Koneru Lakshmaiah Education Foundation
(Deemed to be University estd. u/s. 3 of the UGC Act, 1956)
Accredited by NAAC as 'A' Grade University ❖Approved by AICTE ❖ ISO 9001-2015 Certified
Campus: Green Fields, Vaddeswaram - 522 502, Guntur District, Andhra Pradesh, INDIA.
Phone No. 0863 - 2399999; www.klef.ac.in; www.klef.edu.in; www.kluniversity.in
Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 -2577715, Fax: +91-866-2577717.

KONERU LAKSMAIAH EDUCATION FOUNDATION (KLEF)
DEPARTMENT OF CHEMISTRY
M.Sc Chemistry
2021-22

STUDENT HANDBOOK

Applicable for students admitted into

M.Sc., Program 2021-2022

(Estd. u/s.3 of the UGC Act, 1956) (NAAC Accredited "A" Grade University)

VISION

To be a globally renowned university.

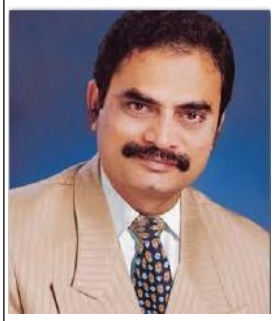
MISSION

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.

NAAC ACCREDITED A++ GRADE

Recognised as CATEGORY 1 UNIVERSITY By UGC, Statutory Body of MHRD

RECOGNISED BY THE
UNIVERSITY GRANTS COMMISSION (UGC)



Koneru Satyanarayana,

President

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. S.S. Mantha

Chancellor

Dr. S S Mantha, an eminent academician and an able administrator, is the Chairman (actg), of the All India Council for Technical Education (AICTE)., since August 2009. Having joined in this Organization in 2019 as Chancellor, he has been at the forefront of bringing in some radical changes for transparency and accountability in its administration.

He holds a Bachelors degree in Mechanical Engineering from the M S University, Baroda, and a Masters in Mechanical Engineering from VJTI, Mumbai. From small beginnings, he progressed to be the Professor and Head, Department of Mechanical Engineering a position he held for 6 years at VJTI, subsequent to which he was appointed the Pro Vice Chancellor, SNDT Women's University by the Government of Maharashtra which he served for two years with distinction.

Dr.L.S.S Reddy

Vice Chancellor

Dr. L.S.S. Reddy is an eminent Professor in Computer Science and Engineering Department holding Ph.D in Computer Science Engineering from BITS Pilani. Dr. Reddy is an outstanding administrator, a prolific researcher and a forward looking educationist. Dr. Reddy has over 30 years of experience in Teaching, Research and Administration at prestigious institutes like BITS Pilani, CBIT etc.

Dr.L.S.S.Reddy had joined Koneru Lakshmaiah College of Engineering in December 1995 and proved his administrative excellence as a Head of Department of Computer Science and

Engineering. Dr. Reddy was instrumental and a driving force as Principal (2002-2009) in promoting KLCE as one of leading Institutions in India.

Welcome to KLEF!

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, 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

Vijayawada is located on the banks of river Krishna in the state of Andhra Pradesh and has been historically a cultural, political and educational center. It is also a part of Andhra Pradesh Capital Region. The city is well connected by National Highway and Rail with Chennai (440 km), Hyderabad (275 km), Vizag (385 km) and is a central junction for trains running from North to South India. Daily flights operate from Hyderabad and Bangalore.

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 KLEF has been situated on a built up area of around 15, 00,000 S. Ft.

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ACRONYMS

Sl No	Acronyms	Full Form
1.	KLEF	Koneru Lakshmaiah Education Foundation
2.	CET	Common Entrance Test
3.	KLEEE	KLEF Engineering Entrance Examination
4.	CGPA	Cumulative Grade Point Average
5.	SGPA	Semester Grade Point Average
6.	LTPS	Lecture Tutorial Practical Skill
7.	SEE	Semester-End Examinations
8.	SIE	Semester-In Examinations
9.	IRP	Industrial Relations and Placements
10.	OPAC	Online Public Access Catalog
11.	QCM	Quality Circle Meeting
12.	MOOC	Massive Open Online Course
13.	MOU	Memorandum of Understanding
14.	OD	On Duty
15.	(A,B)	Between A and B excluding value A and including value B
16.	COE	Controller of Examinations

History

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ACCREDITATIONS:

- Declared as Deemed to be University u/s 3 of UGC Act 1956.
- Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A^{++}' with highest Grade of 3.57 CGPA on 4 point scale.
- Approved by All India Council for Technical Education (AICTE), New Delhi.
- ISO 9001 - 2015 Certified Institution.

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 and 32.98 lakhs eBooks. Access is available on campus on student computers and remotely.

A new library building will be opened shortly on par with international standard with modern IT facilities.

Every department of the college maintains their library to cater the needs of students and faculty. All foreign and Indian journals are made available in the department library for the convenience of faculty and students.

The libraries render following library services.

- Circulation of library documentary.
- Inter-library loan services.
- Photo copying services.
- Reference service.
- CD-ROM search services.
- Inter Net services.
- OPAC
- WEB OPAC
- Audio visual
- Online lectures

The Data Center

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

Hardware:

The configuration of high end stream of servers that provides various services is

Super Computer

HPC Infrastructure (Super Computer):

- 5.3 TERA Flops (CPU + GPU)
- HP SL 230 4* SL230s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA) providing -1.3TF
- HP SL 250 2* SL250s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA + 2 NVIDIA K20 GPU providing -4TF. Master Node:
- HP DL 380P 1* DL380p Gen8 (2* 2.6Ghz, 64GB RAM, 2x2TB HD, 10G IB HCA).

- Compute Switch (48 Port Low latency switch)QLogic IB QDR 36 Port Switch.
- Intel® Composer XE for Linux.
- The data centers consists of BYOD Servers& Backup Server, **Sun Servers, Dell and HP Blade Servers**, **Apple Server Xserver**

SPECIAL LABORATORIES

The institute is equipped with various Industry Collaborated Labs

S. No	Discipline	Name of the Lab	Research Group Associated
1.	Computer Science & Engineering	CISCO	Computer Networks and security
2.	Computer Science & Engineering	IBM	Software Engineering Knowledge Engineering
3.	Computer Science & Engineering	Microsoft	Embedded Systems Software Engineering Knowledge Engineering
4.	Computer Science & Engineering	Adobe	Web technologies Image processing
5.	Computer Science & Engineering	Oracle	Knowledge Engineering
6.	Electronics & Communication Engineering	NI Lab View	Communications Systems

Physical Education- Sports Facilities:

KL University encourages students to explore their latent talents by providing good games and sports facilities. The institute is equipped with the following.

• Athletic track	1	• Handball Court	1
• Hockey Field	1	• Netball Courts	2
• Badminton Courts	4	• Throw ball courts	2
• Tenni-koit 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	-
• Archery	1	• Caroms	-

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

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

Accommodation- Hostels

- KL University 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 studies.
- A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.
- Generators have been provided as power back up.
- Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs and it keeps changing according to their tastes.
- Teaching staff will have to address academic and personal problems of the students.
- Round-the-clock security, communication, dispensary facilities are also available.

➢ The Girls Hostel

The girl's hostel is within the campus with a capacity of 1192 in 500 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available. Suite rooms with modern furniture and separate study room are also available.

➢ The Boys Hostel

It is a short walk from the university with a capacity of 2040 in 780 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are 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 & Regulations

- Students are hereby informed that while staying in the hostel, it is essential to be responsible in 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.
- Student has to intimate to the hostel authorities before you giving police complaint 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 have to hand over the keys to security and can collect them on returning back 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 premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm in case morning shift students and 6.00pm for day shift students. Those students who are utilizing computer lab, library etc., after the times specified have to submit the permission slip to the security while entering into the hostel.
- During public holiday outings, those who seek permission to leave the hostel will have to obtain a written permission from 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 are strictly prohibited.

- Strict study hours from 7.30 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 only will 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 10 PM.

Health Centre

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

Cafeteria

- KL University has a spacious canteen with latest equipment and hygienic environment which provides quality food and prompts service and caters to needs of all the students and the staff.
- A central cafeteria of 1500 Sq.m. is available in 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:

K L University 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 enhancing 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.

Counseling & Career Guidance

A special Counseling Cell consisting of professional student counselors, psychologists, senior 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 also provides career guidance with the help of Industrial Relations and Placements (IRP) department.
A group of 20 students are allotted to a senior faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KL University has a social service wing which is used to channelizing the social service activities of the faculty, the staff and the 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 Wing of Institute

Regularly organizes Blood donation camps, Blood grouping camps, Fund collection and distribution to poor children and old age homes, distribution of old clothes and free medicines to slum dwellers, tree plantations, AIDS awareness program, teaching basic computer skills to a target group of 500 people in villages.

Hobby Clubs

Wholly and solely managed by the students, the clubs have in the past contributed much to the cultural life of the campus and to the cultural evolution of the students, A number of 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 the active members of the Hobby Clubs.

Life Skills and Inner Engineering

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

Technical Festival

KLU organizes various programs for the all round development of the students. The technical festival and project exhibition is being 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 for exhibiting their talents and creativity. Through these festivals KLU is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLU festivals are providing recreation to the student community.

INNOVATION, INCUBATION AND ENTREPRENEURSHIP CENTER

KLU being a pioneering institute supporting Academics and Research in Engineering, Science and Technology is endowed with the entire infrastructure and highly experienced faculty, has an Innovation, Incubation and Entrepreneurship Centre (IIE) that comprises of:

- Innovation centre which aims to inculcate a spirit of innovation.
- Incubation centre which aims to incubate the innovations through prototype product development.
- Entrepreneurship Development Centre (EDC) which aims at fostering entrepreneurial skills among the students.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

AND

PROGRAM OUTCOMES (POs)

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

To be a globally renowned university, as per our vision, we need to produce quality products (graduates/post graduates) into the market who have potential strengths to meet all the professional and personal challenges prevailing at global levels and who can serve in all the possible positions of their respective job domains and contribute towards holistic growth of their respective employment providers as well as the nation, world. The post graduates must also possess cutting edge R&D skills in their domain areas.

This, is exactly what has been framed into the University's Mission and thereby the Mission has converged into the following **Program Educational Objectives (PEOs)** which are best suited to postgraduate CHEMISTRY programs, and are those that complement the university vision, mission.

A. To develop strong student competencies in Chemistry and its applications in a technology-rich, interactive environment.
B. To develop strong student skills in research, analysis and interpretation of complex information.
C. To prepare the students to successfully compete for employment in Pharma Labs, Manufacturing and Teaching and to offer a wide range of experience in research methods, data analysis to meet the industrial needs.

These PEOs are designed to be attained by all the post graduates within 3 to 5 years of their post graduation.

PROGRAM OUTCOMES (POs):

PO-1 Ability to understand the scope and principle of Chemistry

PO-2 Ability to understand and implement complex chemical equations and chemical compositions.

PO-3 Ability to analyze the outcomes of experiments on chemicals and their product

PO-4 Ability to understand the chemicals deeply and their effects on environment and health.

PO-5 Ability to connect the latest developments in Chemistry with the knowledge attained during academics and come up with better ideas.

PO-6 Awareness of the impact of Chemistry in all domain of the society including environment, manufacturing, and production, etc.

PO-7 Use modern techniques, decent equipments and Chemistry software's

PROGRAME EDUCATIONAL OBJECTIVES:
The Program Educational Objectives (PEOs) are as follows:

PEO-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.

PEO-2: To prepare students for advanced studies in Chemical sciences and its allied fields.
PEO-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.
PEO-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.

ACADEMIC RULES & REGULATIONS

FOR

M.Sc. CHEMISTRY PROGRAM

2021- 22

ACADEMIC REGULATIONS FOR M.Sc. CHEMISTRY PROGRAMS

This document supplements the KLEF rules and regulations to provide assistance to all M.Sc. Chemistry students. It is required that every individual has to abide by these regulations.

Note: 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. 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.

Audited Course: It is a course of study which has zero credits and has a "Satisfactory" or a "Unsatisfactory" grade.

Backlog Course: A course is considered to be a backlog course if the student has obtained a failure grade (F).

Betterment: Betterment is a way that contributes towards improving the students' grade in any course(s). It can be done by either (a) re-appearing or (b) re-registering for the course.

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.

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 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.

Credit Transfer: The procedure of granting credit(s) to a student for course(s) undertaken at another institution.

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 up to two decimal places.

Curriculum: Curriculum incorporates the planned interaction of students with instructional content, materials, resources, and processes for evaluating the attainment of Program Educational Objectives.

Degree: A student who fulfills 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 marks in continuous in-semester evaluation and /or minimum prescribed attendance in a course shall be detained in that particular course.

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 is Professional 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.

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.

In-Semester Evaluation: Summative assessments used to evaluate student learning, acquired skills, and academic attainment during a 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 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 has to 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.

Project based laboratory : Project Based Laboratory is a student-centric learning methodology that involve students in design, problem-solving, decision making, and investigative activities; gives students the opportunity to work in teams, over extended periods of time; and culminate in realistic products or presentations

Re-Appearing : 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-Registering : A student desiring to repeat a course is permitted to do so, subject to the regulations contained herein.

Semester: It is a period of study consisting of 15 to 18 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.

Single Section Course: Course taught for a single section.

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 right and will be offered at the discretion of the University.

Dissertation: Dissertation is a course that a student has to undergo during his/her second 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.

CHAPTER 1
ELIGIBILITY CRITERIA FOR ADMISSION INTO M.Sc. CHEMISTRY PROGRAM

Candidates should have passed B.Sc. / B.Sc Honors from recognized Indian or foreign universities/institutions in respective discipline with minimum of 55% marks or equivalent CGPA. Furthermore, the candidates should have secured a qualifying rank in the PG entrance Examination i.e., KLU Entrance /any other equivalent examination.

For foreign students who wish to study at the University, please refer to the "Foreign Student Admission Procedures" stated separately and comply with the study requirements of the Ministry of HRD, Govt. of India.

CHAPTER 2
ACADEMIC INSTRUCTIONS

2.1 GENERAL BEHAVIOUR

a. Students should speak in English only while on campus with the faculty or among themselves.

b. Students are expected to wish / greet all senior officials of the KLEF with due respect.

c. Students should be courteous and polite in dealing with all Faculty & staff.

d. Students should maintain silence and/or speak in a soft voice 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.

e. Students should not loiter during the free time in the university ampus.

f. 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.

g. 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.

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

i. 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.

j. 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.

k. 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.

2.2 KLEF WORKING HOURS

KLEF operates between 09:00 AM to 5:00 PM on all week days.

2.3 LECTURE 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, laboratories. KLEF expects students to conduct themselves in an orderly and cooperative manner by adhering to University Rules & Regulations.

2.4 LABORATORY ENVIRONMENT

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

a. Always listen carefully to the faculty especially for the safety precautions to take in the laboratories. Accidents resulting in injuries may occur if precautions are not taken.

b. Eating in laboratories is strictly prohibited.

c. Proper dress code is to be followed as prescribed by faculty in each lab.

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

e. Follow evacuation procedures quickly and quietly, if needed.

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

g. Only materials required to complete and record the experiment instructions, (e.g. pencils or graph paper, etc.) should be brought into the laboratory.

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

i. Lab station must be cleaned prior to leaving a lab.

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

2.5 REGISTRATION PROCESS

For every course, the student must undertake the registration process prior to commencement of the course-work, based on the following conditions;

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

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

c. KLEF reserves the right to register.

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

e. Students can register upto a maximum of 26 credits of their choice in a semester to meet their program requirements.

f. 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.

g. 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.

h. 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 Academic coordinator for necessary corrective action. The registration may be cancelled for a course or the entire semester either by KLEF if any irregularity is found at a later stage.

CHAPTER 3
M.Sc. CHEMISTRY PROGRAM ON OFFER

3.1 M.Sc. CHEMISTRY PROGRAM

The students are admitted into the 2 year full time M. Sc Program

3.2 M.Sc. CHEMISTRY DEGREE REQUIREMENTS

K L E F confers M. Sc. degree to candidates who are admitted in the Program and fulfills the following requirements for the award of the degree.

1. Must successfully earn minimum of 101 credits, as stipulated in the program structure.
2. Must successfully complete three (3) Professional Elective Courses from the program with 9 credits.
3. Must successfully complete Dissertation.
4. Must have published a minimum of one publication (along with Supervisor) in Scopus indexed Journal.
5. Must successfully complete three electives relate to one specialization either M.Sc. Chemistry with Organic Chemistry or Analytical Chemistry.
6. Must have successfully obtained a minimum CGPA of 5.5 at the end of the program.
7. Must have finished all the above-mentioned requirements in two years from the period mentioned in the Academic structure of the program, which includes debarred period if any, from the University.

CHAPTER 4
M.Sc. CHEMISTRY 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 / Lab / Project), in the choice based credit system.

4.1 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 3^{rd} (or) 4^{th} semesters only.

4.2 COURSE STRUCTURE

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.

Program Structure

S.No	Course Code	Course Name	Category	L	T	P	S	Cr	PR	PO						
										1	2	3	4	5	6	7
1	20CY5101	Theoretical Chemistry-I	Prof. Core	4	0	0	0	4	-	1	2	2				
2	20CY5102	Inorganic Chemistry- I	Prof. Core	4	0	6	0	7	-			2				
3	20CY5103	Organic Chemistry-I	Prof. Core	4	0	6	0	7	-	2	2	2				
4	20CY5104	Physical Chemistry-I	Prof. Core	4	0	6	0	7	-	1	3	2	3			
5	20CY5201	Theoretical Chemistry-II	Prof. Core	4	0	0	0	4	-	2	2	3				
6	20CY5202	Inorganic Chemistry- II	Prof. Core	4	0	6	0	7	-	2		3	3		2	
7	20CY5203	Organic Chemistry-II	Prof. Core	4	0	6	0	7	-		2	3	2	3	2	3
8	20CY5204	Physical Chemistry-II	Prof. Core	4	0	6	0	7	-	1	3	2	3	2	2	
9	20CY5301	Instrumental Methods of Analysis-I	Prof. Core	4	0	6	0	7	-	1	3	2	1	3		
10	20CY5302	Quality Control and Classical Methods of Analysis	Prof. Core	4	0	0	0	4	-	1	3	2	1	3		
11	20CY5303	Applied Chemical Analysis	Prof. Core	4	0	6	0	7	-	1	2	2	3	2		
12	20CY5310	Organic Synthesis-I	Prof. Core	4	0	6	0	7	-	1	3	2	2	1		
13	20CY5311	Natural Products and Bio-molecules	Prof. Core	4	0	6	0	7	-	1	2	2	3	1		
14	20CY5312	Organic Spectroscopy	Prof. Core	4	0	0	0	4	-	1	3	3				
15	20CY5401	Instrumental Methods of Analysis-II	Prof. Core	4	0	6	0	7	-	2	2	3		3		
16	20CY5402	Advance Applied Chemical Analysis	Prof. Core	4	0	6	0	7	-	2	3	2	3	3		
17	20CY5403	Dissertation with	Skill	0	0	1	0	6	-				3			

		Research Publication	Development			2											
18	20CY5407	Organic Synthesis-II	Prof. Core	4	0	6	0	7	-	2	2	3	2	2		
19	20CY5408	Advance Heterocyclic chemistry	Prof. Core	4	0	6	0	7	-	2	3	2	2			
20	20CY5409	Dissertation with Research Publication	Skill Development	0	0	12	0	6	-				3			
21	20CY5304	Separation Techniques	Prof. Electives	3	0	0	0	3	-	2				3		
22	20CY5305	Applications of Chemical Spectroscopy	Prof. Electives	3	0	0	0	3	-	1	2	2	3	2		
23	20CY5306	Bio analytical Chemistry	Prof. Electives	3	0	0	0	3	-	1	3	2	3	2		
24	20CY5307	Environmental Chemistry	Prof. Electives	3	0	0	0	3	-	1	2	2	3	2		
25	20CY5308	Surface Analytical Techniques	Prof. Electives	3	0	0	0	3	-	1	2	2	3	2	1	
26	20CY5309	Analysis of Food and Drugs	Prof. Electives	3	0	0	0	3	-	1	2	2	3	2	1	
27	20CY5313	Photo Chemistry and Pericyclic reactions	Prof. Electives	3	0	0	0	3	-	1	3	2	2	3	1	
28	20CY5314	Organometallic Chemistry	Prof. Electives	3	0	0	0	3	-	1	2	2		3		
29	20CY5315	Bio Organic Chemistry	Prof. Electives	3	0	0	0	3	-	1	2	2		3	2	
30	20CY5316	Green & Sustainable Chemistry	Prof. Electives	3	0	0	0	3	-	2	2	3	2	2	1	
31	20CY5317	Supra molecular Chemistry	Prof. Electives	3	0	0	0	3	-	1	3	2	1	3		
32	20CY5318	Medicinal chemistry	Prof. Electives	3	0	0	0	3	-	2	3	2	2			
33	20CY5404	Chromatographic Techniques & Method Validation	Prof. Electives	3	0	0	0	3	-	2	2	3	2	2	3	
34	20CY5405	Classical Methods of Analysis	Prof. Electives	3	0	0	0	3	-	2	3	2	2	3		

35	20CY5406	Chemo Sensors and body fluid analysis	Prof. Electives	3	0	0	0	3	-	2	2	3	2	2	3	
36	20CY5410	Drug Design & Development	Prof. Electives	3	0	0	0	3	-	2	2	3	3	2		
37	20CY5411	Chemistry of Drugs and Pharmaceuticals	Prof. Electives	3	0	0	0	3	-	2	2	3	2	2		
38	20CY5412	Nano Chemistry	Prof. Electives	3	0	0	0	3	-	2	2	3	2	3		
39	20UC1102	Design Thinking and Innovation - 1	Skill Development	1	0	0	4	2	-	2	2	2	1	2		
40	20UC1203	Design Thinking and Innovation - 2	Skill Development	1	0	0	4	2	20UC1102	2	3	2	2	3		

CURRICULUM

Two years M.Sc. CHEMISTRY COURSES:

20CY5101 – THEORETICAL CHEMISTRY-I

L-T-P-S : 4-0-0-0

Credits : 4

Contact Hours : 4

Course outcomes of 20CY5101

CO#	Course Outcome	PO	BTL
CO1	Describe symmetry elements, operations and groups by representing them in matrices	1,2	3
CO2	Employ the basic principles of Electronic Spectroscopy & Molecular Spectroscopy	3	3
CO3	Employ the basic principles of Infrared spectroscopy	1,2	3
CO4	Employ the basic principles of Raman spectroscopy	1,2	3

Syllabus

Symmetry and Group theory in Chemistry*:* Symmetry elements & operations, group, subgroup, relation between order of a finite group and its subgroup. Point group of symmetry. Schonfiles symbols, representation of groups by Matrices (representation for Cn, Cnv, Cnh, Dn etc. groups to be worked out, explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use, Application of group theory in IR and Raman spectroscopy

Electronic Spectroscopy & Molecular Spectroscopy: Introduction to spectroscopy-Classification based on absorption-Emission-Importance- Characterization of electromagnetic radiation -Beer-Lambert's law-deviations from Beers law-Instrumentation-Applications-Energy levels, molecular orbital's, vibronic transition, vibrational progressions and geometry of the excited sates, Franck-Condon principle. Emission spectra; radioactive and non-radioactive decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra

Infrared spectroscopy: Basics of IR spectroscopy- Units of frequency wavelength- wave number-molecular vibrations-factors influencing vibrational frequencies-IR spectrometer, characterization techniques. Harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths, anhoremonicity Morse potential energy diagram. PQR braches, Born – oppenheimer approximation, selection rules, overtones, hot bands Application **Raman spectroscopy:** Introduction –Principle-Classical and quantum theories of

Raman effects, pure rotational, vibrational and Vibrational – rotational Raman spectra, selection rules, mutual exclusion principle, Resonance Raman spectroscopy, coherent antistrokes Raman Spectroscopy (CARS)-Application.

Mass spectrometry: Basic Principles: instrumentation: mass spectrometer, isotope abundances; the molecular ion, metastable ions-Fragmentation of small molecules. **Mossbauer Spectroscopy**: Principle, Experimental Considerations and Presentation of the Spectrum - Isomer Shifts – Quadrupole splitting and Magnetic hyperfine splitting – Selection Rules. Applications-Iron Compounds: Low-spin and High-spin Fe(II) and Fe(III) Complexes - π-bonding Effects in Iron complexes - Diamagnetic and Covalent Compounds-Iodine Compounds: Isomer Shifts of I^{127} and I^{129} – Applications to Alkali metal iodides and Molecular Iodine.

TEXT BOOKS:

1. Introductory Group Theory for Chemists – George Davidson
2. Group theory for chemistry – A.K.Bhattacharya
3. Molecular spectroscopy by B. K. Sharma
4. Vibrational Spectroscopy by D.N.Sathyanarayana New Age Int. Pub.
5. Spectroscopy by Aruldas.
6. Chemical Analysis by H.A.Laitinan and W.E.Harris, McGraw Hill.
7. Symmetry and Spectroscopy of Molecules- K. Veera Reddy, New Age International Limited Publishers.
8. Fundamentals of Molecular spectroscopy: by C.N.Banwell

20CY5102– INORGANIC CHEMISTRY – I

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5102

CO#	Course Outcome	PO	BTL
CO1	Predict the shapes of molecules, illustrating the bonding models and applying them to simple molecules	1,3	3
CO2	Illustrate the structures, reactivities and chemistry of non-transition elements	1,2	3
CO3	Illustrate the bonding models, structures, reactivities, and	1,3	3

	applications of coordination complexes		
CO4	Illustrate spectral and magnetic properties,color, and analytical applications of transition metal complexes	1,2,6	3
CO5	Advanced laboratory procedures used in inorganic synthesis, identification, and characterization of small molecules. The design and application of an analysis related to a question of relevance based on experience in the laboratory and research of the scientific literature. Laboratory safety protocols.	1,3,6	3

Provide the in-depth knowledge of various types of bonding and its models, MO theory and molecular spectroscopy.

Syllabus

Structure & Bonding: Shapes of molecules (VSEPR Theory, Bent's rule), Valence Bond Theory, Molecular Orbital Theory in explaining the structures of simple molecules [homonuclear diatomics (H_2, H_2^+, He_2, He_2^{2+}, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2), heteronuclear diatomics (HF, CO), and polyatomic molecules (H_3, H_2O)] – role of p and d orbitals in pi bonding. **Chemistry of non-transition elements**: Preparation, structure and reactions of boranes, carboranes, metallocarboranes, boron–nitrogen ($H_3B_3N_3H_3$), phosphorus–nitrogen ($N_3P_3Cl_6$), sulphur-nitrogen (S_4N_4, $(SN)_x$) cyclic compounds, interhalogens, pseudohalogens and silicates. Electron counting in boranes – Wades rules (Polyhedral skeletal electron pair theory).

Chemistry of transition metal compounds: Bonding in Transition metal complexes: Valence Bond theory, 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, nephelauxetic effect, ligand field theory –Applications

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. Charge transfer spectra. Magnetic properties of transition metal and inner transition metal complexes – spin and orbital moments – quenching of orbital momentum by crystal fields in complexes.

Laboratory Component:

I. Qualitative Analysis:

Semi- micro analysis of six radical mixtures (containing interfering radicals as well as less familiar cations)

Interfering anions:Oxalate, phosphate, borate, chromate.

Less familiar Cations: Molybdenum, zirconium, vanadium, thallium, uranium. (Minimum three

Mixtures)

Chromatography.

Separation and identification of components of a mixture by paper chromatography. (at least one experiment)

TEXT BOOKS:

1.Advanced Inorganic Chemistry by F.A. Cotton and G. Wilkinson, IV Edition, John Wiley and Sons, New York, 1980.

2. Inorganic Chemistry by J.E. Huheey, III Edition, Harper International Edition, 1983.

3. Theoretical Inorganic Chemistry, II Edition by M.C. Day and J. Selbin, Affiliated East-West press Pvt. Ltd., New Delhi.

4. Inorganic Chemistry by Shriver and Atkins, Oxford University Press, 5th edition.

5. Concise Inorganic Chemistry by J.D.Lee, Oxford University Press; Fifth edition, Wiley India edition.

20CY5103 – ORGANIC CHEMISTRY–I

L-T-P-S : 4-0-6-0

Credits : 7

Contact hours :10

CO No.	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
1	Describe the structure and reactivity of chemical constituents of various reaction processes.	1	3
2	ply Nucleophilic Substitution reaction mechanism in the synthesis of desired organic entities.	1,2	3
3	Categorize the organic chemical species with respect to their spatial orientation of the groups or atoms attached with them.	1	3
4	Apply free radical reactions pathways to develop new and notable organic compounds.	1,2	3
5	rive the necessary pathways to identify the chemical composition in the given binary mixture and the synthesis of organic molecules.	1,2,3	3

Course Syllabus:

Nature of Bonding in Organic Molecules: Localized and delocalized chemical bonding, conjugation, hyper-conjugation, resonance, tautomerism. Huckel's rule- Aromaticity in benzenoid

and non-benzenoid compounds, alternant and non-alternant hydrocarbons, annulenes, fullerenes metallocenes, homo-aromaticity, anti-aromaticity. Basic mechanistic concepts-kinetic versus thermodynamic control-Hammond's postulate and Curtin-Hammett principle.

Organic reactions-Reactive intermediates-generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity-resonance and field effects, steric effect, quantitative treatment. Hammett equation and linear free energy relationship-substituent and reaction constants-Taft equation.**(14 hrs)**

Aliphatic Nucleophilic substitution: SN2, SN1, mixed SN1 and SN2, SET mechanisms. Reactivity- effects of substrates, attacking nucleophiles, leaving groups and reaction medium. Common carbocation rearrangements – primary, secondary and tertiary. The neighbouring group participation (NGP) -anchimeric assistance, NGP by σ and π- bonds, phenonium ions, norbornyl and norbornenyl systems, Classical and nonclassical carbocations, NGP by halogens and heteroatoms (O,N,S). SNi and SN2 mechanisms-Nucleophilic substitution at an allylic, and vinylic carbons. **Aromatic Nucleophilic Substitution:** The SNAr, SN1, benzyne and SRN1mechanisms. Reactivity - effect of substrate, structure, leaving group and attacking nucleophile. Von Richter, Sommelet - Hauser and Smiles rearrangements. **(12hrs).**

Stereo-Chemistry: Stereoisomerism-StereoisomersClassification-Configuration and conformation. Molecular three-dimensional representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions. Optical isomerism: Molecular Symmetry and Chirality-Cahn-Ingold-Prelog rules R, S-nomenclature, stereoisomerism resulting from more than one chiral center, meso and pseudo-asymmetric compounds. Axial Chirality-Stereochemistry of allenes spiranes-biphenyl derivatives and atropisomerism. Planar chirality-Ansa compounds and trans-cycloalkenes-Helicity-Helically chiral compounds.Geometrical isomerism- E, Z-nomenclature-physical and chemical methods of determining the configuration of geometrical isomers-Stereoisomerism in 3, 4 and 5-membered cyclic compounds.**(14hrs)**

Free Radical Reactions: Introduction-types of free radical reactions and their detection. Free radical substitution-mechanismat aromatic substrates, free radical addition, free radical rearrangement. Reactivity of the attacking radicals-the effect of solvent on reactivity. Allylic halogenation (NBS)-oxidation of aldehydes to carboxylic acids-auto-oxidation, Radical coupling - arylation of aromatic compounds by diazonium salts-Sand Meyer reaction-Hunsdiecker reaction.**(12 hrs)**

LAB COMPONENT: (20 labs)

I) **Identification** of two functional groups in the given organic mixture (Minimum five Mixtures)- Preparation of two solid derivatives of given compounds and reporting the melting points of derivatives

II) **Preparations:** i) Aspirin ii) Acetanilide iii) p-Bromo Acetanilide iv) Iodoform v) Benzoic acid vi) p-Nitroaniline vii) Bezophenone

Reference Book for Lab: Vogel Textbook for Organic Chemistry

REFERENCE BOOKS:

1. Organic Chemistry by Clayden et al., Oxford University press.
2. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley
3. Organic Chemistry Paula YarkanisBruis, John Wiley.
4. Advanced Organic Chemistry, F.A. Carey and R.J Sundberg, Plenum.
5. Structure and Mechanism in Organic Chemistry C.K.Inglod, Cornell University Press.
6. Green Chemistry: Theory and Practice. P.T. Anastas and J.C. Warner. Oxford UniversityPress.
7. Green Chemistry: Introductory Text. M. Lancaster Royal Society of Chemistry
8. Stereochemistry, P.S.Kalsi, Wiley Eastern.
9. Reaction Mechanism in Organic Chemistry by Mukherjee Sirigh, NTerniitarr, Indiar
10. A guide book to mechanism in Organic Chemistry by Peter Sykes, ELBS.

Web references/MOOCS:

1. https://nptel.ac.in/courses/103103033/module9/lecture3.pdf
2. https://nptel.ac.in/courses/104103020/

20CY5104 – PHYSICAL CHEMISTRY – I

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Table 0:1 Course outcomes of 20CY5104

CO#	Course Outcome	PO	BTL
CO1	Utilize the concepts of Classical thermodynamics & laws of thermodynamics	PO-1, PO-2	3
CO2	Devlop the applications of Surfactants and Macromolecules	PO-2	3
CO3	Discuss the different aspects of kinetics of the types of reactions .	PO-2,3,4	3
CO4	lize the concepts of photo chemistry & luminescence	PO-2,3,4	3
CO5	An ability to analyze, generate experimental skills towards the industrial applications.	PO-1,2	3

Syllabus:

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. Nernst heat theorem. Third law of thermodynamics- Determination of the absolute entropy- Apparent exceptions to Third law of thermodynamics.

Micelles and Macromolecules: Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micelllar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization- phase separation and mass action models, solubilization, micro emulsion, reverse micelles.Polymers-Definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization. Molecular mass- Number and mass average molecular mass, molecular mass determination- Osmometry, viscometry, diffusion and light scattering methods. Sedimentation, chain configuration of macromolecules, calculation of average dimensions of various structures.

Chemical Kinetics: Theories of reaction rates- Collision theory- Limitations, Transition state theory. Effect of ionic strength- Debye Huckel theory-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. Skrabal diagram. Fast reactions- different methods of studying fast reactions- flow methods, relaxation methods- temperature jump and pressure jump methods.

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.

List of Experiments:

1. Determination of rate constant of the oxidation of iodide ion with persulphate ion.
2. Relative strengths of acids by studying the hydrolysis of ethylacetate / methyl acetate
3. Determination of equilibrium constant of $KI_3 \leftrightarrow KI + I_2$ by partition coefficient method and determination of unknown concentration of potassium iodide.
4. Distribution coefficient of Benzoic acid between Benzene and water.
5. Determination of critical solution temperature of phenol-water system Study of the effect of electrolyte on the miscibility of phenol-water system.

TEXT BOOKS:

1. Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press.
2. Physical Chemistry by G.W. Castellon, Narosha Publishing House
3. Physical chemistry by K.L. Kapoor

REFERENCE BOOKS:

1. Thermodynamics for Chemists by Samuel Glasstone
2. Chemical Kinetics by K.J.Laidler, McGraw Hill Pub.
3. Photochemistry by R.P. Kundall and A. Gilbert, Thomson Nelson.
4. Introduction to Polymer Science by V.R. Gowriker, N.V.Viswanadhan and J. Sreedhar.,Wiley Easter.
1. Micelles - Theoretical and applied aspects by V.Moroi, Plenum publishers.

20CY5201 - THEORETICAL CHEMISTRY – II

L-T-P-S : 4-0-0-0

Credits : 4

Contact Hours : 4

CO#	Course Outcome	PO	BTL
CO1	Demonstrate various molecular spectroscopic terms with their theoretical background	1,2	3
CO2	Employ Nuclear magnetic resonance spectroscopy to interpret organic molecules	3	3
CO3	Employ the basic principles of Electron Spin Resonance (ESR)-Spectroscopy and XRD applications	1,2	3
CO4	Write a small computer codes to solve basic chemistry problems	1,2	3

Syllabus

Motion of molecules-Degrees of freedom -Energy associates with the degrees of freedom Type of spectra- ***Microwave spectroscopy***. –Principle-Classification molecules, rigid rotator model, effect of isotopic substitution on transition frequencies, Intensities non-rigid rotator-Microwave spectra of polyatomic molecules. ***Photoelectron Spectroscopy*:** Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, Electron spin chemical analysis (ESCA), chemical information from ESCA, Auger electron spectroscopy

***Nuclear Magnetic Resonance Spectroscopy:* (Proton and Carbon -13 NMR)**

Introduction-Principle of NMR-Classical and quantum approach-Nuclear spin, nuclear resonance-Chemically & Magnetically equivalence and Non equivalence protons-The measurement of spectra: Chemical shift: the intensity of NMR signals and integration factors affecting the chemical shifts: shielding-deshielding, spin-spin coupling, (n+1) rule, Pascals triangle, coupling constant, **^{13}C NMR**, chemical equivalent and non-equivalent carbons, chemical shift, Applications

Electron Spin Resonance (ESR)-Spectroscopy- Theory-Instrumentation-ESR lines and

intensity-g-values -factors affecting the ESR lines- Hyperfine interactions. Zero field splitting and Kramer's degeneracy. Applications of ESR for the characterization free radicals and metal compounds. **X-ray diffraction**-Introduction- Instrumentation-principle-Braggs law-Scherrer formula-Applications

Laser spectroscopy- General principles of laser action, features oflasers and population inversion. Examples of some common lasers –solid state, gas and dye lasers.

Computer applications in chemistry-Importance of Coding-Developing of small computer codes using any one of the languages FORTRAN/C/BASIC involving simple formulae in Chemistry, such as Van der Waals equation. Rate constant, Radioactive decay (Half Life), Normality, Molarity and Morality of solutions, Nernst Equation, pH-equation

TEXT BOOKS:

1) Fundamentals of molecular Spectroscopy by 3rd ed., TMH, New Delhi, 1983.
2) Spectroscopy by B.P. Straughan and S.Walker, Vol.3, Chapman Hall, London, 1976.
3) Introduction to Molecular Spectroscopy by G.M. Barrow, McGraw Hill, New York, 1964.
4) Introduction to Photoelectron Spectroscopy by P.K.Ghosh, John Wiley New York, 1989.
5) Spectroscopic Identification of Organic Compounds by P.M. Silverstein, F. X. Wester, 6th ed.,Wiley 1998.
6) Organic Spectroscopy by W. Kemp, 3rd Ed., MacMillon, 1994.
7) Applications of Absorption Spectroscopy of Organic Compounds by J.R. Dyer, Prentice Hall, 1965.
8) Introductory Group Theory for Chemists – George Davidson VOGEL'S (2009) Text Book of Quantitative Chemical Analysis- Pearson, 6th Edin.
9) Basics of computers for Chemists, P.C.Jurs.

20CY5202 – INORGANIC CHEMISTRY-II

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5202

CO #	Course outcome (CO)	PO	BTL
1	Analyze the various reaction mechanisms of coordination complexes	PO-1, 3	4
2	Demonstrate structure and bonding of d-block organometallic complexes	PO-1, 3	3

3	Predict the thermodynamics of complex formation and properties of acids and bases in aqueous medium	PO-1, 4	3
4	Determine structures of metal clusters, categorize the reactions of d-block organometallic complexes, catalysis	PO-1, 3	4
5	Perform chemical reactions to prepare inorganic complexes and analyze samples for quantitative determinations.	PO-1,6	4

Syllabus

Reactivity of coordination complexes: Kinetics of reactions – inert and labile complexes, associative, dissociative and interchange mechanisms – ligand substitution reactions in octahedral and square planar complexes, acid and base hydrolysis reactions, electron transfer reactions – inner and outer sphere electron transfer mechanisms.

Metal Ligand equilibria in solution: Thermodynamics of complex formation in aqueous medium – stepwise and overall formation constants – factors affecting formation constant – determination of formation constant – chelate and macrocyclic effects; isomerism and chirality of coordination complexes – concepts of acids and bases in gas phase and effect of solvation – hard and soft acid base principle.

Organometallic complexes of d-block element :16 and 18 electron rules – synthesis, structure and bonding of complexes with sigma and pi donor ligands (H^-, H_2, alkane, phosphine, N_2, CO, NO, allyl, alkene, alkyne, cyclopentadiene, benzene, cyclooctatraene etc.) – carbenes, carbynes and metallocenes.

Organometallic reactions and catalysis: ligand substitution, addition and elimination reactions, migratory insertion reaction in organometallic complexes, metal-metal bonds, carbonyl and non-carbonyl clusters,isolobal analogy, application of Wade's rule, metal cluster compounds, Zintle ions, Chevrel phases. Catalysis: Homogeneous (Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation) and heterogenous (Fischer-Tropsch reaction, Ziegler-Natta polymerization, Haber process).

Laboratory Component:

Preparation of the coordination complexes

potassium trisoxalato ferrate (III) – mercury (II) tetrathiocyanatocobaltate (II) – tris thiourea copper (I) sulphate – *cis* and *trans* potassium diaquodioxalato chromium (III) – hexa ammine cobalt (III) chloride – nitro and nitritopentaammine cobalt (III) chloride.

Quantitative inorganic analysis

- Determination of Zn^{2+} with potassium ferrocyanide.
- Determination of Mg^{2+}, Ni^{2+} and hardness of water using EDTA.
- Determination of Fe^{3+} by photochemical reduction.
- Determination of chloride by argentometric titration using K_2CrO_4.
- Determination of Ni^{2+} using dimethyl glyoxime, Cu^{2+} using ammonium thiocyanate, Zn^{2+} using diammonium hydrogen phosphate.

TEXTBOOKS

1. Shriver and Atkins' Inorganic Chemistry by Atkins, Overton, Rourke, Weller, Armstrong and Hegerman; Fifth edition, Oxford university press.
2. Inorganic chemistry by Sharpe and Housecroft, Fourth edition, Pearson.
3. Inorganic chemistry: principles of structure and reactivity by Huheey, Keiter, Keiter and Medhi; Fourth edition, Pearson.
4. Advanced inorganic chemistry by Cotton, Wilkinson, Murillo and Bochmann; Sixth edition, Wiley.
5. Vogel's textbook of macro and semi-micro qualitative inorganicanalysis by G. Svehla, Fifth edition, Longman.
6. Vogel's textbook of quantitative inorganic analysis by Jeffery, Bassett, Mendham and Denney, Fifth edition, Longman.

20CY5203–ORGANIC CHEMISTRY–II

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours: 10

Course outcome (CO) of 20CY5203

CO No.	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
1	Derive the Electrophilic addition reaction mechanisms of C=C compounds, the relationship among substitution and addition reactions.	PO2,PO3,PO4, PO5,PO6,PO7	3
2	scribe the types ofelimination reactions and their mechanisms	PO2, PO3, PO4, PO5, PO6, PO7	3
3	Apply various reaction pathways, addition to Carbon-Hetero Multiple Bonds to develop new and notable organic compounds.	PO2, PO3, PO4, PO5, PO6, PO7	3

4	fferentiate the Alkaloids and Terpenoids by their unique properties, recent trends and implication of Green and Nano-chemistry	PO2,	3
5	ability to analyze, generate experimental skills towards the industrial applications.	PO3,PO4,PO5,PO6	3

Course Objective: Provide in-depth knowledge on the synthesis of Organic molecules and their reaction mechanisms to develop novel and stable bio engineering tools. It is required for students to understand various technologies and is suitable to pursue their career in both research and industry.

Course Syllabus:

Reaction mechanism: Electrophilic addition to carbon-carbon double bond: Stereoselective addition to carbon-carbon double bond; anti addition-Bromination and epoxidation followed by ring opening-Syn addition of OsO4 and KMnO4.

Aliphatic Electrophilic Substitution: Bimolecular mechanism-SE2 and SE1. SE1 mechanism, electrophilic substitution accompanied bydouble bond shifts. Effects of substrate, leaving group and the solvent polarity on the reactivity. **Aromatic Electrophilic Substitution:**The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/pararatio, hipso-attack, orientation in other ring systems. Quantitative treatment of reactivity insubstrates and electrophiles. Diazonium coupling-Vilsmeir reaction, Gattermann-Koch reaction. **(14 hrs)**

Elimination reactions: Types of Elimination reactions-E_2, E_1, E_{1CB}-mechanisms. Orientation and stereoselectivity in E_2 eliminations-Bredt's rule, Saytzeff's rule and Hofmann's rule. Pyrolytic syn eliminations-Pericyclic reactions, Factors influencing the elimination reactions-Elimination Vs substitution. Additions involving electrophiles, nucleophiles and free radicals-Markovnikov's rule, Kharash or peroxide effect (anti-Markovnikov's rule). **(12 hrs)**

Addition to Carbon-Hetero Multiple Bonds: Grignard reagents, organo-zinc and organo-lithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanisms-metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Carbon-Carbon bond forming reactions (condensation) involving enolates. Named reactions-Aldol, Diels-Alder reaction, Knoevenagel, Mannich, Benzoin, Perkin, Oppenauer oxidation, Clemmensen reduction, Birch reduction, Michael addition, and Stobbe reactions. Hoffmann, Claisen and Favorsky rearrangements, Hydroboration. **(12 hrs)**

Green Chemistry: Introduction-Basic principles of Green Chemistry, Green catalysis, Bio catalysis, Examples of Green Reactions-Synthesis of ibuprofen, clean Fischer-Indole synthesis comparison with conventional method. **Natural Products:** Alkaloids-General methods of

extraction and isolation of natural products, classification based on nitrogen heterocyclic ring, structure elucidation and synthesis: Atropine, Papaverine and Quinine. Terpenoids-Classification of terpenoids, isolation of lower terpenoids, Isoprene, special isoprene rule and Biogenetic Isoprene rule. Structure determination and synthesis: Terpineol, Farnesol, Camphor and Abietic acid.**Nano Chemistry**-Introduction-Carbon Nano tubes: Structure of single and multiwalled carbon nano tubes, synthesis-solid and gaseous carbon based production technique, synthesis with Controlled orientation, Growth mechanism (catalyst free growth & catalyst activated growth) of carbon nano tubes-applications. **(14 hrs)**

LAB COMPONENT: (20 labs)

III) **Identification** of two functional groups in the given organic mixture (Minimum five Mixtures)- Preparation of two solid derivatives of given compounds and reporting the melting points of derivatives

IV) **Preparations:** i) Aspirin ii) Acetanilide iii) p-Bromo Acetanilide iv) Iodoform v) Benzoic acid vi) p-Nitroaniline vii) Bezophenone

Reference Book for Lab: Vogel Textbook for Organic Chemistry

REFERENCE BOOKS:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J Sundberg, Plenum.
3. Structure and Mechanism in Organic Chemistry C.K.Inglod, Cornell University Press.
4. Organic Chemistry, R.T Morrison and R.N. Boyd, Prentice - Hall.
5. Modern Organic Reactions, H.O. House, Benjamin.
6. Principles of Organic Synthesis, R.O.C Norman and J. M. Coxon, Blackie Academic.
7. Stereochemistry, P.S.Kalsi, Wiley Eastern.
8. Text book of Organic Chemistry, M.C. Murry
9. Organic Chemistry Vol. I (Sixth Edn.) and Vol. II (Fifth Ed.,) by IL finar ELBS.
10. Advanced organic chemistry by Jerry March (4th Edition) Wiley Eastern.
11. Chemistry of Natural Products, K.W.Bentley, Stereochemistry of carbon compounds by E.Eliel, John Wiley & Sons, Inc. Stereochemistry of Organic compounds by D. Nasipuri, Chemistry of Natural products by P.S. Kalsi Kalyani Publishers. 1983

Web references/MOOCS:

1. https://nptel.ac.in/courses/103103033/module9/lecture3.pdf
2. https://nptel.ac.in/courses/104103020/

20CY5204 – PHYSICAL CHEMISTRY-II

L-T-P : 4-0-6

Credits : 7

Contact Hours : 10

Table: Course outcomes of 20CY5204

CO#	Course Outcome	PO/PSO	BTL
CO1	Account for the basic principles and concepts of quantum chemistry.	PO-1,2	3
CO2	Make use of adsorption process and its mechanisms on the *surfaces*	PO-1,2,3	3
CO3	Discuss Electrochemistry of electrode electrolyte interface	PO-1,2,3	3
CO4	Utilize the concepts of Classical thermodynamics & laws of thermodynamics	PO-1,4,5	3
CO5	An ability to analyze, generate experimental skills towards the industrial applications.	PO-2,6	3

Syllabus:

Quantum Mechanics:

Introduction to quantum mechanics. Schrödinger wave equation. Time-independent and timedependent 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. Eigenfunctions and eigenvalues of angular momentum. Ladder operator method for angular momentum.

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), Catalytic activity of surfaces

Electrochemistry: 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. Exchange current density and overpotential. Derivation of Butler-Volmer equation. High field approximation, Tafel equation, Low field equilibrium, Nernest equation. Voltametry-Concentration polarization, experimental techniques.

Statistical Thermodynamics: Fundamentals: Idea of microstates and macrostates. 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. Stirling's approximation, Molecular partition function and its importance. Assembly partition function.

List of experiments:

1. Potentiometric determination of Fe(II) with Cr (VI)
2. Potentiometric titration of chloride with silver nitrate.
3. pH-metric determination of strong acid with strong base.
4. Conductometric titration of strong acid with strong base
5. Verification of Beers Law using potassium permanganate/Potassium dichromate.
6. Determination of formulae and stability constant of a metal complex by spectrophotometric method.
7. Verification of Langmuir isotherm . Determination of unknown concentration of acetic acid by studying its adsorption on activated charcoal.

TEXT BOOKS:

1. Lowe, J. P. & Peterson, K. Quantum Chemistry Academic Press (2005).
2. McQuarrie, D. A. Quantum Chemistry Viva Books Pvt Ltd.: New Delhi (2003).
3. Mortimer, R. G. Mathematics for Physical Chemistry 2nd Ed. Elsevier (2005)
4. Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press.
5.Physical Chemistry by G.W. Castellon, Narosa Publishing House
6.Physical chemistry by K.L. Kapoor
7. Thomas, J. M. & Thomas, M. J. *Principles and Practice of Heterogeneous Catalysis* John Wiley & Sons (1996).
8. Hamley, I. W. *Introduction to Soft Matter: Polymers, Colloids, Amphiphiles and Liquid Crystals* John Wiley & Sons (2000).

REFERENCE BOOKS:

1) Introduction to Electrochemistry by S.Glasstone.
2) Fundamentals of Molecular Spectroscopy by Banwell
3) Spectroscopy by Barrow.
4) *Bowley, Roger and Sanchez, Mariana (2000). Introductory Statistical Mechanics. Oxford University Press*

SEMESTER-3
ANALYTICAL CHEMISTRY SPECIALIZATION
20CY5301- INSTRUMENTAL METHODS OF ANALYSIS-I

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5301

CO#	Course Outcome	PO	BTL
CO1	Understand the concepts of excitation spectroscopic methods.	PO-1,2	3
CO2	Understand the basic concepts of rotational and vibrational spectroscopic methods.	PO-3,4	3
CO3	Illustration of the concept of Nuclear magnetic and ESR spectroscopy and their applications.	PO-1,3	3
CO4	Comprehend the basic knowledge of mass spectroscopy and X-ray spectroscopy to characterize the unknown molecules	PO-1,2,5	3
CO5	Ability to analyze chemicals by Instrumental methods	PO-1,5	3

Provide in depth knowledge on various types of spectroscopic characterization techniques with interpretation process.

Syllabus:

UV-Visible Spectroscopy: laws of absorption, deviation from Beer's law, single and double beam spectrophotometers-instrumentation, sources of radiation, detectors, qualitative analysis by absorption measurements, general precautions in colorimetric determinations, determination of certain metal ions by using ligands – Fe^{2+}, Fe^{3+}, Al^{3+}, NH^{4+}, Cr^{3+}, Cr^{6+}, Co^{3+}, Cu^{2+}, Ni^{2+} and anions – NO^{2-}, PO_4^{3-} using suitable reagents, simultaneous determinations of dichromate and permanganate in a mixture, spectrophotometric titrations, principle of diode array

spectrophotometers. **Spectrofluorimetry:** Theory of fluorescence, phosphorescence, factors affecting the above, quenching, relation between intensity of fluorescence and concentration, instrumentation, application with reference to Al^{3+}, chromium salts, fluorescence, thiamin (B1) and riboflavin (B2) in drug samples.

Chemiluminescences: Introduction, principle, types Measurement of chemiluminescence, Instrumentation quantitative chemiluminescences Gas phase chemiluminescence's analysis Chemiluminescences titrations, Electro-chemiluminescence.

Infrared spectroscopy: Units of frequency, wavelength and wave number molecular vibrations, factors influencing vibrational frequencies, instrumentation, sampling techniques, detectors, characteristic frequencies of organic molecules, qualitative and quantitative analysis with reference to (petroleum refinery and polymer industry), selected molecules like CO, CO_2, non-destructive IR method for the analysis of CO and other organic compounds, principles of Fourier transform IR.

Mass Spectroscopy: Principle, basic instrumentation, energetics of ion formation, types of peaks observed, resolution, qualitative analysis, molecular weight determination, quantitative analysis, advantages. **X-ray Spectroscopy:** chemical analysis by X-ray spectrometers, energy dispersive and wavelength dispersive techniques, evaluation methods, instrumentation, matrix effects, applications.

An Introduction to Microscopy (surface characterization techniques) Limitations of the Human Eye, the X-ray Microscope, The Transmission Electron Microscope, The Scanning Electron Microscope, Scanning Transmission Electron Microscope, Analytical Electron Microscopy, Scanning-Probe Microscopes, the transmission electron microscope.

List of Experiments:

1. Determination of alkalinity in a colored effluent using pH metric end point
2. Determination of purity of commercial HCl, H_2SO_4, H_3PO_4 and CH_3COOH using pH metric end point
3. Determination of Cr (VI) with Fe (II) using potentiometric end point
4. Determination of a mixture of Ce (IV) and V (V) with Fe (II) using potentiometric end point
5. Determination of a mixture of Mn (VII) and V (V) with Fe (II) using potentiometric end point
6. Determination of a mixture of bromide and chloride with $AgNO_3$ using potentiometric end point
7. Determination of KSCN with $AgNO_3$ using potentiometric end point
8. Estimation of aspirin from given tablet by spectrophotometry
9. Determination of Strength of commercial phosphoric acid by potentiometric titrations using standard solution of sodium hydroxide

10. To determine chloride and iodide from given mixture by potentiometry
11. Analysis of Riboflavin from vitamin supplementary capsules / syrup / tablet sample by Photoflurometry
12. Determination of relative strength of acetic acid, chloroacetic acid and trichloroacetic acid through measuring their Ka value by conductivity measurement method
13. Determination of commercial vinegar by potentiometric titration.
14. Determination of boric acid by conductometry.
15. Estimation of micronutrient from food by AAS (any two elements such as Fe, Cu, Zn, Mo, B, Mn)

TEXT BOOKS:

1) Instrumental methods of analysis by H.H Willard, Meritt Jr. and J.A Dean
2) Principles of instrumental analysis by Skoog and West
3) Vogels Textbook of Quantitative Inorganic analysis by J. Basset, R.C Denney, G.H Jefferey and J.Madhan
4) Instrumental methods of analysis by B.K Sarma, Goel Publishing House, Meerut
5) Instrumental methods of Analysis by Chatwal and Anand
6) Instrumental methods of Analysis by Ewing

REFERENCE BOOKS:

1) Introduction to instrumental analysis by R. D. Braun, Mc Graw Hill - International edition.
2) Analytical spectroscopy by Kamalesh Bansal, 1st edition.
3) Instrumental methods of chemical analysis by Willard, Dean and Merittee- 6th edition.
4) Analytical chemistry principles by John H. Kenedey- 2nd edition, Saunders college publishing.
5) Spectroscopic identification of organic compounds Fifth Edition by Silvestrine, Bassler, Morrill, John Wiley and sons.
6) Analytical Chemistry by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley –VCH
7) Vogel's Textbook of quantitative Chemical Analysis, sixth Edition by Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.

20CY5302- QUALITY CONTROL AND CLASSICAL METHODS OF ANALYSIS

L-T-P-S : 4-0-0-0

Credits : 4

Contact Hours : 4

Course outcomes of 20CY5302

CO#	Course Outcome	PO	BTL

CO1	Understand the principles of Quality control in Analytical Chemistry	PO-1,3	3
CO2	Explain the various concepts of decomposition techniques in analysis	PO-1,4	3
CO3	Illustrate, discuss and apply the various principles behind the various Redox systems involved in the classical Volumetric methods of Analysis.	PO-1,3	3
CO4	Explain the various principles involved in the analysis of Organic Functional Groups	PO-1,2,5	3

Provide the knowledge in principles of quality control and various principles behind redox systems, classical methods of analysis.

Syllabus:

Characteristics of an analysis: quality of an analytical procedure, limit of detection, sensitivity, safety, cost measurability, selectivity and specificity, quality control-principles of Ruggedness test, control charts, Youden plot, and ranking test. **Evaluation and reliability of analytical data:** limitation of analytical methods, accuracy, precision, errors in chemical analysis, classification of errors, minimization of errors, significant figures, computations and propagation of errors. Statistical analysis: Mean deviation, Standard deviation, coefficient of variance, normal distribution, F test, T test, rejection of results, presentation of data. **Quality assurance and management systems:** elements of quality assurance, quality assurance in design, development, production and services, quality and quantity management system, ISO 9000 and ISO 14000 series-meaning of quality, quality process model, customer requirement of quality calibration and testing, statistical process control, process control tools, control chart, statistical quality control, acceptance sampling. Good laboratory practices (GLP) – need for GLP, GLP implementation and organization, GLP status in India. Brief out line of ICH guide lines on drug substances and products.

Decomposition techniques in analysis: Principle of decomposition and Dissolution. Difference between dissolution / decomposition of Organic and Inorganic substances. Prinicples of decomposition techniques in Analysis. Decomposition of samples with acids – H_2O, HCl, HF, HNO_3, H_2SO_4 and $HClO_4$ Decomposition of samples by fusion, Alkali Fusion-Na_2CO_3, NaOH, Acidic Fusion-Sodium Hydro Sulphate, Sodium Pyro Sulphate Oxidation Fusion-Na_2O_2, Sodium Chlorate Reductive Fusion Na_2CO_3 + Na_4BO_4, Sintering process, Fusion with alkali carbonates, alkali hydroxides, Sodium Peroxide Decomposition of samples by sintering with sodium peroxide, sodium carbonate, Principles of decomposition at high temperatures, high pressures, Principles of Microwave and ultrasonic decomposition techniques.

Organic Compounds Principles of solubility of organic compounds, non polar, polar solvents. Recrystallisation methods and application of solubility and Recrystallisation.

Oxidant systems – Principles and applications in analysis Applying the Analytical chemistry of some selected oxidant systems – formal, standard and normal potentials in various media, species responsible for the oxidation properties, stability of the solutions, standardization, requirement for the selections of the oxidants, selection of suitable indicators for Oxidant systems.

a) Inorganic Systems Mn (III), Mn (VII), Ce (IV), Cr (VI), V (V), periodate, iodate,

b) Organic Systems chloramine-T.

Organic Functional group analysis: Classification of functional groups with suitable examples. Determination of: Functional groups imparting acidic nature – thiol, enediol, phenolic hydroxyl. Functional groups imparting basic nature – Aliphatic and Aromatic primary, secondary and tertiary amines – hydrazine derivatives. Functional groups which impart neither acidic nor basic nature – Aldehydes, Ketones, Nitro, Methoxy, Olifinic.

TEXT BOOKS:

1. Technical methods of analysis by Griffin, Mc Graw Hill Book Co.
2. Chemical Separation and measurements by D.G Peterseti, John M.Haves Sanders Co.
3. Chemical analysis by H.A Laitinan, Mc Graw Hill Book Co.
4. Newer redox titrants by Berka, Zyka and Vulterin, Pergamon Press
5. Volumetric Analysis, Vol III by I.M Kolthoff and R. Belcher, Interscience Public, New York
6. Vogel's Text Book of Inorganic Quantitative Analysis by J. Bassett et al, ELBS
7. Organic functional groups by S. Siggia

REFERENCE BOOKS:

1. Analytical Chemistry, An Introduction by D.A Skoog, D.M West and F.J Holler, Sanders College Publishing, New York.
2. Environmental Management by K.V.S.G Murali Krishna, An Introduction ISO 9000, ISO 1400 Series, Quality Assurance and Good Laboratory Practices by Prof. Y. Anjaneyulu, In Now Publication, New York
3. Quality Assurance in Analytical Chemistry by G.Kateman and F.W Pijpers, John Wiley and Sons, New York
4. Quantitative Chemical Analysis by I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London
5. Decomposition Techniques in Inorganic Analysis by J.Dolezal, P.Povondra, Z.Sulcek

20CY5303- APPLIED CHEMICAL ANALYSIS

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5303

CO#	Course Outcome	PO	BTL
CO1	Understand the principles, methodology and adoptability various procedures for the analysis of Analysis of Iron, Manganese, Chromite , Phosphate and Aluminium Ores	PO-1,2	3
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	PO-1,3	3
CO3	Finding the adoptability by applying the general methods of analysis for Cement, Soaps, Oils and paints analysis	PO-1,2,4	3
CO4	Explain and apply the various principles involved in the chemical and physicochemical analysis of Organic Functional Groups	PO-1,4,5	3
CO5	Analysis of chemicals by instrumental methods	PO-1,2	3

Provide the knowledge of analysis, principles, methodlogy for analyzing various ore samples and commercial elements.

Syllabus:

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, phosphrous, manganese, alkalies, 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 - 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.

Aluminium Ore (Bauxite)-Analysis of the Constituents-Silica, Alumina, Fe_2O_3, Titania, MnO, P_2O_5, CaO, MgO, vanadium, zirconium, and alkalies. 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 Analysis of fluxes - limestone and dolomite. Chemical Analysis of cement-silica, NH_4OH group, ferric oxide, alumina, lime, magnesia, Sulphide 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. 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.

List of Experiments:

Water analysis

(i) Analysis of water for total hardness (Ca^{2+} and Mg^{2+})

(ii) Analysis of water for chloride (Cl^-)

(iii) Analysis of water for alkalinity (CO_3^{2-}, HCO_3^-)

(iv) Analysis of dissolved oxygen (DO) in drinking water and sewage water

(v) Analysis of chemical oxygen demand (COD) in drinking water and sewage water

Fertilizer analysis

(i) Analysis of fertilizer for ammonia, nitrate and phosphate

Analysis of iron ore

(i) Complete analysis of iron ore

(ii) Analysis of iron ore (with special reference to percentages of Fe (II) and Fe (III) present in the sample)

TEXT BOOKS:

1. Handbook of Analytical Control of Iron and Steel Production by Harrison John, Weily 1979
2. Standard methods of Chemical Analysis by Welcher
3. Technical Methods of Analysis, Griffin by Mc Graw Hill
4. Commercial Methods of Analysis by Foster Dee Sneel and Frank M. Griffin, Mc Graw Hill Book Co.
5. Water Pollution, Lalude by Mc Graw Hill
6. Environmental Chemistry by Anil Kumar De, Wiley Eastern Ltd.
7. Environmental Analysis by S.M. Khopkar (IIT Bombay)

SEMESTER-3
ORGANIC CHEMISTRY SPECIALIZATION

20CY5310 -ORGANIC SYNTHESIS- I

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5310

CO#	Course Outcome	PO	BTL
CO1	Build carbon-carbon single bond associated molecules (carbenes-carbenoids)	PO-2,4	3
CO2	Develop carbon-carbon double bonds using notable elimination reactions	PO-2,3	3
CO3	Make use of organic polymerization processes	PO-1,5	3
CO4	Understand the applications of organic boranes.	PO-2,4,5	3
CO5	Ability to synthesize organic molecules for general health issues	PO-2,3	3

Provide the knowledge of c-c single, double bonds, organic polymerization process

Syllabus:

Formation of Carbon-Carbon single bounds: alkylations via enolate the enamine and related reactions, umplong (dipole inversion) reactions – the aldol reaction – applications of organo palladium, organo nickel and organo copper reagents ,applications of α-thiocarbonions, selenocarbonions and sulphur ylides, synthetic applications of carbenes and carbenoids.

Formation of carbon-carbon double bonds: Elimination reactions Pyrolytic, syneliminations, sulphoxide-sulphonate rearrangement the witting reaction-alkenes from arylsulphonyl hydrazones, claisen rearrangement of allyl vinylethers.

Organoboranes: Preparation of Organobornaes viz hydroboration with BH_3-THF, dicyclohexyl 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 cyanoborate process and reaction of alkenyl boranes and trialkenyl borates.

Methods of polymerization (a) addition polymerization (b) Condensation polymerization (c) Radical polymerizations (two examples of each method) Reactions of unactivated carbon-hydrogen bonds: The HoffmannLieffier- Freytag reaction-the Barton reaction-Photolysis of organic hypothalites.

List of Experiments

S. No	Name of the Experiment
1	Synthesis of P- Bromo acetanilide from aniline

2	Preparation of Aspirin from Methyl salicylate
3	Preparation of 2,4- Di Nitro Phenol from Chlorobenzene
4	Synthesis of Anthraquinone from Phthalic anhydride
5	Synthesis of P- Nitro Aniline from Acetanilide
6	Synthesis of Benzylic acid from Benzoin
7	Synthesis of 1,3,5- Tribromo Benzene from Aniline
8	Synthesis of M- Nitro Aniline from Nitro Benzene
9	Synthesis of Beta- Naphthol from Naphthalene
10	Synthesis of Coumarin from Phenol

TEXT BOOKS:

1) Advanced Organic Chemistry-Reactions, Mechanism and Structure by Jerry March, John Wiley.
2) Advanced Organic Chemistry by F.A. Carey and R.J Sundberg, Plenum.
3) Structure and Mechanism in Organic Chemistry by C.K.Inglod, Cornell University Press.
4) Organic Chemistry by R.T Morrison and R.N. Boyd, Prentice - Hall.
5) Principles of Organic Synthesis by R.O.C Norman and J. M. Coxon, Blackie Academic
6) Stereochemistry by P.S.Kalsi, Wiley Eastern.
7) Text book of Organic Chemistry by M.C. Murry
8) Organic Chemistry Vol. I (Sixth Edn.) and Vol. II (Fifth Ed.,) by IL Finar ELBS. Chemistry (fifth Edn.,) by Morrison and Boyd, PHI, India.
9) Organic Chemistry (fifth edition) by Francis A. CareyTata Mc Graw Hill publishing company Limited, New Delhi.
10) Reaction Mechanism in Organic Chemistry by Mukherjee Sirigh, N Terniitarr, Indiar
11) Text book of Practical Organic Chemistry by Vogel

20CY5311-NATURAL PRODUCTS AND BIOMOLECULES

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

CO#	Course Outcome	PO	BTL
CO1	Illustrate the drug metabolic pathways, adverse effect and therapeutic value of alkaloids and microbial metabolites	1,4	3
CO2	Identify the mechanism pathways of different class of medicinal compounds like terpenoids and steroids.	1,3,5	3
CO3	Interpret the chemistry of carbohydrates with respect to their pharmacological activity	1,2,3	3
CO4	Demonstrate the function of proteins, nucleic acids and recognize the importance of amino acids and peptides.	4,5	3
CO5	Evaluate and carryout independent investigations of plant materials and natural products	2,3	5

Provide the basic knowledge of origin and nature of natural products like alkaloids and terpenoids.

Syllabus:

Occurrence, nomenclature, basic skeleton, stereochemistry, Isolation, Structure determination and synthesis of the following class of natural products from plant, animal and microbial sources and biopolymers.

Alkaloids: Morphine, reserpine and vincristine

Microbial metabolites: Penicillin G, Cephalosporin-O and streptomycin.

Terpenes: Forskolin, Taxol, Azadirachtin, Biosynthesis of terpenes

Steroids: Diel's hydrocarbon, Cholesterol, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone, and Biosynthesis of Steroids.

Carbohydrates: Naturally occurring sugars: Deoxy sugars, amino sugars, branched sugars. Structure elucidation of lactose, D-glucosamine and meso inositol. Structural features and applications of inositol, starch, cellulose, chitin and heparin

Biomolecules:

Amino acids, peptides and proteins: Chemical and enzymatic hydrolysis of proteins to peptides, Secondary, tertiary and quaternary structure of proteins, amino acid sequencing, α-Amino acids-general properties & synthesis. Synthesis of peptides by Merrifield solid phase synthesis.

Nucleic acids: Structure and function of physiologically important nucleotides (c-AMP, ADP, ATP) and nucleic acids (DNA and RNA), replication, genetic code, protein biosynthesis, mutation.

List of Experiments

S. No	Name of the Experiment
1	Estimation of Hydroxyl group by acetylation or phthalation method
2	Estimation of phenol by bromination method
3	Estimation of aniline by Bromination method
4	Estimation of sugars by using Fehling's method
5	Estimation of Vitamin-C in lime Juice
6	Identification of secondary metabolites present in plant extracts
7	Isolation of Caffeine from tea
8	Isolation of Lycopene from Tomatoes
9	Isolation of Lactose from Milk
10	Isolation of Citric Acid from Lemon
11	Isolation of Limonene from Orange peels
12	Isolation of Piperine from Black Peppercorns

TEXTBOOKS:

1. Organic Chemistry by I.L. Finar Vol. I and II, 9th Edition, Pearson, 2009.
2) Medicinal Chemistry by Graham L. Patrick, Oxford University Press, 2005.
3) Textbook of Practical Organic Chemistry by Vogel

20CY5312 -ORGANIC SPECTROSCOPY

Course Title : Organic Spectroscopy

Course Code : **20CY5312**

L-T-P-S Structure : 4-0-0-0

Credits : 4

Course Outcome (CO)

CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
1	Discuss about UV-VISIBLE and IR Spectroscopy and Applications towards deduction of structure of Molecule	1,2,3	3
2	Describe about NMR- Spectroscopy and Applications towards deduction of structure of Molecule	1,2	3
3	Discuss the concept of 2D-NMR Spectroscopy and Applications towards deduction of structure of Molecule	1,2	3
4	Discuss the Mass Spectroscopy and Applications towards deduction of structure of Molecule	1,2	2

SYLLABUS

CO-I-UV-VISIBLE SPECTROSCOPY: Various electronic transitions - Effect of solvent on electronic transitions - Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes and conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds - Ultraviolet spectra of aromatic and heterocyclic compounds - Steric effect in biphenyls. Applications towards deduction of structure of Molecule. **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, Applications towards deduction of structure of Molecule

CO-II: NMR SPECTROSCOPY:HNMR: Nuclear spin - Nuclear resonance - Saturation, shielding of magnetic nuclei - Chemical shifts and its measurements - Factors influencing chemical shift - Deshielding - Spin-spin interactions - Factors influencing coupling constant 'J' – Classification on (ABX, AMX, ABC, A2B2etc.) - Spin decoupling - Basic ideas about instrument - 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, en ols, carboxylic acids, amines and amides) - Chemical

exchange - Effect of deuteration - Complex spin-spin interaction between two, three, four and five nuclei (First order spectra) - Virtual coupling. Stereochemistry - Hindered rotation - Karplus curve variation of coupling constant with dihedral angle. Simplification of complex spectra: nuclear magnetic double resonance - Contact shift reagents - Nuclear overhauser effect (NOE).

CO-III: 2D-NMR SPECTROSCOPY: The separation of Chemical shift and coupling on to two different axes (2D-NMR, Cosy), spin decoupling, the nuclear over hauser effect associating the signal from directly bonded ^{1}H. ^{13}C-NMR Spectroscopy: General considerations - Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon) - Coupling constants. Applications towards deduction of structure of Molecule.

CO-IV- 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 labeling - High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination

TEXT BOOKS:

1. Spectroscopic methods in Organic Chemistry
2. Fundamentals of molecular Spectroscopy by 3rd ed., TMH, New Delhi, 1983.
3. Spectroscopy by B.P. Straughan and S.Walker, Vol.3, Chapman Hall, London, 1976.
4. Introduction to Molecular Spectroscopy by G.M. Barrow, McGraw Hill, New York, 1964.
5. Introduction to Photoelectron Spectroscopy by P.K.Ghosh, John Wiley New York, 1989.
6. Spectroscopic Identification of Organic Compounds by P.M. Silverstein, F. X. Wester, 6th ed., Wiley 1998.
7. Organic Spectroscopy by W. Kemp, 3rd Ed., MacMillon, 1994.
8. Applications of Absorption Spectroscopy of Organic Compounds by J.R. Dyer, Prentice Hall, 1965.

SEMESTER-4
ANALYTICAL CHEMISTRY SPECIALIZATION

20CY5401-INSTRUMENTAL METHODS OF ANALYSIS-II

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5401

CO#	Course Outcome	PO	BTL
CO1	Discuss and understand the principles and instrumentation involved in the Flame photometry. Atomic Absorption Spectrometer, Inductively coupled plasma spectrometer and Arc and Spark spectrographic Direct analysis.	PO-2, 5,	3
CO2	Discuss and apply the various principles and methodology in TGA, DTA and DSC	PO-1,3	3
CO3	Discuss and apply the principles and methodology involved in Voltametry, polarography, Anode stripping voltammetry and Coulometry.	PO-1,3,5	3
CO4	Discuss the principles and methodology in assaying the analytes using Ion Selective Electrodes and Radio chemical methods	PO-2,3,5	3
CO5	Ability to analyse chemicals by Instrumental methods	PO-3,5	3

Provide in depth knowledge of various instrumentation electro analytical techniques like Cyclic voltammetry, polarography and thermal techniques like TGA, DTA and DSC.

Syllabus:

Electro analytical Methods of Analysis: Polarographic principles, Instrumentation (different types of microelectrode such as dropping mercury electrode, the static drop mercury electrode, rotating disc and ring disc electrode, cell for polarography, reference and counter electrode and circuit diagram), 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 suppresors, interference due to dissolved oxygen, Applications (qualitative analysis, quantitative analysis by calibration curve and standard addition methods), specific examples of analysis–analysis of Cu, Cd, Zn, Pb, etc. from tap water and alloys., problems. **Pulse Polarography:** different types of excitation signals in pulse polarography, Differential pulse polarography, square wave polarography, Stripping method. Voltametry with ultra microelectrode, Applications of these techniques Cu and Zn from tap water by differential pulse polarography and by square wave polarography, Vitamin-C by differential pulse polarography **Anode stripping voltametry:** 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 voltamogram of $K_3[Fe(CN)_6]$, and parathion, criteria of

reversibility of electrochemical reactions, quasireversible 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 **Spectro-Analytical Methods Of Analysis: Flame photometry:** theory, instrumentation, combustion flames, detectors, and analysis of Na, K, Ca, Mg etc. **Atomic Absorption Spectrometer:** theory, instrumentation, flame and non-flame techniques, resonance line sources, hollow cathode lamp, instrumentation, chemical and spectral interferences, applications with special reference to analysis of trace metals in oils, alloys and toxic metals in drinking water and effluents.

Inductively coupled plasma spectrometer (ICP-AES, ICP-MS): principles, instrumentation, plasma, AES detectors, quadrupole mass spectrometers, difference between the two detectors, analysis methods for liquids and solids, applications in the analysis of trace and toxic metals in water, geological and industrial samples **Thermal methods of Analysis:** Thermo gravimetry-theory, instrumentation, applications with special reference to $CuSO_4.5H_2O$, $CaC_2O_4.2H_2O$, $CaCO_3$, $(COOH)_2.2H_2O$ Differential thermal analysis-principle, instrumentation, difference between TG and DTA-applications with special reference to the clays and minerals, coals (fuels)**.** Differential scanning calorimetry-principle, instrumentation, applications to inorganic materials like chlorates and per chlorates, ammonium nitrate, organic compounds and Drugs

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, radio carbon dating technique

List of Experiments:

Voltammetry

1. Fabrication of carbon paste electrode.
2. Determination of peak potential of Pb, Cd and Zn using differential pulse voltammetry at carbon paste electrode.
3. Determination of amount Pb present in unknown sample using square wave voltammetry.
4. Determination of amount Cd present in unknown sample using square wave voltammetry.
5. Determination of amount Zn present in unknown sample using square wave voltammetry.

Spectrophotometry

1. Spectrophotometric determination of Fe (III) using KSCN.
2. Spectrophotometric determination of phosphate.
3. Spectrophotometric determination of Cr (VI).
4. Spectrophotometric determination of Nitrite.
5. Determination of pKa value of an indicator by spectrophotometry.

pH-metry

1. Determination of dissociation constant (pKa) of acetic acid using pH-metry.

2. Determination of dissociation constant (pKa) of acetic acid using point wise calculation
3. Determination of carbonate and bicarbonate in the given mixture by pH-metry.
4. Determination of isoelectric point of amino acids.
5. Determination of ionization constant of amino acids using Irving Rosotti method.

Conductometry

1. Determination of halides (Cl^-, I^- etc.) using conductometric method.
2. Determination of the degree of ionization and ionization constant of weak electrolytes.
3. Determination of solubility of sparingly soluble salts by conductometric method.
4. Estimation of Aspirin by conductometry.

Chromatography

1. Separation of amino acids by TLC.
2. Determination of aspirin by HPLC.
3. Separation of pigments by paper chromatography.
4. Separation of cations and their quantification by ion exchange chromatography.

Flame photometry

Determination of Na, K and Li by Flame photometry.

TEXT BOOKS:

1) Instrumental methods of analysis by H.H Willard, Meritt Jr. and J.A Dean
2) Principles of instrumental analysis by Skoog and West
3) Vogels Textbook of Quantitative Inorganic analysis by J. Basset, R.C Denney, G.H Jefferey and J.Madhan
4) Instrumental methods of analysis by B.K Sarma, Goel Publishing House, Meerut
5) Instrumental methods of Analysis by Chatwal and Anand
6) Instrumental methods of Analysis by Ewing

REFERENCE BOOK:

1) Thermal Analysis by W.Wendtlandt, John Wiley Sons, New York

20CY5402-ADVANCED APPLIED CHEMICAL ANALYSIS

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5402

CO#	Course Outcome	PO	BTL

CO1	To discuss the concepts of analysis of ferrous, non-ferrous metals and allied Fe compounds	PO-2,5	3
CO2	To understand analysis of soil, fertilizer and fuel for applied purposes.	PO-3,4	3
CO3	To discuss different methods involved in analysis of different gaseous components in air.	PO-1,3	3
CO4	To determine moisture content in drugs and other samples.	PO-2,3,5	3
CO5	Explain the various principles involved in the analysis of Organic Functional Groups	PO-2,4	3

Provide the knowledge in various analytical methods analyse the materials like soil, fertilizer and fuel.

Syllabus:

Analysis of raw materials: Analysis of non-ferrous alloys: Brass – Analysis of the constituents – Cu, Zn, Sn, Pb and Fe. Bronze -Analysis of the constituents -Cu, Sn, Zn, Pb and Fe. Solder - Analysis of the constituents – Sn, Pb and Sb. Analysis of Ferro alloys : Ferro silicon - Analysis of the constituents – Si, C, P,S Ferro vanadium - Analysis of the constituents – V, C, P, S. Si, Al. Ferro manganese - Analysis of the constituents – Mn, S, C, P, Si Silico manganese - Analysis of the constituents –Mn, S, C, P, Si Ferro chromium - Analysis of the constituents – Cr, C, Si.

Analysis of Soil, Fertilizer and Fuel: Analysis of soils: sampling, determination of moisture, total N, P, Si, lime, humus nitrogen, alkali salts, soil absorption ratio. Analysis of fertilizers: ammonical fertilizers, Phosphate fertilizers, Nitrate fertilizers. Analysis of fuels: solid fuels-coal, proximate analysis, ultimate analysis, heating value, grading of coal based on Ultimate Heat Value (UHV).

ASSESSMENT OF AIR QUALITY: Composition of Pure Air, Classification of Air Pollutants, Toxic Elements Present in Dust and their Sources – Collection of Air Samples.

Sources, Effects, Control of Pollution and Chemical Analysis for the following. Primary Pollutants:

Carbon compounds - Carbon monoxide(CO) and Carbon dioxide(CO_2). Sulphur compounds- sulphur dioxide (SO_2), Sulphur trioxide (SO_3) and Hydrogen Sulphide (H_2S). Nitrogen compounds - nitric oxide (NO), and nitrogen dioxide (NO_2), Hydrocarbons - Aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH). Particulate matter - Repairable and Suspended particulate matter, Inorganic and Organic particulates. Secondary pollutants - ozone (O_3), peroxy acetyl nitrate (PAN), peroxy benzyl nitrate (PBN), Standards for ambient air quality.

Kinetic Methods of Analysis & Non aqueous Titrimetry: Kinetic methods of analysis: introduction, slow reactions, catalyzed reactions, methods of determination of catalyst concentration, extrapolation method for the determination of catalyst, variable time method, fixed time method, examples for the determination of toxic metals and anions using some typical kinetic reactions.

Non aqueous titrimetry: Classification of solvents and titrations for non aqueous titrimetry-Types of reactions – Indicators. Determination of acids Determination of bases Karl-Fisher reagent for the determination of moisture content in drugs and other samples.

List of Experiments:

1. Complexometric titrations

(i) Analysis of zinc in zinc ore by using EDTA

(ii) Analysis of nickel by EDTA

(iii) Analysis of limestone or dolomite

2. Analysis of oils, fats and soaps

(i) Analysis of oil for the determination of saponification value, acid value and iodine value

(ii) Analysis of soaps for moisture content and total alkali

3. Analysis of coal

(i) moisture content

(ii) volatile matter

(iii) fixed carbon ash content

TEXT BOOKS:

1) Chemical analysis by H.A Laitinan, Mc Graw Hill Book Co
2) Standard methods of Chemical Analysis by Welcher
3) Technical Methods of Analysis by Griffin, Mc Graw Hill
4) Commercial Methods of Analysis by Foster Dee Sneel and Frank M. Griffin, Mc Graw Hill Book Co.
5) Environmental Chemistry by Anil Kumar De, Wiley Eastern Ltd.
6) Environmental Analysis by S.M Khopkar (IIT Bombay)
7) Environmental Air Analysis by Trivedi and Kudesia, Akashdeep Pub.

20CY5407-ORGANIC SYNTHESIS–II

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5407

CO#	Course Outcome	PO	BTL
CO1	Explain the properties of Oxidising agents and reducing agents	PO-1,4	3
CO2	ıstrate reaction mechanisms for some Organosilane related compounds	PO-2,3	3
CO3	Explain theory and principles involved in Disconnection approach and principals of Phase transfer catalysis	PO-1,3	3
CO4	Explain about the Retrosynthesis and applied to various cyclic organic molecules	PO-1,5	3
CO5	To carryout multistep synthesis of organic molecules	PO-2,4	3

Provide the knowledge of organosilanes, oxidizing, reducing properties and retro synthesis of various cyclic organic molecules.

Syllabus:

Organo silanes, Synthetic applications of trimethylsilyl chloride dimethyl-t-butylsilyl chloride, trimetthylsilyl cyanide, trimethylsilyl iodide and trimethylsilyl triflate, synthetic applications of silyl carbanion and B-silyl carbonium ions.

Oxidations of hydrocarbons, alkenes, alcohols, aldehydes and ketones. Oxidative coupling reactions by the use of Pb $(OAC)_4$, NBs, CRO_3, SeO_2, $NinO_2$ Dc-alkoxyluphonium 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.

Design of Organic Synthesis: Retrosynthesis the disconnection approach-basic principles convergent and linear synthesis.

Phase transfer catalysis-Principle and applications.

Experiments:

S. No	Name of the Experiment

1	Synthesis of 1- Bromo-2- Bromo Methyl Naphthalene
2	Synthesis of Sulphanilide from Acetanilide
3	Synthesis of Hippuric acid
4	Synthesis of 7- Hydroxy- 4- Methyl Coumarin
5	Synthesis of 1,3,5- Tri Bromo Benzene
6	Synthesis of 2,4,6- Tri bromo Aniline
7	Synthesis of Anthracene- Maleic anhydride adduct
8	Synthesis of Meta dinitro Benzene
9	Synthesis of Meta Nitro Aniline
10	Synthesis of Azalactone

TEXTBOOKS:

1) Some Modern Methods of Organic Synthesis by W. Carothers, Third Edition, Cambridge University Press, Cambridge, 1988.
2) Organic Synthesis: The disconnection approach by S. Warrant John Wiley & sons, New York, 1984.
3) Modern Synthetic Reactions by Herbet O. Horase, Second Edition, W.A. Benzamine Inc. Menio Park, California, 1972.
4) Organic Synthesis viz Boranes by Herbet C. Brown Gray, W. Kramer Alan B. Levy and M. Mark Midland John Wiely &. Sons, New York, 1975.
5) Textbook of Practical Organic Chemistry by Vogel
6) Textbook of Practical Organic Chemistry by Mann & Sunders

20CY5408-ADVANCE HETEROCYCLIC CHEMISTRY

L-T-P-S : 4-0-6-0

Credits : 7

Contact Hours : 10

Course outcomes of 20CY5408

CO#	Course Outcome	PO	BTL
CO1	To classify, synthesis and reactivity of simple heterocyclic aromatic and non-aromatic compounds as electron deficient or electron rich and explain their reactivity based on these properties	PO-1,2	3
CO2	ply the aromaticity, reactivity and synthesis of Five, six membered heterocyclic compounds with two hetero atoms	PO-1,2	3
CO3	Apply the aromaticity, reactivity and synthesis of heterocyclic compounds with more than hetero atoms	PO-2,3	3
CO4	Apply the synthesis, structure, reactivity and stability of larger ring heterocyclics	PO-1,3,4	3
CO5	Ability to synthesize heterocyclic compounds	PO-2,4	3

Provide the knowledge of synthesis, structural reactivity of heterocyclic compounds.

Syllabus:

Nomenclature (Hantzsch Widman System), spectral characteristics, reactivity and aromaticity of monocyclic, fused and bridged heterocycles. Nonaromatic heterocycles. Different types of strains, interactions and conformational aspects on nonaromatic heterocycles. Synthesis, reactivity and importance of the following ring systems. Azirines, Oxaranes, Thiiranes, Diazirenes, Diaziridines, Azetidines. Five and six-membered heterocycles with two hetero atoms: Synthesis, reactivity, aromatic character and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Pyrimidine, Pyrazine, Oxazine, and Thiazine.

Heterocycles with more than two hetero atoms: Synthesis, reactivity, aromatic character and importance of the following heterocycles: Triazoles, Oxadiazoles, Thiadiazoles, Triazines. Larger ring and other heterocycles: Synthesis and reactivity of Azepines, Oxepines and Thiepines.

Synthesis and rearrangement of Diazepines. Synthesis of Benzoazepines, Benzodiazepines, Benzooxepines, Benzothiepines, Azocines, and Azonines. Banzanellated azoles and dipolar structures: Banzanellated azoles: Synthesis and reactivity of Benzimidazoles, Benzoxazoles and Benzothiazoles. Heterocyles with Ring-Junction nitrogen: Synthesis and reactivity of Quinolizines, Indolizines and Imidazopyridines. Heterocycles with dipolar structures.

Betaines: Formation, aromaticity and reactivity of pyridine-N-oxides and pyridinium imides. Mesoionic heterocycles: Synthesis and aromaticity of sydnones and 1,3- dipolar addition reaction of mesoionic heterocycles.

Experiments:

S. No	Name of the Experiment

1	Synthesis of Thiepine
2	Synthesis of benzophenone
3	Synthesis of diazotized compounds (Triazoles)
4	Synthesis of1,2,4- Triazole
5	Synthesis of Isoxazole
6	Synthesis of Ergotamine (Indole based alkaloid)
7	Synthesis of Cinchonine
8	Synthesis of Quinine
9	Synthesis of Prima Quinine
10	Synthesis of Acetazolamide

TEXT BOOKS:

1) Heterocyclic Chemistry by T.Gilchrist
2) An introduction to the Chemistry of heterocyclic compounds by R.M.Acheson
3) Heterocyclic Chemistry by J.A.Joule&K.Mills
4) Principles of Modern Heterocyclie Chemistry by A.Paquette
5) Heterocyclic Chemistry by J,A.Joule& Smith
6) Handbook of Heterocyclic Chemistry by A.R.Katritzky
7) Aromatic character and aromaticity by G.M.Badger
8) Non-benzenoid aromatic compounds by D.Ginsberg
9) Nonbenzenoid compounds by Lloy

PROF.ELECTIVES

Analytical Chemistry Electives

20CY5304: SEPARATION TECHNIQUES

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5304

CO#	Course Outcome	PO	BTL

CO1	Describe the theory and principles of chromatographic separation.	PO1,PO5	3
CO2	Discuss principle of paper chromatography, different techniques and its modification to thin layer chromatography for analytical applications	PO1,PO5	3
CO3	Describe the ION exchange & ION chromatography	PO1,PO5	3
CO4	Explain the Liquid-Liquid chromatographic techniques, instrumentation and Applications.	PO1,PO5	3

Provide in depth knowledge of basic principles of chromatography and its instrumentation.

Syllabus:

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. **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. **Thin layer chromatography:** principle, chromatographic media-coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, 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. **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.

TEXT BOOKS:

1. Techniques and practice of Chromatography by R.P.W Scott, Marel Dekker Inc., New York
2. Separation methods by M.N. Sastri, Himalaya Publishing Company, Mumbai

REFERENCE BOOKS:

1. Chromatography by E. Helfman, Van Nostrand and Reinhold, New York
2. Chromatography by E. Lederer and M. Lederer, Elsevier, Amsterdam.
3. Chemical separation methods by John A Dean, Von Nostrand Reinhold, New York
4. Techniques and practice of Chromatography by R.P.W Scott, Marel Dekker Inc., New York
5. Basic Gas Chromatography by H.M Mc Nair and J. M. Miller, John Wiley, New York
6. Analytical Gas Chromatography by W. Jeumings, Academic Press, New York
7. Practice of HPLC by H. Eugelhardt (ed), Springer Verrag, Berrin

20CY5305-APPLICATIONS OF CHEMICAL SPECTROSCOPY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5305

CO#	Course Outcome	PO	BTL
CO1	scuss the fundamental principles of basic characterization techniques	PO-1,4	3
CO2	ply NMR techniques in the elucidation of complex molecules	PSO-1,2	3
CO3	termination of elemental or isotopic signature of sample	PO-2,3	3
CO4	ntification of chemical structure of a molecule by spectroscopy	PO-3,4,5	3

Provide the knowledge in fundamental principles of basic characterization techniques like NMR, elemental spectroscopic methods.

Syllabus:

Infrared Spectroscopy: Fourier Transform infrared spectroscopy: Applications. Ultraviolet and

visible spectroscopy: Applications of UV-Visible spectroscopy, Nuclear Magnetic Resonance Spectroscopy:

Applications of AB, AX, ABC, AMX Systems; double resonance, Lanthanide shift reagents; Carbon-13 NMR spectroscopy; COSY, NOE, FT NMR, 2D NMR and CIDNP.

Mass Spectrometry: Fragmentation: McLafferty rearrangement. Particle bombardment methods, PD, SIMS, FAB, Gas chromatography-mass spectrometry, MS data system.

Combined Applications: UV, IR, NMR and Mass in the elucidation of molecular structure.

TEXT BOOKS:

1) Introduction to Spectroscopy by Donald L. Pavia and Gary M Lanyman, 3rd Edition, Thompson Publishers, 2008.
2) Spectroscopy of Organic Compounds by P.S. Kalsi, 6th Edition, New Age International Publishers, 2004.
3) Elementary Organic Spectroscopy-Principles and Applications by Y. R. Sharma, 5th Edition, S. Chand Publishers, 2007.

20CY5306- BIO ANALYTICAL CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5306

CO#	Course Outcome	PO	BTL
CO1	Understand the basic principles of bioanalysis	PO-2,4	3
CO2	plain the basic concept of Radiochemical Manometric and Calorimetric	PO-1,3	3
CO3	Apply electrophoretic method in bioassay	PO-2,3	3
CO4	Explain and apply biosensors in biomolecule analysis	PO-2,3,5	3

Provide in depth knowledge of bio assaying & bio chemical analysis.

Syllabus:

Relevance of BioAssaying and Biochemical Analysis; Spectroscopic methods and fluorimetric methods; Quantitation of Enzymes and Optical Methods of Detection of Enzymes; Electroanalytical Methods of Enzyme Detection.

Radiochemical, Manometric, Calorimetric and Other Miscellaneous Methods; Immobilization Methods; Methods; Mass Spectrometry of Biomolecules, Matrix-assisted laser desorption/ionization (MALDI).

Chromatography of macromolecular biomolecules; Mass Transfer Methods; Centrifugation and

Sedimentation Methods; Electrophoretic Methods.

Electrochemical Sensors and BioSensors in Bioanalysis; Immuno assaying.

TEXT BOOKS:

1) Bio Analytical Chemistry by Susan R. Mikkelsen and Eduardo Cortón, John Wiley & Sons Inc, 2004
2) Bio Analytical Chemistry by Andreas Manz and Nicole Pamme, Imperial College Press, 2012

20CY5307-ENVIRONMENTAL CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5307

CO#	Course Outcome	PO	BTL
CO1	Understand green house effect concept	PO-2,5	3
CO2	Employ various sampling techniques for air sampling	PO-2,3,5	3
CO3	Understand various pollution monitoring techniques	PO-1,3,4	3
CO4	Explain environmental Impact Assessment process	PO-1,2,5	3

Provide in depth knowledge of pollution and types pollution and its effects.

Syllabus:

Chemistry of Atmosphere: Composition and structure of atmosphere, Greenhouse effect, Ozone depletion, Photochemical smog, Air sampling techniques, Sources, effects and monitoring of air pollutants by Instrumental methods.

Control of air pollution, Water Pollution, Different types of water pollutants, Sources, characteristics and effects of water pollutants, Monitoring of Water Pollutants.

Treatment of Municipal Waste Water, Treatment of Industrial Waste Water, Environmental Impact Assessment process in India.

Basic principles of Green Chemistry

TEXT BOOKS:

1) Fundamental Concepts of Environmental Chemistry by G.S. Sodhi, 2nd Edition, Narosa publishing House, 2005
2) New Trends in Green Chemistry by V.K. Ahluwalia, M. Kidwai, Anamaya publishers, 2004.

20CY5308-SURFACE ANALYTICAL TECHNIQUES

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5308

CO#	Course Outcome	PO	BTL
CO1	derstand the basic principles of Electron Spectroscopy for Chemical Analysis	PO-1,2	3
CO2	nploy Surface enhanced Raman Spectroscopy (SERS) in mapping and imaging	PO-2,3,6	3
CO3	scribe Electron Energy Loss Spectroscopy	PSO-1,2	3
CO4	pply Low Energy Ion Scattering Spectroscopy for Surface structural analysis	PO-1, 4,5	3

Providing the knowledge of principles of Raman spectroscopy, EELS and Low Energy Ion Scattering Spectroscopy for Surface structural analysis.

Syllabus:

Electron Spectroscopy for Chemical Analysis (ESCA): Principles, Instrumentation, and Analytical Applications. Auger electron spectroscopy: Principles, Instrumentation, Applications. Secondary ion mass spectrometry (SIMS): Principles, Instrumentation, Applications.

Surface enhanced Raman Spectroscopy (SERS): Principles, Instrumentation, Nanoparticulate SERS substrates, Surface enhanced resonance Raman scattering (SERRS), SERRS of Ag and Au metal colloids, Thin solid films, Langmuir-Blodgett Monolayers, SERRS, Mapping and imaging, Applications.

Electron Energy Loss Spectroscopy (EELS): Principles, Instrumentation, Applications. Electron Microprobe analysis: Principles, Instrumentation, Analysis of semiconductors and crystalline materials, Applications.

Low Energy Ion Scattering Spectroscopy: Principle, Instrumentation, Surface structural analysis

TEXT BOOKS:

1) Surface Analysis Methods in Materials Science by D J O'Connor, Brett A Sexton, Roger S C Smart (Eds), 2nd Edition, Springer, 2010.
2) Surface Analysis: The Principal Techniques by John C Vikerman, Ian Gilmore (Eds.), 2nd Edition, Wiley, 2009.
3) An Introduction to Surface Analysis by John F Watts and John Wolstenholme, 2nd Edition, Wiley VCH, 2011.

20CY5309-ANALYSIS OF FOOD AND DRUGS

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5309

CO#	Course Outcome	PO	BTL
CO1	nderstand the importance of food analysis	PO-1,2	3
CO2	etermination of various nutrients in food samples	PO-1, 3,6	3
CO3	entification of food adulterants	PO-1,2,4	3
CO4	nploy quantitative methods of analysis in drugs in biological fluids	PO-1,5,6	3

Provide the knowledge of analyzing food samples and identification of food adulteration and analysis of drugs.

Syllabus:

Food Analysis: Importance of food analysis, food adulterants, Analysis of Chemical Additives in foods : Division of colour additives, Chromatographic identification of colours, and quantitative estimation of added dyes in foods (Titanium Trichloride Method) **Carbohydrates:** Definition, classification, and functions, Analysis of carbohydrates from food sample by different method i) volumetric determination by Fehling's solution, ii) Colorimetric analysis of carbohydrates by Folin Wu method, Nelson Somyogi method, iii) total carbohydrates by Anthrone method. **Proteins:** Definitions and functions, Analysis of proteins by Kjedahl's method, analysis of protein by Lowry method, Estimation of amino acids by colorimetric method, Estimation of food grain for methionine content. **Determination of food preservatives:** Definition, SO2 legistration and determination by Tanners method, Nitrate and nitrites legistration and determination, boric acid legistration and determination, Benzoic acid legistration and determination, 4-hydroxybenzoate legistration and determination, ascorbic acid legistration and determination, Analysis of Butylated Hydroxy Toluene (BHT) (Spectrophotometry). **Analysis of Lipids:** Estimation of oil in oilseeds, Estimation of free fatty acids, Saponification value of oils, iodine value, Determination of acid value of oil, determination of peroxide value of oil, Identification and quantification of fatty acids. **Analysis of milk and milk products:** Composition of milk, analysis of milk with respect to pH, acidity, fates, casein content, lactose content, mineral content, adulteration of milk. **Analysis of drugs:** General idea of the properties of drugs for their characterization and quantification. Qualitative and quantitative estimation of pharmaceutical drugs (Antibiotics, anticancer etc.) in biological fluids using spectroscopic and electrochemical methods. Aspirin,paracetamol and codein in APC tablets (NMR), Phenobarbitone in tablets (IR), pivolic acid in dipivefrin eye drops(GC), Assay of hydrocortisone cream. (HPLC). Impurity profiling of Propranolol (GC-MS), famotidine (LC-MS).

TEXT BOOKS:

1) Food Analysis, Food Science Texts Series by S Suzanne Nielsen, 3rd Edition, Springer, 2003.
2) Pharmaceutical Analysis by D Lee and M Webb, 1st Edition, Blackwell, 2003.
3) Forensic pharmacy by B.S Kuchekar, and A.M Khadatare Nirali Prakshan)
4) Shreves' Chemical Process Industries fifth edition by George Austin Mg Graw Hill
5) Practical Pharmceutical Chemistry by Becket
6) Basic Analytical Toxicology Published by WHO, By R. J. Flanagan, R. A. Braithwaite, S. S. BrownAvailable Online
7) Biochemical Methods, Third Edition, By S Sadashivan, A.Manickam; NEW AGE International (P) limited, PIBLICATION
8) Pearson's chemical analysis of food

ORGANIC CHEMISTRY ELECTIVES

20CY5313-PHOTO CHEMISTRY AND PERICYCLIC REACTIONS

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5313

CO#	Course Outcome	PO	BTL
CO1	Ability to apply nucleophillic / electrophillic pathway to synthesize new organic entities	PO-2,3	3
CO2	Apply aromatic nucleophillic and free radical substitution mechanisms in new chain linkages	PO-1,3	3
CO3	Understand organic reaction mechanism in terms of pericyclic reactions at different conditions.	PO-3,4	3
CO4	Ability to explain pericyclic reactions involved in various organic rearrangement reactions.	PO-1,5,6	3

Provide the Knowledge in the most important simple heterocyclic ring systems, pericyclic ring systems,nucleophillic and free radical mechanisms.

Syllabus:

CO-I: Organic Photo chemistry: Photo chemical energy plank Condon Principle, Jabionski diagram singlet and triplet states, dissipation of photochemical energy, photosensitization, quenching, quantum efficiency and quantum yield, experimental methods of photochemistry. Photochemistry of carbonyl compounds n- n*π=π ,π– transitions Norrish type I and Norrish type II cleavages, patterno-Buchi reaction.

CO-II: Photo reduction photochemistry of enone - Hydrogen abstraction, rearrangement of α ; ß - unsaturated ketones and cyclo hexadienes, Photochemistry of p- Benzoquinones, photochemistryof unsaturated systems - Olefins, cis trans Isomerisation and dimerization

hydrogen abstractionsand, addition acetylenes dimerisation, dienes - Photochemistry of 1,3 butadienes (2+2) additionsleading to cage structures photochemistry .of cyclohexadienes.Photochemistry of aromatic compounds - Excited state of benzene its 1,2-1,3 1-4 additions,photo Fries rearrangements, photofries reactions of anilides, photosubstitution reactions ofbermene derivatives. Photochemistry of pyridinium yields, pyrolysis of nitrites esters and barton reaction.

CO-III: Molecular orbital symmetry, frontier orbitals of ethylene, 1,3 Butadiene, 1,3,5-Hexatriene, allylsystem, classfication of pericyclic reactions FMO approach, Woodwrd- Hoffman correlationdiagram method and perturbation of molecular (PMO) approach for the explanation of pericyclicreactions under thermal and photochemical conditions.Electrocyclic Reactions: Conrotatory and disotatory motions (4n) and (4n+2), allyl systems andsecondary effects.

Cycloadditions: Antarafacial and suprafacial additions, notation. of cycloadditions, (4n) and(4n+2) systems with a greater emphasis on (2+2) and (4+4) - cycloadditions, (2+2) - additionsof ketones secondary effects of substitutes on the rates of cycioadditions and chelotropicreactions.

CO-IV: FMO approach and perturbation of molecular (PMO) approach for the explanation of sigmatropic rearrgements under thermal and photochemical conditions. suprafacial and antarafacialshifts of H Sigmatropic shift involving carbon moieties, retention and inversion ofconfigurations, (3.3) and (5.5) sigmatropic rearrangements detailed treatment of Claisen andCope rearrangements fluxional tautomerism, aza-Cope rearrangements and Barton reaction

TEXT BOOKS:

1) Advanced Organic Chemistry: Reactions Mechanisms and Structure by Jerry March, Mc.Graw Hill and Kogakush.
2) Molecular reactions and Photochemistry by Charles Dupey and O. Chapman, Prentice Hall.
3) Pericyclic reactions by S.N. Mukharji, Mcmilan.
4) The modern structural theory in Organic Chemistry by L.N.Ferguson, Pretice Hall
5) Physical Organic Chemistry by Jack Hine, Mc. Graw Hill
6) Mechanisms and Theory in Organic Chemistry by T.H. Lowery and K.S. Rich gardson.

20CY5314-ORGANOMETALLIC CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5314

CO#	Course Outcome	PO	BTL
CO1	Explain the alkyls and aryls of transition metals.	PO-2,3	3
CO2	Describe the transition metal Π-Complexes.	PSO-1,2	3
CO3	Discuss the Homogeneous catalysis	PO-1,2,3	3
CO4	Demonstrate the fluxional organo metallic compounds.	PO-1,2,5	3

To have basic knowledge of principles and applications of organometallic compounds.

Syllabus:

Organometallic compounds (OMCs): Classification, Types, Synthetic routes, and stability-Metal alkyl-metal aryl complexes, Metal-Carbon Multiple Bonds: Metal carbenes-Alkylidenes, and metal carbines-alkylidynes; low valentcarbenes and carbynes-synthesis, nature of bond structural characteristics.

OMCs (Transition Metal Π-Complexes):TMCs with unsaturated organic molecules,alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes-preparations, properties,nature of bonding and structural features.

Important reactionsin organic synthesis relating to nucleophilic andelectrophilic attack on ligands.

Catalysis: Stoichiometric reactions – Homogeneous: Catalytic Hydrogenation and olefin oxidation, Heterogenous: Metathesis, C-H bondactivation, Ziegler-Natta polymerization of olefins, catalytic reactions involving CO such as hydro carbonylation of olefins (oxo reaction), oxopalladation reactions.

Applications of Organometallic Reagents (OMRs) as catalysts for C-C and C-N:

Grignard reagents, Organo-Cu, Zn, Li reagents etc.Carbon-carbon bond formation through coupling reactions - Heck, Suzuki, Stille and Sonogoshira, Oxidative addition, reductive elimination, Migratory insertion reactions, Ligand substitution reactions

Fluxoinalityand dynamic equilibria in OMCssuch as n2-olefin, n3-allyl and dienyl complexes.

TEXT BOOKS:

1) Advanced Organic Chemistry by F.A. Carey and R.J Sundberg, Plenum.
2) Structure and Mechanism in Organic Chemistry by C.K.Inglod, Cornell University Press.
3) Organic Chemistry by R.T Morrison and R.N. Boyd, Prentice - Hall.
4) Modern Organic Reactions by H.O. House, Benjamin.

20CY5315 -BIO ORGANIC CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5315

CO#	Course Outcome	PO	BTL

CO1	Recognize the structure and function of Carbohydrates, Lipids, Amino acids, proteins, nucleotides and nucleic acids.	PO-1,2	3
CO2	Understand the reactions of the major catabolic and anabolic pathways of carbohydrates, Lipids, Amino acids, metabolism.	PO-1,3	3
CO3	Understand the signaling pathways of Lipids and Amino acids.	PO-2,3	3
CO4	Demonstrate the chemistry and kinetics of enzymes.	PO-1,5,6	3

Bio-organic chemistry seeks to obtain these substances in a chemically pure state, determine their structure, synthesize them, discover the relationship between their structure and biological properties, and study the **chemical** aspects of the mechanism of the biological action of biopolymers and of natural and synthetic polymers.

Syllabus:

Amino acids, peptides and proteins Amino acids: acid base properties, isoelectric point, separation, resolution of racemic mixtures of amino acids, asymmetric synthesis Peptide bonds: peptide secondary structures and their stabilization, strategies for peptide synthesis, automated peptide synthesis.

Primary, secondary, tertiary and quaternary structures, protein denaturation, natural β-amino acids and β-peptides; β-turn peptidomimetics, β-lactam based peptidomimetics.

Enzymes Classification of enzymes, enzyme catalysis and kinetics, nucleophilic acid, base and metal-ion catalysis, the catalytic triad, mechanisms of carboxypeptidase A, serine proteases and lysozyme, enzyme inhibition and drug design.

Nucleosides and nucleotides, conformation of sugar-phosphate backbone, hydrogen bonding by bases, the double helix, A, B, and Z double helices.

TEXTBOOKS:

1. Organic Chemistry by P. Y. Bruice, 5th Ed., Pearson, 2014.
2) Introduction to Bioorganic Chemistry and Chemical Biology by D.V. Vranken and G.A. Weiss, 1st Ed., Garland Science, 2012.
3) Essentials of Carbohydrate Chemistry and Biochemistry by T. K. Lindhorst, 3rd Ed., Wiley 2007.
4) Peptides: Chemistry and Biology by N. Sewald and H.D Jakubke, 2nd Ed. Wiley, 2009.

20CY5316-GREEN & SUSTAINABLE CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5316

CO#	Course Outcome	PO	BTL
CO1	Explain basic principles of green and sustainable chemistry.	PO-2,4	3
CO2	Understand the Stoichiometric calculations and relate them to green process metrics.	PO-1,3,4	3
CO3	Review the principles of catalysis, photochemistry and other interesting processes from the view point of Green Chemistry.	PO-3,6	3
CO4	Apply alternative solvent media and energy sources for chemical processes.	PO-2,3,5	3

Green chemistry aims to design and produce cost-competitive **chemical** products and processes that attain the highest level of the pollution-prevention hierarchy by reducing pollution at its source.

Syllabus:

Principles of Green Chemistry, Concept of atom economy, Tools of Green Chemistry: Alternative feedstocks/starting materials, Reagents, Solvents, Product/target molecules, Catalysis and process analytical chemistry. Evaluation of chemical product or process for its effect on human health and environment.

Evaluation of reaction types and methods to design safer chemicals. Evaluating the effects of Chemistry: Toxicity to humans, Toxicity to wildlife, Effects on local environment, Global environmental effects. Planning a green synthesis.

Applications of Green Chemistry: Green synthesis of Ibuprofen, Design and application of surfactants for carbon dioxide for precision cleaning in manufacturing and service industries, Polyester regeneration technology, Microbes as environmentally benign synthetic catalysts, Environmentally safe marine antifoulant.

Biodegradable polyaspartate polymers for inhibitors and dispersing agents, Recent applications in green chemistry.

TEXT BOOKS:

1) Introduction to Industrial Chemistry by Howard, W.L., Wiley-Interscience.

2) Industrial Organic Chemistry by Weissermel, K., and Arpe, H.J., 3rd ed.

3) Green Chemistry and Catalysis by Sheldon, R.A., Arends, I., and Hannefed, U., Wiley-VCH

Verlag GmbH and Co.

4) Green Chemistry Frontiers in Benign Chemical Synthesis and Processes by Anastas, P., and

Williamson, T. C., Oxford University Press.

5) New Trends in Green Chemistry by Ahluwalia, V. K., and Kidwai, M., Anamaya Publishers

20CY5317-SUPRAMOLECULAR CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5317

CO#	Course Outcome	PO	BTL
CO1	Explain concepts, properties and reactions of supra molecular chemistry.	PO-2,3	3
CO2	Cation-binding hosts and binding of anions and neutral molecules.	PO-1,4	3
CO3	Apply the supra molecular chemistry in biology	PO-2,4	3
CO4	Apply the supra molecular chemistry in Chemistry	PO-1,2,5	3

Syllabus:

Concepts of Supramolecular Chemistry: Definition: From molecular to Supramolecular**.**Nature of supramolecular interactions (hydrogen bonding, metal coordination, hydrophobic forces, van der Waals forces, pi–pi interactions and electrostatic effects).Host-guest interaction.Molecular recognition.Types of recognition. Self-assembly in biological systems (including DNA and enzymes)

Cation-binding Hosts:Concepts: Macrocyclic and template effects. Cation receptors: Crown ethers, Cryptands, Spherands, Calixarens. Selectivity of cation complexation . ***Binding of Anions and Neutral molecules:*** Concepts, Anion host design, Anion receptors. Shape and selectivity, Neutral receptors, clathrates, cavitands, cyclodextrins, cyclophanes.

Applications of Supramolecular Chemistry in Biology: Biological mimics, Metalloproteins, Membrane transport, Ionophores, Heme analogues, Photosynthesis, Oxygen transport, Metalloenzymes

Other applications of Supramolecular Chemistry:Supramolecular reactivity and catalysis, Supramolecular devices and sensors,Nanoscience applications,Drug delivery and sensing

TEXT BOOKS:

1) Advanced Text Book on Food and Nutrition by Swaminathan M. Volume I and II Printing and Publishing CO., Ltd., Bangalore. 1993.

2) Text Book on Food Chemistry by Swaminathan M. Printing and Publishing CO., Ltd.,

Bangalore. 1993.
3) Food science by Norman N. Potter, CBS publishers and distributors New Delhi. 1994.
4) Food Chemistry by Lillian Hoagol and Meyer CBS publishers and distributors, New Delhi. 1994.

20CY5318-MEDICINAL CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5318

CO#	Course Outcome	PO	BTL
CO1	To understand the drug metabolic pathways adverse affects and the therapeutic value of drugs.	PO-2,4	3
CO2	To know the structure activity relationship of the different class of drugs.	PO-1,3	3
CO3	To describe the mechanisms pathways of different class of medicinal compounds.	PSO-1,2	3
CO4	To understand the chemistry of drugs with respect to their pharmacological activity	PO-1,2,3	3

Provide the in depth knowledge of drug metabolic pathways, adverse effects and pharmacology activity.

Syllabus:

Classification and Nomenclature of Drugs. Medicinal chemistry: Important terminology in medicinal chemistry. Classification and Nomenclature of Drugs. Concept of prodrugs and soft drugs. a) Prodrugs: i) Prodrugs designing, types of prodrugs. Prodrug formation of compounds containing various chemical groups, Prodrugs and drug delivery system b) Soft drugs: i) Soft drug concept ii) Properties of soft drug.

Theories of drug activity: i) Occupancy theory, ii) Rate theory, iii) Induced theory. QSAR method: Introduction, Methods used in QSAR studies, Hansch method, Free-Wilson method, Advantages and disadvantages of free approach, Computer based methods of QSAR related to receptor binding, Physico-Chemical properties, Lipophilicity, Electronic parameters, Steric substituent constants, Experimental determination of partition coefficients.

Structure based drug design: i) Process of structure based drug design, ii) Deactivation of certain drug, iii) Determination of the structure of the protein, iv) Design of inhibitors. Molecular modelling using computers. i) Introduction ii) Uses of molecular modeling: a) Manual use, b)

Further-computer programming, c)X-ray crystallography. Pharmaco kinetics and Pharamodynamics. A] Pharmacokinetics: a)Drug absorption, b) Distribution, c)Elimination, d) Disposition. B] Pharmacodynamics. a) Introduction, Elementary treatment of enzyme inhibition, b) Membrane active drug, c) Sulphonamides Mechanism of action of following drugs: Action of CNS disorder, inflammation, cardiac dysfunction. MC-4: Drug metabolism.

TEXT BOOKS:

1. Burger's Medicinal Chemistry and Drug Discovery by M.E. Wolf, Vol. I, John Wiley.
2. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.

20CY5403 – DISSERTATION WITH RESEARCH PUBLICATION

L-T-P-S : 0-0-12

Credits : 6

Contact Hours : 12

20CY5404- CHROMATOGRAPHIC TECHNIQUES & METHOD VALIDATION

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5404

CO#	Course Outcome	PO	BTL
CO1	Discuss about the GC & GC-MS Techniques and its applications	PO-1,3,4	3
CO2	Discuss the Liquid-Liquid partition chromatography and HPLC techniques and their applications	PO-1,3	3
CO3	Apply LC-MS and inorganic molecular sieves for various purposes.	PO-3,5	3
CO4	Develop analytical methods to solve industrial problems and solvent extraction as significant analytical method of purification and separation.	PO-2,3,6	3

Provide in depth knowledge of various types of chromatography techniques and development of analytical methods.

Syllabus:

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.

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.

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.

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, regularatory 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

TEXT BOOKS:

1) Techniques and practice of Chromatography by R.P.W Scott, Marel Dekker Inc., New York.
2) Separation methods by M.N Sastri, Himalaya Publishing Company, Mumbai.

REFERENCE BOOKS:

1) Chromatography by E. Helfman, Van Nostrand, Reinhold, New York
2) Chromatography by E. Lederer and M. Lederer, Elsevier, Amsterdam.
3) Chemical separation methods by John A Dean, Von Nostrand Reinhold, New York.
4) Techniques and practice of Chromatography by R.P.W Scott, Marel Dekker Inc., New York.
5) Thin layer chromatography by E.Stahl, Academic Press, New York

20CY5405- CLASSICAL METHODS OF ANALYSIS-II

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5405

CO#	Course Outcome	PO	BTL
CO1	Understand the principles of Quality control in Analytical Chemistry	PO-2,4	3
CO2	Explain the various concepts of decomposition techniques in analysis	PO-2,3	3
CO3	Illustrate, discuss and apply the various principles behind the various Red-ox systems involved in the classical Volumetric methods of Analysis.	PO-1,3,5	3
CO4	Explain the various principles involved in the analysis of Organic Functional Groups	PO-1, 4,5	3

Provide in depth knowledge of principles of quality control, concepts of decomposition techniques.

Syllabus:

Precipitation methods-I Crystal habit and super saturation, nucleation and crystal growth, homogeneous and heterogeneous nucleation, solubility and particle size, colloids, completeness of precipitation , effect of excess precipitant, pH, complex formation, temperature, purity of precipitates, aging. **Co-precipitation and post precipitation :** theory of adsorption of salts having an ion in common with the main precipitate, co-precipitation in colloidal precipitates, adsorption of solvents, mixed crystal formation by occlusion and entrapment, re-precipitation with examples, Post-precipitation – theory of post-precipitation, examples of post-precipitation, conditions for obtaining pure and quantitative precipitates. **Precipitation Titrations**: Principle, Indicators for precipitation titrations, determination of halides.

Precipitation methods-II

Precipitation from Homogeneous Solution (PFHS): theory of PFHS, methods of PFHS – increase in pH, decrease in pH, cation release, anion release, reagent synthesis, change in oxidation state, photochemical reactions, precipitation from mixed solvents Applications of PFHS methods. **Gravimetric determinations:** nature of species, preparation of solutions, limitations, interferences, inorganic precipitants-chloride and sulphate, organic precipitants dimethyl glyoxime (DMG), oxine, benzidine, salicylaldoxime, benzoin oxime, sodium tetraphenyl boron,

tetraphenyl arsonium chloride. **Electro-gravimetric analysis:** principle, important terms in electrogravimetry, decomposition voltage or decomposition potential, over voltage and their importance, instrumentation, electrolysis at constant current, determination of Cu^{2+} by constant current electrolysis, electrolysis at controlled potentials, determination of Cu, Pb, Sn in brass and bronze by controlled potential electrolysis.

Reductant system – Principles and applications in analysis: Analytical chemistry of some selected reductant systems – formal, standard and normal potentials in various media, stability of the solutions, species responsible for the reduction properties, standardization, requirement for the selection of the reductants, selection of suitable indicators for various reductant systems: Inorganic Systems – Cr (II), V (II), Ti (III), Sn (II), Fe (II) in H_3PO_4 and hydrazine. Organic Systems: hydroquinone and Ascorbic acid. **Analysis of some selected Drugs:** Basic considerations of drugs – Classification **Determination** of the following Drugs: Acetyl salicylic acid (Antipyretic–Analgesic)**,** Testosterone, progesterone and cortisone (Steroids and corticoids)**,** Sulphadiazine (sulphadrugs)**,** Phenobarbitone (Barbituric acid derivatives)**,** Chloramphenicol, Benzyl penicillin and Tetracycline (Antibiotics).

Determination of Thiamine (B1), Riboflavin (B2) and ascorbic acid (c) [Vitamins] Isoniazid (Antimicrobacterial agents)**,** Methlydopa (Antihypertensive agents) Metronidazole (Antiamoebic agents).

TEXT BOOKS:

1) Technical methods of analysis by Griffin, Mc Graw Hill Book Co.
2) **C**hemical Separation and measurements by D.G Peterseti, John M.Haves Sanders Co.
3) Chemical analysis by H.A Laitinan, Mc Graw Hill Book Co.
4) Newer redox titrants by Berka, Zyka and Vulterin, Pergamon Press
5) Volumetric Analysis, Vol III by I.M Kolthoff and R.Belvher, Interscience Public, New York
6) Vogel's Text Book of Inorganic Quantitative Analysis by J.Bassett et al, ELBS
7) Pharmaceutical analysis by T. Higuchi, Brochmann hausfen

REFERENCE BOOKS:

1) Analytical Chemistry, An Introduction, D.A Skoog, D.M West and F.J Holler, Sanders College Publishing, New York

Quantitative Chemical Analysis by I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London

20CY5406- CHEMO SENSORS AND BODY FLUID ANALYSIS

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5406

CO#	Course Outcome	PO	BTL
CO1	nderstand the principles of various chemical sensors	PO-2,3	3
CO2	nalysis of biomolecules in body fluids	PO-1,2,3	3
CO3	mploy analytical techniques in the determination of vitamins	PO-2,3,6	3
CO4	pply Immuno analytical Techniques in clinical analysis	PO-3,4,5	3

Provide the knowledge of immuno analytical techniques and these techniques applicable to various bio molecules in the body.

Syllabus:

Chemical Sensors: Introduction, definitions, Classification of chemical sensors, descriptions of chemical sensors (electrochemical sensors, potentiometric sensors, voltametric chemical sensors, sensors based on conducting properties), Optical sensors (light guides, the evanescent wave, design of fiber optic sensor, indicator mediated sensor), Calorimetric sensors (catalytic gas sensor, thermal conductivity sensor), mass sensor (piezoelectric quartz crystal resonator, surface acostic wave sensor). **Biosensors in analysis:** Introduction, producing biological surface, Achievement of biotransduction (amperometric, potentiometric, optical).

Collection of Specimens: Blood: Collection of Blood specimens, storage and preservation, Urine: Collection of Urine, physical characteristics of urea, preservation and storage, Faeces: Collection and preservation. **Analysis of Blood and urine**: Determination of blood and plasma glucose by glucose oxidase method, Determination of urine for glucose, Determination of ketone bodies in blood, Determination of serum creatinin, estimation of serum bilirubin, Estimation of serum cholesterol, determination of blood hemoglobin, Determination of urea in urine by urease method and by direct colorimetry.

Determination of vitamins in body fluid:

Classification of vitamins with example, Each vitamin must be explained with respect of functions, deficiency diseases, daily requirement, and analytical method i) Retinol (determination of retinol and serum carotene in serum using TFA), Vit D3 (Cholecalciferol), Vitamin E (Tocopherols, Determination of serum tocopherol by spectrophotometry by dipyridyl method), Vitamin B1 (thiamine determination by flurometry), Vitamin B2 (riboflavin, Photofluorometric method), Vitamin B6 (Pyidoxine, Fluorometric determination of Xanthuric acid), Nicotinic acid and Niacin: determination by fluorometry, Ascorbic acid (vitamin –c) Volumetric method using 2,6 dichlorophenol method, colorimetric determination of leucocyte ascorbate.

Immunoanalytical Techniques: Radioimmunoassay, its principle and applications,

instrumentation for radio bioassay, clinical application of the radioimmunoassay of insulin, Estrogen and progesterone, receptor techniques of breast cancer. Enzyme- linked immunosorbent assay (ELISA), Types of ELISA, principles, practical aspects, applications.

TEXT BOOKS:

1) Standard methods of chemical analysis by F.J. Welcher, 6th Edition,.
2) Quantitative Inorganic Analysis including Elementary Instrumental analysis by A. I. Vogel, 3rd Edition, ELBS, 1964.
3) Instrumental methods of analysis by R. D. Braun
4) Analytical Chemistry, Ed. by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley – VCH
5) Practical Clinical Biochemistry by Gowenlock, CBS published, 6th Ed.

20CY5410-DRUG DESIGN & DEVELOPMENT

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5410

CO#	Course Outcome	PO	BTL
CO1	Outline the synthesis and properties of antibiotics.	PO-2,3	3
CO2	Describe the psycho active drugs and their synthesis along with properties.	PO-1,3	3
CO3	Exposed to drug design and its tools	PO-1,2,3	3
CO4	Describe the QSAR Studies	PO-1,2,4,5	3

Syllabus:

Antibiotics : β-lactam rings, antibiotics inhibiting protein synthesis. Synthesis of penicillin G, penicllin V, amoxicillin, cephalosporin, tetracycline.

Local Anti-infective Drugs Introduction and general mode of action. Synthesis of sulphonamides,furazolidone, ciprofloxacin, norfloxacin, dapsone, amino Salicylic acid, ethionamie, flucanazole, griseofulvin, chloroquin and pramaquin.

Psychoactive Drug: Introduction, neurotransmitters, NA Dopamine, 5HT, acetylcholine, GABA, Histamine, serotonin, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazipinene, neurochemistry of mental diseases. Antipsychotic drugs-neurolcptics, antidepressants, butyrophenones. Synthesis of diazepam, oxazepam, phenytoin, barbiturates, thiopental sodium, glutethimide.

Drug Design: Development of new drugs, procedures followed in drug design, concept of lead compound and lead modification, concepts of prodrugs and softdrugs, structure- activity relationship (SAR). Theories of drug activity: occupancy theory, rate theory, induced theory, Quantitative structure activity relationship.

History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptor interactions. physicochemical parameters: lipophilicity, partition coefficient, electronic ionization constant, steric, Shelton and surface activity parameters and redox potentials. Free-Wilson analysis, Hansch analysis, relationship between Free-Wilson and Hansch analysis. LD-50, ED-50 (mathematical derivation of equations excluded).

TEXT BOOKS:

1) The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1, 5th Edition, John Wiley & Sons, 2001.
2) Organic Chemistry by IL Finar, Vol. I and II, 5th Edition, ELBS, 2004.
3) Graham L. Patrik, Drug Design and Development, Elsevier Publisher, 2002.
4) Exploring QSAR: Fundamentals and applications in Chemistry and Biology, Vol-I, by corwin hasch, Albert lio and David Hoekman, ACS Professional Reference books.

20CY5411-CHEMISTRY OF DRUGS AND PHARMACEUTICALS

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5411

CO#	Course Outcome	PO	BTL
CO1	Understand the medicinal and pharmaceutical importance of the organic compounds.	PO-1,2	3
CO2	Explain the Chemical and Biological assay of the various class of compounds.	PO-1,2	3
CO3	Describe the structure and properties of Vitamins: A, B, C, D, E and K; Hormones: Sex hormones, Steroidal and Non-steroidal hormones, Adrenaline, Thyroxine and Cardiac glycosides etc.,	PO-1,4,5	3
CO4	Paraphrase the Pharmalogical activity, uses and limitations of Antipyretics, Analgesics, Sedatives, Hypnotics, Barbiturates, Sulphadrugs, Anaesthetics, Antiseptics, Antibacterials, Diuertics, Anthelmentics, Anticoagulants, Anticonvulsants, Antihistamines,	PO-1,2,3,	3

	Psychotherupeutics.		

Provide in depth knowledge of medicinal and pharmaceutical importance of the organic compounds

Syllabus:

Chemical and Biological assay of the following compounds: Vitamins: A, B, C, D, E and K; Hormones: Sex hormones, Steroidal and Non-steroidal hormones, Adrenaline, Thyroxine and Cardiac glycosides.

Penicillin, Streptomycin, Chloromycetin, Tetracyclins, Novobiocin and Cephalosporins.

Pharmalogical activity, uses and limitations of Antipyretics, Analgesics, Sedatives, Hypnotics, Barbiturates, Sulphadrugs, Anaesthetics, Antiseptics, Antibacterials, Diuertics, Anthelmentics. Anticoagulants, Anticonvulsants, Antihistamines, Psychotherupeutics.

TEXT BOOKS:

1) The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1, 5th Edition, John Wiley & Sons, 2001.

2) Organic Chemistry by IL Finar, Vol. I and II, 5th Edition, ELBS, 2004.

3) Graham L. Patrik, Drug Design and Development, Elsevier Publisher, 2002.

20CY5412 – NANO CHEMISTRY

L-T-P-S : 3-0-0-0

Credits : 3

Contact Hours : 3

Course outcomes of 20CY5412

CO#	Course Outcome	PO	BTL
CO1	Understand the affects of nano dimensions of particles.	PO-1,2	3
CO2	Exemplify links between nano science and biological systems.	PO-1,3	3
CO3	Describe several synthetic methods for the fabrication of nano particles.	PO-1,2,3	3
CO4	Provide perspectives on future nano chemistry developments.	PO-1,4,5	3

Provide in depth knowledge of nano Chemistry, fabrication of nano particles and future developments.

Syllabus:

Scope and importance of nanoscience and nanotechnology. Synthetic Methods: Chemical Routes: Physical methods, Techniques for characterization.

BET method for surface area analysis. Dynamic light scattering for particle size determination.

Synthesis, properties and applications of fullerenes, carbon nanotubes, core-shell nanoparticles, self- assembled monolayers, nanocrystalline materials, magnetic nanoparticles thermoelectric materials.

Non-linear optical materials, liquid crystals.

TEXT BOOKS:

1) NANO: The Essentials by T. Pradeep, McGraw-Hill, 2007.

2) Textbook of Nanoscience and Nanotechnology by B S Murty, P Shankar, Baldev Rai, B B Rath and James Murday, Univ. Press, 2012.

20CY5403-DISSERTATON WITH RESEARCH PUBLICATION

L-T-P-S : 0-0-12

Credits : 6

Contact Hours : 12

20CY5409-DISSERTATON WITH RESEARCH PUBLICATION

L-T-P-S : 0-0-12

Credits : 6

Contact Hours : 12

COURSE TITLE : DESIGN THINKING AND INNOVATION – 1
COURSE CODE : 20UC1102
L-T-P-S: 1-0-0-4

COURSE OUTCOMES (CO – PO MAPPING):

CO No	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the basics of design thinking and its implications in product or service development	PO1	2
CO2	Understand and Analyse the requirements of a typical problem	PO2	4
CO3	Plan the necessary activities towards solving the problem through ideation and prototyping	PO4, PO5, PO11	4
CO4	evaluate the solution and refine them based on the customer feedback	PO3, PO9	5

SYLLABUS:

Overview of Design Thinking: Define Design Thinking, Differentiate Design Thinking from Design, Get an Overview of the Design Thinking Process, **Empathize and Understand**: Explain how empathy influences the outcomes of Design Thinking, List Different Empathy Research Techniques, Define the Guidelines for an Empathetic Research,

Defining Needs: Explain how PoV can be used in defining the design problem, Use a structured approach to arrive at a PoV,

Ideation for Solutions: List the best practices for conducting a successful ideating session,

Describe the techniques for evaluating and prioritizing ideas, **Prototyping**: Define prototyping, Explain how prototyping aids in communicating ideas effectively, List various tools for prototyping,

Testing the Solution: Define the steps of a successful testing approach, Demonstrate the process of gathering and responding to user feedback.

REFERENCE BOOKS:

1. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems

COURSE TITLE : DESIGN THINKING AND INNOVATION - 2
COURSE CODE : 20UC1203
L-T-P-S: 1-0-0-4

CO No	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the problem statement, requirements and formulating approaches to solve real world problems.	PO1, PO2	2
CO2	Implementing Design Thinking Framework.	PO3	5
CO3	Develop innovative thinking ability through design thinking and also develop metrics for successful implementation of Design Thinking.	PO4, PO5, PO11	4
CO4	Understand the copyright, IPR, Trademark, Patent and license agreement policies for protecting own R&D innovations and enhancing brand image.	PO3, PO9	2

Design Thinking for Problem Solving Mindset : Understanding Problem Statements, Recapping Design Principles, Design Thinking Toolsets, Formulating approaches to Solutions, Applications of Design Thinking: Case Study

Designing Services : Functional requirements, User requirements, Designing for sustainability and resilience, Case study

Designing Thinking for Space and Environment : Functional requirements, user requirements,Implementing Design Thinking Framework,Case study

Design Thinking and Innovation Management Culture : How design thinking leads to innovative thinking,Business model thinking,How design Thinking can lead to next generation customer experience,Metrics for successful implementation of Design Thinking

Intellectual property and protection of ideas : Concepts of copyright, Intellectual Property,Trademark, Service mark Patent and typical business benefits,Applying for patent,Product license agreement,Open-source license,Need for protecting own R&D innovations,Enhancing brand image with IP

REFERENCE BOOKS:

1. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems

4.3 SUMMER TERM COURSES

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

a. 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 time table.

b. 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.

c. In any case, a student can register only for a maximum of 12 credits during summer term.

d. 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

4.4 AWARD OF DEGREE

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 ≥ 7.75 will be awarded First class with Distinction provided the student has cleared all the courses in first attempt and must have fulfilled all the program requirements in two years duration.

CHAPTER 5
ATTENDANCE RULES

5.1 ATTENDANCE POLICY

Students must maintain a minimum attendance of 85% in every course. In case of medical exigencies, the student/parent should inform the Head of the Department within a week by submitting necessary proofs and in such cases the attendance can be condoned up to an extent of 10% by Principal concerned on the recommendation of the Head of the Department.

1. 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 a 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 75% condition after going through case by case.
2. Attendance in a course shall be counted from the date of commencement of the class work.
3. Attendance for the students who are transferred from other institutes and for new admissions, attendance must be considered from the date of her/his admission.

5.2 ATTENDANCE 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, s/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 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, [88, 91] = 2 marks, [91, 94] = 3 marks, [94, 97] = 4 marks and [97, 100] = 5 marks, 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.

5.3 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 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.

5.4 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 extra-curricular 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 9 instructional days per semester, and in Entrepreneurship related activities a maximum of 18 instructional days per semester. This condonation is not applicable for summer term.

5.5 ELIGIBILITY FOR APPEARING IN SEM-END EXAMINATION

A Student registered for a course is eligible to write the Semester-End Examination for that course unless found ineligible due to one or more of the following reasons:

a. Shortfall of attendance
b. Acts of indiscipline
c. Withdrawal from a course

5.6 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 on the basis of recommendations made by the concerned Head of the Department.

If a student fails to write Sem-In Exam-I or obtained less than 50% marks in Sem-In Exam-I, he has to attend remedial classes and score 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 all the Laboratory exam.

1. A student is in genuine absence for a Sem-In Exam only under the following circumstances:
    a. Pre-approved participation in University/State/National/International co-curricular and extra-curricular activities
    b. 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.
    c. Death of immediate family member

5.7 Remedial Classes:

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

- Students who did not attend or obtain a minimum of 50% marks in the Sem-In exam 1
- Students those for whom CO1/CO2 is(are) not attained in Sem-In Exam 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 which are scheduled to be conducted usually one- or two-weeks post conclusion of Sem-In exam 1.

- The number of remedial classes to be conducted shall be 50% of regular classes held till the Sem-In exam-I.
- Remedial classes MUST NOT be scheduled during regular class work hours.
- The following ALMs are recommended for slow learners:
    - One minute paper
    - Think/Plan/Share
    - Role play
    - Focussed listening and Listening for specifics
    - Just-in time teaching

  Course coordinators may also include alternate Active learning Methods based on the course being taught.

CHAPTER 6
ASSESSMENT & EVALUATION PROCESS

The assessment in each theory subject consists of two Sem-In Exams (Sem-in Exam-I and Sem-In Exam -II), in-class quizzes/tutorials/home-assignments/Active Learning Methods (continues assessment), and the Semester-End Exanimation (SEE). The distribution of weightage for each assessment step is listed below. The distribution of internal marks in the table below is only a guideline. Instructors at their discretion may apportion some marks for attendance beyond 75%. In such cases, the marks shown for quizzes and assignments will be accordingly be adjusted. Students are advised to consult the course handout to get more detailed information on assessment.

a. The Sem-In tests and the Semester-End Examinations will be conducted as per the Academic Calendar.
b. As per the necessity, the Supplementary examinations will be conducted at the discretion of Dean Academics with the approval of the Vice-Chancellor.
c. Students may have to take more than one examination in a day either during Sem-In exams, Semester-End Examinations /Supplementary examinations.

6.1 SEMESTER-IN EVALUATION

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

a. The process of evaluation is continuous throughout the semester.
b. The distribution of marks for Semester-In evaluation is 60% of aggregate marks of the course.
c. The distribution of weightage for various evaluation components 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.
d. In order 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.
e. 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.
f. 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.

g. In case a student has missed any of the two semester in evaluations, He/She is eligible for and will be provided with an opportunity of appearing for re-examination. However such a facility is applicable for only one semester in evaluation tests.

6.2 SEMESTER END EXAMINATION

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

a. The weightage for Semester End Examination is 40% of the aggregate marks and the student should secure minimum 40% in Semester End Examination.

b. The pattern and duration of such examination are decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academic.

c. 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.

d. 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 one fortnight of the declaration of the results.

6.2.2 EVALUATION FOR THEORY COURSES

The table below gives details about the evaluation components in courses which contain only the lecture components.

Type of Evaluation	Maximum Marks for which the Evaluation is Conducted	Duration	Weighatge
Sem-In Exam-I	50 marks	Refer course handout (Annexure A)	Refer course handout (Annexure A)
Sem-In Exam -II	50 marks	Refer course handout (Annexure A)	Refer course handout (Annexure A)
Quizzes / ALM / Tutorial	Each quiz/ALM/ Tutorial will be conducted for a minimum of 10 marks	Refer course handout (Annexure A)	Refer course handout (Annexure A)
Assignment	In the form of a report, seminar, presentation, quiz, experiment, GD, etc. as defined in the course syllabus/ course plan	Refer course handout (Annexure A)	Refer course handout (Annexure A)

Sem-End Exam	100 marks	3 hours	Refer course handout (Annexure A)

6.2.3 ASSESSMENT OF LABORATORY BASED COURSES

The continuous assessments in laboratory courses will be based on supervision of the students' work, their performance in viva-voce examinations and the quality of their work. The Sem-End Exam for the laboratory courses are conducted by a panel of examiners including experts from outside KLEF as approved by Dean Academics.

Type of Evaluation	Evaluation Component	Marks	Remarks	Weighatge out of 100
Internal	Sem-In Lab Exam -1	30	Sem-In lab exam will have questions framed from the experiments conducted in the lab.	Refer to course Handout (Annexure A)
	Sem-In Lab Exam -2	30	Sem-In lab exam will have questions framed from the experiments conducted in the lab.	
	Continuous Assessment	20 per Lab	Assessment includes marks for record, observation, execution of experiment and viva-voce	
	Mini Project	20	Project evaluation includes weekly reviews, project completion, process management	
External	Report	Refer course Handout (Annexure A)		50
	Lab Experiment			
	Viva-voce			
	External Review	Refer course handout (Annexure A)		

NOTE: Check for specific courses or as specified by the Course Coordinator.

6.2.4 ASSESSMENT OF THEORY COURSES WITH EMBEDDED LABORATORY

The following table briefs the evaluation components of a theory course with embedded lab.

Type of Evaluation	Evaluation Component	Marks	Remarks	Weightage out of 100
Internal	Sem-In Exam-1	50	refer course handout (Annexure A)	Refer to course Handout (Annexure A)
	Sem-In Exam-1	50	refer course handout (Annexure A)	
	Quizzes / ALM / Tutorial	Each quiz/ALM/ Tutorial will be conducted for a minimum of 10 marks	refer course handout (Annexure A)	
	Lab Continuous Assessment	20 per Lab	Assessment includes marks for record, observation, execution of experiment and viva- voce	
External	Lab Experiment	Refer course Handout (Annexure A)		Refer Course Handout (Annexure A)
	Viva-Voce	Refer course handout (Annexure A)		
	Semester End Exam	100		

6.2.5 ASSESSMENT OF PROJECT/RESEARCH-BASED SUBJECTS

All project or research-based subjects must have a defined time-limit for completion. The specific time limits for completion and schedule for monitoring and evaluation of performance of students will be announced by the school each term. The final project report, after getting the plagiarism certificate only will be considered and evaluated by a panel of examiners including external experts. Student project reports must be as prescribed by the office of Dean Academics. Students conducting their projects outside the campus can participate in project reviews through an online video conferencing tool.

6.3 GRADING PROCESS

At the end of all evaluation components based on the performance of the student, each student is awarded 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.

6.4.1 ABSOLUTE GRADING

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

Letter Grade	Grade Point	Percentage of marks
O	10	90 - 100
A+	9	80 - 89
A	8	70 - 79
B+	7	60 - 69
B	6	50 - 59
C	5	46 - 49
P	4	40 - 45
F	0	0 – 39
Ab (Absent)	0	Absent

6.4.2 RELATIVE GRADING

a. 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 from the μ.

6.4.3 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.

$$SGPA(S_i) = \frac{\sum C_i * G_i}{\sum C_i}$$

where *'C_i'* is the number of credits of the ith course and *'G_i'* is the grade point scored by the student in the ith course.

The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a program,

$$CGPA(S_i) = \frac{\sum C_i * S_i}{\sum C_i}$$

where 'S'$_i$ is the SGPA of the ith semester and *'C_i'* is the total number of credits in that semester.

a. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
b. CGPA can be converted to percentage of marks: 10 X CGPA - 7.5
c. 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 has to 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.
d. Audit/Certificate courses are graded as satisfactory (S) or non-satisfactory (NS) only.
e. At the end of each semester, the KLEF issues grade sheet indicating the SGPA and CGPA of the student. However, grade sheet will not be issued to the student if he/she has any outstanding dues.

6.4.4 ILLUSTRAION OF COMPUTATION OF SGPA AND CGPA

Computation of SGPA and CGPA Illustration for SGPA

COURSE	CREDITS	GRADE LETTER	GRADE POINT	CREDIT POINT (Credit x Grade)
Course 1	**3**	A	**8**	3 X 8 = 24
Course 2	**4**	B+	**7**	4 X 7 = 28
Course 3	**3**	B	**6**	3 X 6 = 18
Course 4	**3**	O	**10**	3 X 10 = 30
Course 5	**3**	C	**5**	3 X 5 = 15
Course 6	**4**	B	**6**	4 X 6 = 24
	20			139

Thus, SGPA =139/20 =6.95

Illustration for CGPA

Item	**Semester**					
	I	II	III	IV	V	VI
Credits	20	22	25	26	26	25
SGPA	6.9	7.8	5.6	6.0	6.3	8.0

Thus,

$$CGPA = \frac{(20*6.9+22*7.8+25*5.6+26*6.0+26*6.3+25*8.0)}{(20+22+25+26+26+25)} = 6.73$$

6.5 BETTERMENT

A student may reappear for semester end examination for betterment only in the theory part of the course for improving the grade, subject to the condition that, the student has passed the course, his/her CGPA is ≤ 6.75 and the grade in the respective course to be equal to or lower than "C". In the case of reappearing, the better of the two grades is considered.

A Student can re-register in any course in any semester during the program for improvement of grade if the current grade in the course is lower than B^+ and with due approval from Dean Academics in accord of academic regulations.

A student cannot reappear for semester end examination in courses like Industrial Training, courses with their L-T-P-S Structure like 0-0-X-X, Project, Practice School and Term Paper.

6.6 COURSE BASED DETENTION POLICY

In any course, a student must maintain a minimum attendance as per the attendance policy referred in Chapter 5.1 and 5.4, 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. He/she is thereby ineligible to take semester end exam.

CHAPTER 7
PROMOTION

7.1 CREDIT TRANSFER

7.1.1 CREDIT TRANSFER BETWEEN KLEF AND OTHER INSTITUTION

a. Credit transfer from other institutions to KLEF or vice versa is permitted only for under graduate program.

b. Credit transfer from KLEF to other institutions: Student studying in KLEF can take transfer to another institution under the following conditions:

- KLEF has signed MOU with the institution.
- However, a student, after seeking transfer from KLEF can return to KLEF after a semester or year. Based on courses done in the other institution, equivalent credits shall be awarded to such students.

c. Credit transfer from another institution to KLEF: A student studying in another institution can take transfer to KLEF under the following conditions:

- When a student seeks transfer, equivalent credits will be assigned to the student based on the courses studied by the student.
- The student, when transferred from other institutions, has to stick to the rules and regulations of KLEF.
- To graduate from KLEF, a student must study at least half of the minimum duration prescribed for a program at KLEF.

7.1.2 CREDIT TRANSFER THROUGH MOOCS:

Under graduate students can get credits for MOOCs courses recommended by KLEF up to a maximum of 20% of their minimum credits required for graduation. The discretion of allocation of MOOCs courses equivalent to the courses in the curriculum lies with the office of the Dean Academics.

A student may also be permitted to obtain 20 credits through MOOCs in addition to the minimum credits required for graduation. These 20 credits can also be utilized to acquire a Minor degree or a Honors degree if the courses are pronounced equivalent to those specified for the respective degrees by the office of the Dean Academics. These additional credits through MOOCs if to be considered for CGPA/Minor/Honors degree must be approved by Dean Academics prior to enrollment in the respective MOOCs.

Students acquiring additional credits for Honors/Minor degree must adhere to the

rules governing the award of the respective degree, otherwise, a student applying for registering into additional credits through MOOCs must possess a minimum CGPA of 7.5 till that semester.

7.2 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 one tutorial hour per week or two hours per week of practical/ field work or four hours per week of skilling during a semester.

7.3 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. 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.

7.4 ACADEMIC COUNSELING BOARD (ACB)

Academic Counseling Board is constituted by the Dean Academics, for each program separately. This board shall comprise of the respective Chairmen, Board of Studies, two Professors and two Associate Professors of the program.

A student will be put under Academic Counseling Board in the following circumstances:

- Secured a CGPA of less than 6.00.
- Secured ‘F’ grade in 3 or more courses.

The students under Academic Counseling Board may not be allowed to register for all regular courses in the semester, based on the recommendation of Academic Counseling Board and decision of Dean Academics.

7.5 BACKLOG COURSES

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

7.6 RUSTICATION

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

7.7 AWARD OF MEDALS

KLEF awards Gold and silver medals to the top two (2) students based on CGPA. However,

a. The grade obtained by betterment, will not be considered for this award.
b. He/She must have obtained first class with distinction for the award of Gold or Silver medal.

CHAPTER 8
STUDENT COUNSELLING

Guidelines for effective counselling for students on academic and non-academic activities Student counselling 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. Student counselling promotes the development of students in the following aspects:

Academic: It disseminates information about different academic programs of the Institute and provides efficient time management and learning skills. It also addresses academic issues of students, e. g. inadequate academic performance, fall of attendance, lack of basic IT skills and language skills of students, particularly from non-English background. Besides, counselling helps students to take proper direction as they leave the campus, viz. higher education in a specialized field (both in India and abroad), job (different types of career options), entrepreneurship, etc.

Co-Curricular & Extra-Curricular: It strives to develop talents in students and encourages them to discover their extra-curricular interests/hobbies, viz. sports, fine-arts, etc.

Personal: It provides a cushion against homesickness and assists in adjusting to the new environment by providing personalized guidance. The following Orientation/training programs could be organized:

a. Counselling for Academic Excellence - Closely monitoring the Academic Progress of the students
b. Orientation Program for new students to acquaint them with the Institute
c. Awareness on Anti-ragging, gender sensitization, etc.
d. Stress and time management
e. Health care and hygiene
f. Career counselling
g. Motivational lectures by eminent speakers.

Every student should approach her/his counsellor only, for any of his/ her requirements. One slot of 50 minutes duration per week is provided in the time-table for counselling.