constant – determination of formation constant-HSAB principle to explain the stability of coordination compounds.
Module 3	Organometallic complexes of d-block element – 16 and 18 electron rules – Synthesis, structure and spectral properties of metal carbonyl and metal nitrosyl complexes-Fischer and Schrock carbene complexes.
Module 4	metal clusters – metal-metal bonds – carbonyl and non-carbonyl clusters – isolobal analogy and application of Wade's rule – Zintle ions – Chevrel phases. Catalysis: Homogeneous (Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation) and hrterogenous (Fischer-Tropsch reaction, Ziegler Natta Polymerization, Haber process).

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Inorganic Chemistry	F.A. Cotton and G. Wilkinson	IV Edition, John Wiley and Sons, New York,	1980
2	Inorganic Chemistry	J.E. Huheey	III Edition, Harper International Edition,	1983
3	Theoretical Inorganic Chemistry	M.C. Day and J. Selbin	Affiliated East-West press Pvt. Ltd., New	1997

			Delhi.	
4	Inorganic Chemistry	Shriver and Atkins	Oxford University Press,	2010
5	Concise Inorganic Chemistry	J. D. Lee	Oxford University Press; Fifth edition, Wiley India edition.	2008
6	Vogel's textbook of quantitative inorganic analysis	Jeffery, Bassett, Mendham and Denney	Fifth edition, Longman.	2003
7	Organometallic and Bioinorganic chemistry	Ajai Kumar	7^{th} edition	2021
8	Basic Organometallic Chemistry	B D Gupta	Second edition	2013

Quantum, Surface & Electrochemistry (QSEC)

COURSE CODE	23CY5206	MODE	General	LTPS	3-0-4-0	PRE-REQUISITE	MTCK

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Utilize the tools of quantum chemistry to analyze the structure and dynamics of molecules.	3	PO-1,2
CO2	Make use of adsorption process and its mechanisms on the *surfaces*	3	PO-1,2,3
CO3	Critically evaluate and apply electrochemical theories and models.	3	PO-1,2,3
CO4	Analyze the stability of thermodynamic systems and apply theories of phase transitions.	3	PO-1,4,5
CO5	An ability to analyze, generate experimental skills towards the industrial applications.	4	PO-2,6

Syllabus

Module 1	**Quantum Mechanics:** Introduction to quantum mechanics. Schrödinger wave equation. Time-independent and time dependent Schrödinger wave equations and the relation between their solutions. Eigenfunctions and Eigenvalues. Physical Interpretation of wave function. Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermition operators. Angular Momentum operators and their properties. Commutation of operators. Normalization, orthogonality and orthonormality of wave functions. Average (expectation) values. Postulates of quantum mechanics. Solutions of Schrödinger wave equation for a free particle, particle in a ring, particle in a three-dimensional box. Quantum mechanical degeneracy, tunneling (no derivation). Application of Schrödinger equation to harmonic oscillator, rigid rotator.
Module 2	**Surface phenomena:** Types of adsorption isotherms, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena),
Module 3	E**lectrochemistry**: Activity coefficients and ion-ion interactions. Physical significance of activity coefficients, mean activity coefficient of an electrolyte and its determination. Derivation of the Debye-Hückel theory of activity coefficients the electrode-electrolyte interface. The electrical double layer. The Helmholtz-Perrin parallel-plate model, the Gouy-Chapman diffuse-charge model and the Stern model. Electrodics: Charge transfer reactions at the electrode-electrolyte interface. Derivation of Butler-Volmer equation.Tafel equation, Low field equilibrium, Nernest equation.
Module 4	***Statistical Thermodynamics:*** Fundamentals: Idea of microstates and macro states. Concept of distributions- Binomial & multi-nomial distributions for non-degenerate and degenerate systems, Thermodynamic probability, and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its importance in chemistry. Types of statistics: Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. Thermodynamic probability (W) for the three types of statistics. Derivation of distribution laws (most probable distribution) for the three types of statistics. Lagrange's undetermined multipliers.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Physical Chemistry	Gurdeep Raj	Krishna Prakashan Media P. Ltd	2016
2	Physical Chemistry	Peter Atkins and Julio de Paula,	Oxford University Press	2018
3	Quantum Chemistry	Lowe, J. P. & Peterson, K.	Quantum Chemistry Academic Press	2005
4	Physical Chemistry	Gilbert Castellon	Narosa Publishing House	2004
5	*Introductory Statistical Mechanics.*	*Bowley, Roger and Sanchez, Mariana*	Oxford University Press	2000

Biomolecules (BM)

COURSE CODE	23CY5207	MODE	General	LTPS	3-0-4-0	PRE-REQUISITE	SOSC

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Interpret the structure, functions, and chemistry of carbohydrates with respect to their pharmacological activity	3	PO 1, PO 6, PO 7
CO2	Demonstrate the structure, function of amino acids and proteins and explain their metabolic pathways.	3	PO 1, PO 6, PO 7
CO3	Relate the structure of nucleic acids with their functionality and understand the central dogma of molecular biology.	3	PO 1, PO 6, PO 7
CO4	Illustrate the physicochemical properties and characterization of fats and oils.	3	PO 1, PO 6, PO 7
CO5	Apply the principles of chromatography, and qualitative analysis to isolate, separate and identify various biomolecules.	3	PO 3, PO 8

Syllabus

Module 1	**Carbohydrates:** Classification, Physicochemical properties- stereochemistry- Chemistry, Structure and functions of monosaccharides, disaccharides, polysaccharides- Mucopolysaccharides- Deoxy sugars, amino sugars, reactions of carbohydrates- Proteoglycans, Glycoproteins and Glycolipids- separation of carbohydrates.
Module 2	**Amino acids & Proteins:** α- Amino acids: Classification, Structure Physicochemical properties, and biological significance- synthesis and reactivity; Peptides: bond, Peptides of biological importance; Chemical synthesis of peptides – Solid phase peptide synthesis; Proteins – Classification, Isolation, Purification and Characterization of proteins, structure, functions, properties, and significance; Enzymes- Characteristics and functionality.
Module 3	**Nucleic Acids:** Basic Structure, Biological significance, Reactions of Nucleic acid bases, Physicochemical properties of Nucleic Acids, DNA- structure, denaturation, RNA, Functions of Nucleotides, Structure, and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thiamine, Uracil) bases. Structural features of nucleic acids (DNA & RNA) and their biological functions.
Module 4	**Lipids:** Classification, role of lipids, fatty acids and glycerol derived from oils and fats; Physical properties - polymorphism, reactions of fats, rancidity, reversion, polymerization, saponification, addition, hydrogenation, phospholipids, lipid metabolism; intermediary metabolism of fatty acids, synthesis of fatty acids.

LAB COMPONENT:

1. Qualitative analysis of carbohydrates
2. General colour reactions of proteins
3. Identification of fats
4. Qualitative analysis of Amino acids
5. Separation of plant pigments by column chromatography
6. Separation of amino acids by thin layer chromatography

7. Estimation of carbohydrates by Anthrone method
8. Estimation of Amino acids
9. Isolation of polysaccharide (starch or glycogen) from the biological material.
10. Isolation of casein from milk.
11. Extraction of lipid/oil from plant material and determination of its saponification value and iodine number.
12. Demonstration of GC and HPLC

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Organic Chemistry, Volume 2	I.L. Finar	Pearson	1975
2	Medicinal Chemistry	Graham L. Patrick	Oxford University Press	2005
3	Chemistry of Natural products	S V Bhat, B.A. Nagasampagi	Narosa	2006
4	Chemistry of Natural Products	V. K. Ahluwalia	Springer & Ane books Pvt. Ltd.	2022
5	The Biosynthesis of Secondary Metabolites	Richard B Herbert	Chapman &Hall	2011

Concepts of Organic Synthesis (COS)

COURSE CODE	23CY5121	MODE	General	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the nucleophillic addition reactions in synthesizing organic compounds	3	1,2
CO2	Use of various organic reagents to synthesize organic compounds	3	1,2
CO3	Apply various reaction pathways, addition to Carbon-Hetero Multiple Bonds to develop new and notable organic compounds.	3	2,3
CO4	Illustrate the synchronous reactions in organic reaction mechanisms.	3	3

Syllabus

Module 1	**Modern methods of synthesis**: Modern methods of synthesis and reactions of Carbonyl compounds, addition of N, O, and S nucleophiles, Reduction using hydride reagents, chemo and stereoselectivity, formation of enols and enamines, kinetic and thermodynamic enolates.
Module 2	**Reagents:** lithium and boron enolates in aldol and Michael reactions, stereoselective aldol condensations, alkylation, and acylation of enolates, condensation reactions, Claisen, Dieckman, Knoevenegal, Stobbe and Darzen glycidic ester, acyloin, emphasis on synthetic utility of these reactions.
Module 3	**Rearrangements:** Rearrangement reactions involving electron deficient carbon, nitrogen, oxygen centers and the synthetic utility of these rearrangements. Coupling reactions: Heck, Suzuki, Negishi, Stille, Sonogashira coupling.
Module 4	**Pericyclic reactions:** Classification, electrocyclic, sigmatropic, cycloaddition, chelotropic and ene reactions, Woodward-Hoffmann rules, frontier orbital and orbital symmetry correlation approaches, examples highlighting pericyclic reactions in organic synthesis, stereochemical aspects.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Organic Chemistry-Reactions, Mechanism and Structure	Jerry March	John Wiley.	2006
2	*Advanced Organic. Chemistry.*	*FRANCIS A. CAREY* and RICHARD J. *SUNDBERG*.	Springer	2007
3	Structure and Mechanism in Organic Chemistry	C.K.Ingold, Cornell	University Press.	2018
4	Principles of Organic Synthesis,	R.O.C Norman and J. M. Coxon.	Springer	1993
5	Stereochemistry of carbon compounds	E.Eliel	McGraw Hill Education	2001

Separation Techniques (ST)

COURSE CODE	**23CY5122**	MODE	General	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Describe the theory and principles of chromatographic separation.	3	1,2
CO2	Discuss principle of paper chromatography, different techniques, and its modification to thin layer chromatography for analytical applications	3	2
CO3	Describe the ION exchange & ION chromatography	3	2,3,4
CO4	Explain the Liquid-Liquid chromatographic techniques, instrumentation, and Applications.	3	2,3,4

Syllabus

Module 1	**Chromatography:** classification of different chromatographic methods, methods of development-Elution development, Gradient elution development, displacement development, and frontal analysis. Principles of chromatography, different migration, adsorption phenomena, partition, adsorption coefficient, retardation factor, retention time and volume, column capacity, temperature effects, partition isotherm. Dynamics of chromatography-efficiency of chromatographic column, zone spreading, High Equivalent Theoretical Plate (HETP), Van Deempter equation, resolution, choice of column, length and flow velocity, qualitative and quantitative analysis.
Module 2	**Column chromatography (adsorption chromatography):** principles, general aspects, adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications. **Paper chromatography:** principle, papers as a chromatographic medium, modified papers, solvent systems, mechanism of paper chromatography, experimental technique, different development methods-ascending, descending, horizontal, circular spreading, multiple development, two-dimensional development, reverse phase paper chromatographic technique-visualization and evaluation of chromatograms, applications.
Module 3	**Thin layer chromatography:** principle, chromatographic media-coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromate plate, types of development, visualization methods, documentation, applications in the separation, HPTLC-principle, technique, applications. **Capillary Electrophoresis:** Principle, Details of the Instrument, Applications to Inorganic and Organic compounds. **Ion Exchange:** principles of ion-exchange systems, synthetic ion-exchange resins, properties of anion and cation exchange resins, ion-exchange mechanism, ion-exchange equilibria, selectivity, ion-exchange capacity, applications of ion-exchangers in different fields.
Module 4	**Ion exchange chromatography:** Principle, Equipment, Application Specifically Separations of Lanthanides, Actinides, amino acids. **Ion chromatography:** principles of separation, instrumentation, detectors, separation of cations and anions, applications in the analysis of water and air pollutants. **Solvent Extraction:** principles and processes of solvent extraction, Distribution Law and Partition coefficient, nature of partition forces, different types of solvent extraction systems Batch extraction,

	Continuous extraction, Counter current extraction, solvent extraction systems, applications in metallurgy, general applications in analysis and pre-concentration, special extraction systems like crown ethers, super fluid, and surfactant extractions-examples. **Gel Exclusion chromatography or Gel filtration chromatography:** principles, properties of xerogels, apparatus and detectors, resolution of gel type, applications to organic compounds.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Techniques and practice of Chromatography	R.P.W Scott	Marel Dekker Inc., New York	2015
2	Separation methods	M.N. Sastry	Himalaya Publishing Company, Mumbai	2012
3	Chromatography	E. Helfman, Van Nostrand and Reinhold,	Reinhold, New York	2014
4	Chromatography	E. Lederer and M. Lederer,	Elsevier, Amsterdam.	2009
5	Chemical separation methods	John A Dean, Von Nostrand	Reinhold, New York	2008

Biosensors and Diagnostic Devices (BDD)

COURSE CODE	23CY52E1	MODE	General	LTPS	2-1-0-0	PRE-REQUISITE	ST

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Demonstrate the working mechanism and applications of biosensors towards clinical diagnosis	3	1, 6
CO2	Discuss the principle of various structural and morphological techniques and apply them for clinical quantitative analysis	3	1, 2
CO3	Illustrate the working principles and fabrication of different biosensors	3	1, 2
CO4	Discuss the principle of various diagnostic devices and apply them in clinical samples to understand working principles	3	1, 5

Syllabus

Module 1	**Introduction to Biosensors:** Definition and historical perspective, Various components of biosensors, working mechanism, Probes: antibodies, nucleic acids, enzymes, receptors etc. Methods for probe attachment to surfaces Adsorption; chemisorption, physisorption, polymer trapping, covalent attachment, film deposition techniques; molecularly imprinted polymers and biomimicry. Biosensor construction and modification, Electrodes: carbon (graphene, carbon nanotubes, fullerene, corannulene) metal nanoparticles, polymer, nanocomposites, Thin-Film Electrodes and Screen-Printed electrodes etc. based electrodes. Sensor characteristics: calibration, dynamic range, signal-to-noise ratio, sensitivity, selectivity, interference etc.
Module 2	**Surface characterization and Transducers:** Techniques used to characterize biosensors (UV-Vis, FT-IR, SEM, AFM, XPS, XRD etc.), Various types of transducers and detection methods; principles of Calorimetric, Optical, Electrochemical, Impedimetric, and Chemiluminiscene-based Biosensors.
Module 3	**Design and Applications of Biosensors:** Fabrication and applications of colorimetric, fluorescence, voltammetric, amperometric, and optical biosensors. Working principles of some commercialized biosensors- Glucose biosensor, Urea/Uric Acid biosensor, Pregnancy test biosensor etc. Immunosensors and clinical applications, Biosensors for drug resistance and environmental pollution.
Module 4	**Diagnostic Devices:** Point of care device, necessity and applications, Lab-on-Chip platform, Microfluidic device, Introduction-antigen-antibody binding and assays; Immunoassays –types (RIA, ELISA, Chemiluminescent IA, FIA), working mechanism of few commercial point of care devices.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Biosensors an Introduction	Brian R Eggins	John Wiley & Sons	1996, 1st Edition
2	Biosensors Principles and Applications	Loic J Blum, Pierre R Coulet	Marcel Dekker,Inc	1991, 1st Edition
3	Biosensors Theory and Applications	Donald G. Buerk	Technomic Publishing	1993, 1st Edition

Instrumental Methods of Chemical Analysis (IMCA)

COURSE CODE	23CY61E2	MODE		LTPS	3-0-6-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Demonstrate the working mechanism and applications of voltametric techniques towards pharmaceutical drug analysis and environmental monitoring	3	1, 6
CO2	Discuss the principle of fluorescence spectroscopy and apply it for clinical quantitative analysis	3	1, 2
CO3	Apply the basic principles of IR and Mass spectroscopy for the interpretation of organic molecules	3	1, 2
CO4	Apply the basic principles of thermal and radiochemical methods of analysis for the determination of stability of compounds and quantitative estimations of radioactive elements	3	1, 5
CO5	Apply the key concepts of instrumentation techniques to set a procedure for the analysis of target species of interest and analyze the obtained results	4	1, 5

Syllabus

Module 1	**Electro analytical Methods of Analysis:** Polarographic principles, polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppressors, interference due to dissolved oxygen, Applications, numerical problems. Differential pulse polarography, square wave polarography, **Anode stripping voltammetry:** principle, instrumentation, hanging mercury drop electrode, application in the analysis of Pb and Cd in environmental samples, principle of cathode stripping voltammetry. **Principle of cyclic Voltammetry**, cyclic voltammogram of $K_3[Fe(CN)_6]$, and parathion, criteria of reversibility of electrochemical reactions, quas irreversible and irreversible processes. **Coulometric analysis:** principles of coulometric analysis with constant current, coulometric analysis with controlled potential, applications of coulometric methods for the analysis of cations-As (III), Fe (II) and I^- and S^{2-} by using I_2 liberations and Ce^{4+} liberation in solutions
Module 2	**UV-Visible Spectroscopy**: Single and double beam spectrophotometers-instrumentation, sources of radiation, detectors, determination of certain metal ions by using ligands, simultaneous determinations of dichromate and permanganate in a mixture, spectrophotometric titrations. **Spetcrofluorimetry:** Theory of fluorescence, phosphorescence, factors affecting the above, quenching, the relation between the intensity of fluorescence and concentration, Chemiluminescence, Electroluminescence and Bioluminescence (Principle and Applications).
Module 3	**Infrared spectroscopy:** Principle, instrumentation, molecular vibrations, factors influencing vibrational frequencies, sampling techniques, characteristic frequencies of organic molecules, principle of Fourier transform IR. **Mass Spectroscopy:** Principle, basic instrumentation, ionization techniques, fragmentation rules, interpretation of mass spectra. **Spectro-Analytical Methods of Analysis: Flame photometry:** theory, instrumentation, applications **Atomic Absorption Spectrometer:** theory, instrumentation, radiation source, applications. Inductively coupled plasma, principle of ICP-OES and ICP-MS.

Module 4	**Thermal methods of Analysis:** Thermo gravimetry-theory, instrumentation, applications with examples, Differential thermal analysis-principle, instrumentation, Differential scanning calorimetry-principle, instrumentation, applications. **Radio chemical methods of analysis:** detection and measurement of radioactivity, introduction to radioactive tracers, applications of tracer technique, isotope dilution analysis-applications, activation analysis-application, advantages and disadvantages, radiocarbon dating technique and applications, Radiochemical Immunoassay, and clinical applications.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Instrumental methods of analysis	H.H Willard, Meritt Jr. and J.A Dean	CBS Publishers & Distributors	1988, 7th Edition
2	Instrumental Methods of Analysis	Chatwal and Anand	Himalya Publishing House	2011, 5th Edition
3	Instrumental methods of analysis	B.K Sarma	Goel Publishing House	2014, 17th Edition
4	Principles of instrumental analysis	Douglas Skoog, F. Holler, Stanley Crouch	Brooks/Cole	2017, 7th Edition
5	Vogel's Textbook of Quantitative Chemical Analysis	Mendham, Denney, Barnes, Thomas	Pearson Education	2008, 6th Edition

Chromatographic techniques and method validation (CTMV)

COURSE CODE	23CY61E3	MODE	General	LTPS	**2-1-0-0**	PRE-REQUISITE	**NIL**

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the principles and common applications of a Gas chromatographic techniques.	3	1,2
CO2	Apply Liquid-liquid partition chromatography principles to the development and validation of complex chemical methods.	3	1,2,3
CO3	Apply LC-MS principles to the development and validation of complex biochemical methods.	3	1,2,3
CO4	Interpret chromatograms and analyse and interpret retention times, peak shapes, and peak resolution.	3	1,2,3

Syllabus

Module 1	Gas chromatography: Theory, Instrument description of equipment and different parts, columns (packed and capillary columns), detector specifications-thermal conductivity detector, flame ionization detector, electron capture detector, nitrogen-phosphorus detector, photo ionization detector, programmed temperature gas chromatography; applications in the analysis of gases, petroleum products etc., other detectors used their Principles and Applications. GC-MS-Introduction: Instrumentation – GC – MS interface – Mass spectrometer (MS) Instrument operation, processing GC – MS data – ion chromatogram Library searching – Quantitative measurement-sample preparation Selected ion monitoring – Application of GC-MS for Trace constituents, Drugs analysis, Environmental analysis, and others.
Module 2	Liquid-liquid partition chromatography: Principle supports, partitioning liquids, eluents, reverse phase chromatography, apparatus, and applications. High performance liquid chromatography: Theory, Instrument description of the different parts of the equipment, columns, detectors-UV detector, refractometric detector, Fluorescence detector, Diode Array detector, applications in the separation of organic compounds, names of other detectors used their Principles and Applications.
Module 3	LC-MS: Introduction-Instrumentation-liquid chromatograph-Mass spectrometer Interface Instrumental Details-Processing LC-MS data-ion chromatograms-Library Searching-Quantitative measurements. Sample preparation – selected ion monitoring. Application of LC-MS for Drug analysis, Environmental samples, and others. Inorganic molecular sieves: structure of zeolites, crystals, types of sieves, application in the separation of gases including hydrocarbons, ion exclusion-principles and applications, Counter current chromatography-principles and application, Affinity chromatography-principles and applications.
Module 4	Analytical Method Developments and validation: Importance of Qualitative and Quantitative analysis in research and development, industries, and other branches of science. Development and validation of an analytical method, units, concentrations, calculations, standards, chemical reactions, expressions of concentrations. Introduction, Dissolution test, Apparatus –USP type –I and II, Sampling and analytical

	instrumentation, Single point test Vs. Dissolution profile, Calibration, regulatory guidelines, analytical validation, linearity, accuracy, precision, specificity. Limit of quantification, sensitivity, ruggedness and robustness, analyte stability in the sample matrix, how to reduce systematic errors, mean and standard deviation, reliability of results, confidence interval, comparison of results, comparison of two means of two samples, experimental design. Sampling of solids, liquids, and gases.

Textbooks:

Sl No	Title	Author(s)	Publisher	Year
1	Chemical Applications of Group Theory	F.A. Cotton	Wiley	3rd Edition
2	Organic Spectroscopy	W. Kemp	MacMillan	1994
3	Modern Spectroscopy	J. Michael Hollas	Wiley	2013
4	Atomic and molecular Spectroscopy	S. Svanberg	Springer	2003
5	Basic atomic and molecular Spectroscopy	J. Micheal Hollas	Royal Society of Chemistry	2002

Applied Chemical Analysis (ACA)

COURSE CODE	23CY61E4	MODE	General	LTPS	3-0-6-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles, methodology and adoptability various procedures for the analysis of Analysis of Iron, Manganese, Chromite, Phosphate and Aluminium Ores	3	PO-1,2
CO2	Discuss, explain, and illustrate the applications of the general methods of analysis for finished products such as Steel, dolomite, fire clay, four spar and magnesite	3	PO-1,2,3
CO3	Finding the adoptability by applying the general methods of analysis for Cement, Soaps, Oils, and paints analysis	3	PO-1,2,3
CO4	Explain and apply the various principles involved in the chemical and physicochemical analysis of Organic Functional Groups	3	PO-1,4,5
CO5	Analysis of chemicals by instrumental methods	4	PO-2,6

Syllabus

Module 1	Analysis of Ores: General techniques of analysis applied to complex materials - Scope of metallurgical analysis-General methods of dissolution of complex materials - Various chemical methods for the effective separation of the constituents in the complex materials. Analysis of ores: Iron ore- Analysis of the Constituents – Moisture, loss of ignition, Total Iron, ferrous Iron, Ferric Iron, alumina, silica, Titania, Lime, Magnesia, Sulphur, phosphorus, manganese, alkalis, combined water, Carbon in blast furnace, flue dust and sinter. Manganese Ore-Analysis of the Constituents– Total Manganese, MnO_2, SiO_2, BaO, Fe_2O_3, Al_2O_3, CaO, P and S Chromite Ore - Analysis of the Constituents-Chromium, SiO_2, FeO, Al_2O_3 CaO, & MgO. Phosphate rock Ore –
Module 2	Analysis of the Constituents-CaO, P_2O_5, F, SiO_2, CO_2, S, Na_2O, Al_2O_3, Fe_2O_3, Mgo, K_2O, Cl, MnO. Organic carbon, Moisture, Loss of ignition. Aluminum Ore (Bauxite)-Analysis of the Constituents-Silica, Alumina, Fe_2O_3, Titania, MnO, P_2O_5, CaO, MgO, vanadium, zirconium, and alkalis. Analysis of Finished Products: Analysis of steel for C, Si, S, P, Mn, Ni, Cr; Mg and analysis of blast furnace slag. Analysis of refractory materials: fire clay, flour spar, and magnesite
Module 3	Analysis of fluxes - limestone and dolomite. Chemical Analysis of cement-silica, NH_4OH group, ferric oxide, alumina, lime, magnesia, Sulfide Sulphur, K_2O,Na_2O, free CaO in Cement and Clinker, SO_3 and loss on ignition. Analysis of oils- saponification number, iodine number, and acid number. Analysis of soaps - moisture, volatile matter, total alkali, total fatty matter, free caustic alkali or free fatty acids, sodium silicate, chloride. Analysis of paints-vehicle and pigment, $BaSO_4$, total lead and lead chromate.
Module 4	Assessment of water Quality: Sources of water, classification of water for different uses, types of water pollutants and their effects, Analytical methods for the determination of the following ions in water: Anions: CO_3^{2-}, HCO^{3-}, F^-, Cl^-, SO_4^{2-}, PO_4^{3-}, NO^{3-}, NO^{2-}, CN^-, S^{2-} Cations: Fe^{2+}, Fe^{3+}, $Ca^{2+,}$ Mg^{2+}, Cr^{3+}, As^{5+}, Pb^{2+}, Hg^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, Co^{2+}. Determination of Dissolved oxygen (D.O), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), standards for drinking water.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Handbook of Analytical Control of Iron and Steel Production	Harrison John,	Wiley	2016
2	Standard methods of Chemical Analysis	Welcher	CRC	2018
3	Technical Methods of Analysis,	Griffin	Mc Graw Hil	2005
4	Commercial Methods of Analysis	Foster Dee Sneel and Frank M. Griffin,	Mc Graw Hill Book Co.	2004
5	Water Pollution	Lalude	Mc Graw Hill	2000

Nano Chemistry (NC)

COURSE CODE	23CY52E5	MODE	General	LTPS	3-0-0-0	PRE-REQUISITE	COS

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Describe a working knowledge of the basic concept of nano chemistry and changes of chemical and physical properties.	3	PO1, PO2, PO5
CO2	Analyse several synthetic methods for the fabrication of nano particles.	3	PO1, PO2, PO3
CO3	Apply the links between structure and catalytical activity of the nanomaterials.	3	PO3, PO1, PO7
CO4	Illustrate the application and prospects of nano chemistry.	4	PO1, PO4, PO5

Syllabus

Module 1	**Introduction**: Scope and importance of nano chemistry. Types of nanostructures, Properties of nanomaterials: Chemical, and Physical. Role of particle size, Concept of confinement, strong and weak confinement with suitable examples, Size and shape dependent optical, electronic, photonic, magnetic, properties.
Module 2	**Nanoparticles synthesis**: Bottom-up synthesis of nanomaterials: Chemical precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Hydrothermal routes, Microwave heating synthesis; Top-down synthesis of nanomaterials: ball milling, photolithography, laser ablation, CVD. Green pathways to synthesize nanomaterials. Characterization methods: X-ray absorption spectroscopy, BET method for surface area analysis. Dynamic light scattering for particle size determination.
Module 3	**Metal nanoparticles in catalysis**: Catalysis by nanoparticles in Gas-Phase Reactions: CO Oxidation, Propylene Epoxidation, Catalysis by nanoparticles in Liquid-Phase Reactions: Hydrogenations, Coupling Reactions (Sonogashira, Hiyama–Denmark, Heck-Mizoroki, Suzuki-Miyaura Cross-Coupling), Oxidation of Alcohols (Alcohols to Aldehydes, Aldehydes to Carboxylic Acids, Esterification of Alcohols and Aldehydes).
Module 4	**Applications of nanochemistry in energy, environment, and health**. Hydrogen energy and development. Hydrogen storage. Carbon capture, Transformation of CO_2 to fine chemicals. Environmental remediation by chemical degradation/removal of contaminants. Nanomaterials as sorbents.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	NANO: The Essentials	T. Pradeep,	McGraw-Hill	2012
2	From Theory to Application for In-Depth Understanding of Nanomaterials	Wang, X.; Bashir, S.; Liu, J.	Walter de Gruyter GmbH & Co KG	2023
3	Textbook of Nanoscience and Nanotechnology	S Murty, P Shankar, Baldev Rai, B. Rath, and James Murday	Springer	2013
4	Nanomaterials handbook	Gogotsi, Y.	New York: CRC Press	2006
5	Nano chemistry for Chemistry Educators	R. A. Much, K. Winkelmann & M. Hugerat	RSC publishers	2022

Organic Synthesis (OS)

COURSE CODE	23CY61E6	MODE	General	LTPS	3-0-6-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply appropriate reagents and reaction conditions to achieve selective carbon- carbon bond formation.	3	PO-2,4
CO2	Use knowledge of reaction conditions, catalysts, and reagents to design and executive selective functionalization reactions of organoboranes and silanes.	3	PO-2,3
CO3	Employ appropriate oxidizing and reducing agents and reaction conditions to achieve selective transformations.	3	PO-1,5
CO4	Design synthetic route utilizing phase transfer catalysis, retro synthetic approach, polymerization mechanism to achieve challenging transformations.	3	PO-2,4,5
CO5	Execute multi-step synthetic sequences to synthesize target molecules efficiently and demonstrate a deep understanding of reaction mechanisms and reaction optimization.	4	PO-2,3,7

Syllabus

Module 1	**Formation of Carbon-Carbon bonds:** alkylation via enolate the enamine and related reactions, umpolung (dipole inversion) reactions – the aldol reaction – applications of organo palladium, organo nickel and organo copper reagents, applications of α-thio carbanions, seleno carbanions and sulphur ylides, synthetic applications of carbenes and carbenoids. Elimination reactions Pyrolytic, syn-eliminations, sulphoxide-sulphonate rearrangement the witting reaction-alkenes from aryl sulphonyl hydrazones, claisen rearrangement of allyl vinyl ethers.
Module 2	**Organoboranes & Silanes:** Preparation of Organo bornaes viz hydroboration with BH_3-THF, di cyclohexyl borane, disiamyl borane, thexyl borane, 9-BBN and diisopino camphenyl borane, functional group transformations of Organo Boranes-Oxidation, protonolysis and rearrangements. Formation of carbon – carbon bonds viz organo boranes carbonylation, the cyano borate process and reaction of alkenyl boranes and trialkenyl borates. Organo silanes: Synthetic applications of trimethylsilyl chloride dimethyl-t-butyl silyl chloride, trimethyl silyl cyanide, trimethylsilyl iodide and trimethylsilyl triflate, synthetic applications of silyl carbanion and B-silyl carbonium ions.
Module 3	**Oxidation and Reduction:** Oxidations of hydrocarbons, alkenes, alcohols, aldehydes, and ketones. Oxidative coupling reactions using Pb $(OAC)_4$, NBs, CRO_3, SeO_2, $NinO_2$ Dc- alkoxyl uphonium yields, $KMnO_4$, OsO_4, peracids and Ti (III) nitrate. Catalytic hydrogenation (homogeneous and heterogeneous), reduction by dissolving metals. Reduction by hydride transfer -reagents, reduction with hydrazine and diamide, selectivity in reduction of nitroso and nitro compounds, reductive cleavage.
Module 4	**Design of Organic Synthesis:** Retrosynthesis the disconnection approach-basic principles convergent and linear synthesis. Phase transfer catalysis-Principle and applications. Methods of polymerization (a) addition polymerization (b) Condensation polymerization

	(c) Radical polymerizations (two examples of each method) Reactions of un activated carbon-hydrogen bonds: The Hoffmann Lieffier- Freytag reaction-the Barton Reaction-Photolysis of organic hypo phthalates.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Organic Chemistry-Reactions, Mechanism and Structure	Jerry March	John Wiley	2015
2	Advanced Organic Chemistry: Part A Structure and Mechanisms.	F.A. Carey and R.J Sundberg	Springer	2008
3	Structure and Mechanism in Organic Chemistry.	C. K. Inglod	Cornell University Press	1969
4	Organic Chemistry	R.T Morrison and R.N. Boyd	Prentice - Hall.	1992
5	Principles of Organic Synthesis	R.O.C Norman and J. M. Coxon	Blackie Academic	1993

Organic spectroscopy (OSP)

COURSE CODE	23CY61E7	MODE	General	LTPS	**2-1-0-0**	PRE-REQUISITE	**NIL**

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Demonstrate UV-VISIBLE and Applications towards deduction of the structure of Molecule	3	PO-1,2,3
CO2	Explore IR Spectroscopy and Applications towards deduction of the structure of Molecule	3	PO-1,2
CO3	Depreciate NMR- Spectroscopy and Applications towards deduction of the structure of Molecule	3	PO-1,2
CO4	Illustrate the Mass Spectroscopy and Applications towards deduction of the structure of Molecule	3	PO-1,2

Syllabus

Module 1	**UV-VISIBLE SPECTROSCOPY:** Various electronic transitions - Effect of solvent on electronic transitions - Chromophores, Auxochromes, Bathochromic and hypsochromic shifts, Solvent effects Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, and conjugated polyenes. Woodward -Fieser rules for conjugated dienes and carbonyl compounds - Ultraviolet spectra of aromatic and heterocyclic compounds - Steric effect in biphenyls. Applications towards deduction of the structure of Molecule and instrumentation of recording of spectra.
Module 2	**IR SPECTROSCOPY:** Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, Nitrogen compounds and sulphur compounds-Detailed study of Bending vibrations and stretching vibrations- Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect steric effect on vibrational frequencies, overtones, combination bands and Fermi resonance, Factors affecting I.R. group frequency, Applications towards deduction of structure of Molecule.
Module 3	**NMR SPECTROSCOPY: HNMR**: Nuclear spin - nuclear resonance - Saturation, shielding of magnetic nuclei - Chemical shifts and its measurements - Factors influencing chemical shift FT-NMR - Advantages of FT-NMR. Shielding mechanism - Mechanism of measurement - Chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, and amides) Contact shift reagents - Nuclear overhauser effect (NOE). **2D-NMR SPECTROSCOPY:** The Coupling constants. Applications towards deduction of the structure of Molecule.
Module 4	**MASS SPECTROMETRY** Mass Spectrometry Introduction - Ion production - Types of ionization; EI, CI, FD, and FAB - Factors affecting fragmentation - Ion analysis - Ion abundance. Mass spectral fragmentation of organic compounds - Common functional groups - Molecular-ion peak - Metastable peak - Mc. Lafferty rearrangement. Nitrogen rule - Isotope labelling – High-resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination. NUMERICAL PROBLEMS- Spectroscopic Interpretation of different Compounds for structure elucidation problems using multiple spectroscopic data (NMR, MS, IR and UV-Vis).

Textbooks:

Sl No	Title	Author(s)	Publisher	Year
1	Organic Spectroscopy	W. Kemp	MacMillan	1994
2	Spectroscopic Identification of Organic Compounds	P.M. Silverstein F. X. Wester	Wiley	1998
3	Elementary organic Spectroscopy	Y R Sharma	S. Chand	1980
4	Fundamentals of molecular Spectroscopy	P S Sindhu	TMH, New Delhi	1983
5	Spectroscopy by Vol.3	B.P. Straughan and S. Walker	Chapman Hall, London	1976
6	Introduction to Molecular Spectroscopy	G.M. Barrow	McGraw Hill, New York	1964
7	Applications of Absorption Spectroscopy of Organic Compounds	J.R. Dyer	Prentice Hall	1965
8	Instrumental Methods of Chemical Analysis	B.K Sharma	Krishna prakashan Media,	1981
9	Introduction to Spectroscopy	Donald L. Pavia	Cengage Learning	2008
10	Spectroscopic Methods in Organic Chemistry	Ian Fleming, Dudley Williams	Springer	2019

Natural Products & Heterocyclic Chemistry (NPHC)

COURSE CODE	23CY61E8	MODE	General	LTPS	3-0-6-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate the drug metabolic pathways, adverse effect and therapeutic value of alkaloids and steroids.	3	PO 1, PO 5, PO4, PO 7
CO2	Interpret the mechanistic pathways and mode of action of different class of medicinal compounds like terpenoids and vitamins.	3	PO 1, PO4, PO 5, PO 7
CO3	Explore chemical behaviour of aromatic heterocycles, use of heterocycles in functional group and ring transformations.	3	PO 1, PO 3, PO 4, PO 6
CO4	Illustrate the synthesis, reactions of Meso-ionic compounds and interpret the special feature of aliphatic heterocycles.	3	PO 1, PO 3, PO 4, PO 6
CO5	Isolate, analyse independent investigations of natural products, and use classical synthetic methods to synthesize heterocyclic compounds.	4	PO 3, PO 8, PSO 1

Syllabus

Module 1	**Chemistry of Alkaloids & Steroids**: Introduction- classification- General methods of extraction and isolation of natural products, importance of natural products, biosynthesis- acetate pathway, shikimate pathway, mevalonate pathway- Structure elucidation, synthesis, and biological significance of Alkaloids- Quinine, cinchonine, morphine, reserpine; Steroids- Cholesterol, Oesterone, Progesterone.
Module 2	**Chemistry of Terpenoids & Vitamins:** Terpenoids-Classification of terpenoids, isolation and biosynthesis, Isoprene rule, Structure determination and synthesis of Farnesol, Camphor and Abietic acid, biological significance, and mode of action of forskolin and Taxol; Vitamins: Introduction, chemical properties and structure elucidation of vitamin A, Vitamin B, Ascorbic Acid and Vitamin D.
Module 3	**Aromatic Heterocycles:** General introduction to heterocyclics and their importance, classification, Nomenclature of ring systems (Hantzsch-Widman System). Synthesis and reactions of indoles, Quinoline, iso quinoline, pyrazole, pyridine, furan, oxazole, thiophene- Role of heterocyclic compounds in biological systems.
Module 4	**Aliphatic Heterocycles and Betaines:** Synthesis and reactions of oxetanes, piperidines, epoxides, aziridines, diazirines, thiiranes; Azirines, Oxiranes, Azetidines. Betaines: Formation, aromaticity, and reactivity of pyridine-N-oxides and pyridinium imides. Meso-ionic heterocycles: Synthesis and aromaticity of Sydnones and 1,3-dipolar addition reaction of meso-ionic heterocycles.

LAB COMPONENT:

1. Isolation of Caffeine from tea
2. Isolation of Lycopene from Tomatoes
3. Isolation of Lactose from Milk
4. Isolation of Citric Acid from Lemon

5. Isolation of Limonene from Orange peels
6. Isolation of Piperine from Black Peppercorns
7. Identification of secondary metabolites present in plant extract.
8. Synthesis of indigo
9. Synthesis of benzotriazole
10. Synthesis of 2- hydroxy- 4- methyl quinoline
11. Synthesis of benzofuran
12. Synthesis of acridone
13. Synthesis of coumarin

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Organic Chemistry, Volume 2	I.L. Finar	Pearson	1975
2	Medicinal Chemistry	Graham L. Patrick	Oxford University Press	2005
3	Chemistry of Natural products	S V Bhat, B.A. Nagasampagi	Narosa	2006
4	Heterocyclic Chemistry	T. Gilchrist	Pearson	2005
5	An introduction to the Chemistry of heterocyclic compounds.	R. M. Acheson	Wiley	2008
6	Heterocyclic Chemistry	J. A. Joule & K. Mills	Wiley	2010

PROFESSIONAL COMMUNICATION SKILLS (PCS)

COURSE CODE	23UC5201	MODE	R	LTPS	0-0-4-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To develop and demonstrate principles of listening, speaking, reading, and writing in various functional contexts	3	PO 5
CO2	To demonstrate different types of personal and professional skills and apply them for growth in professional zone.	3	PO 5
CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic, Algebra & Geometry to improve problem solving ability.	3	PO5
CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.	3	PO5

Syllabus

Module 1	A) Vocabulary: Synonyms, Antonyms and One-word substitutes, (B)Reading comprehension, Critical reading, (C) Writing skills: Email writing, report writing and paragraph writing (D) Listening/Speaking Skills: listen & speak, Functional grammar
Module 2	(A)Personal Skills: Intra & Interpersonal skills (B) Assertiveness (C) Group Discussion (D) Resume writing (E) Video resumes (F) Interview skills
Module 3	Simple Equations, Ratio & Partnership, Averages, Percentages, Profit & Loss, Simple & Compound Interest, Numbers, Quadratic Equations & Inequalities, Time & Work, Time, Speed & Distance, Permutations & Combinations, Probability, Mensuration, Data Interpretation.
Module 4	Syllogism, Logical Venn Diagrams, Cubes & Dice, Number& letter series, Number, letter & word Analogy, Odd Man Out, Coding & Decoding, Blood Relations, Directions, clocks, calendars, Number, ranking & Time sequence test, Seating Arrangements, Data Sufficiency.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Business Student's Handbook: Skills for Study and Employment	Fisher, Julie and Bailey, Peter	Cengage Learning	2017
2	The Complete Guide to mastering soft skills for workplace success	Adams, John	Adams media	2019
3	Writing Tools: 55 Essential Strategies for Every Writer	Roy Peter Clark	Little, Brown, and Company	2006
4	Quantitative Aptitude	R. S. Agarwal	SCHAND	2017
5	A Modern Approach to Verbal Reasoning	R. S. Agarwal	SCHAND	2018

Essentials of Research Design (ERD)

COURSE CODE	23IE5201	MODE		LTPS	1-1-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	PO1
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	PO2
CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	PO2
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	PO2

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question-Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools- Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources.
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables -scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multidimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Research Methods for Engineers	C.R. Kothari	New Age International Publishers	2019
2	Engineering Research Methodology	Y Krishnan Nallaperumal	Wiley	2013
3	Engineering Research Methodology -A Practical Insight for Researchers	Dipankar Deb and Balas	Springer	2019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