M.Sc. CHEMISTRY

CHOICE BASED CREDIT SYSTEM (CBCS)

Curriculum & Syllabus

2024-2025

DEPARTMENT OF CHEMISTRY

FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)
(Accredited with A+ Grade by NAAC in the Second Cycle)
Pollachi Main Road, Eachanari (Post), Coimbatore- 641 021,
Tamil Nadu, India

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FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT
POST GRADUATE PROGRAMMES
(M.Sc. M. Com and M.A)

REGULAR MODE
CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS - 2024

The following regulations are effective from the academic year 2024 -2025 and are applicable to the candidates admitted in Post Graduate (PG) Degree programmes in the Faculty of Arts, Science, Commerce and Management, Karpagam Academy of Higher Education (KAHE).

1. PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

1.1. P.G. PROGRAMMES OFFERED

The various P.G. Programmes offered by the KAHE are listed in the table below.

S. No.	Programmes Offered
1	M.Sc. Biochemistry
2	M.Sc. Microbiology
3	M.Sc. Biotechnology
4	M.Sc. Physics
5	M.Sc. Chemistry
6	M.Sc. Mathematics
7	M.Sc. Computer Science
8	M.Com.
9	M.A. English

1.2. MODE OF STUDY

All programmes are offered under Full-Time Regular mode. Candidates admitted under 'Full-Time' should be present in the KAHE during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

1.3. ADMISSION REQUIREMENTS (ELIGIBILITY)

A candidate for admission to the first semester Master's Degree Programme shall be required to have passed an appropriate Degree Examination of this Karpagam Academy of Higher Education or any other University accepted by the KAHE as equivalent thereto. Admission shall be offered only to the candidates who possess the qualification prescribed against each course as given in the table below.

QUALIFICATIONS FOR ADMISSION

S. No.	Programme	Eligibility
1	M.Sc. Biochemistry	B.Sc. Degree with Biology / Biochemistry / Chemistry / Biotechnology / B.F.Sc. / Polymer Chemistry / Microbiology/ Zoology / Botany / Plant Science / Plant Biotechnology / Animal Science / Animal Biotechnology / B.Pharm / Industrial Chemistry / Applied Microbiology / Medical Microbiology / Human Genetics / Medical Genetics / Molecular Biology / Genetics Technology / Environmental Science / Environment Biotechnology / Genetics Engineering / Bioinformatics / Plant Biology & Biotechnology / Animal Cell & Biotechnology / Agriculture / Medical Lab Technology / Nutrition & Dietetics
2	M.Sc. Microbiology	B.Sc. Microbiology / Applied Microbiology / Industrial Microbiology / Medical Microbiology / Botany / Zoology / Biology / Biotechnology /Industrial Biotechnology/ Molecular Biology / Genetic Engineering / Biochemistry / Agriculture / Forestry / Medical Lab Technology / Life Sciences

3	M.Sc. Biotechnology	B.Sc. Degree with Biotechnology/ Industrial Biotechnology/ Biology / Biochemistry / B.Sc Biology with Chemistry Ancillary / B.F.Sc. / Microbiology / Zoology / Botany / Plant Science /Plant Biotechnology / Animal Science /Animal Biotechnology / B.Pharm / Applied Microbiology / Medical Microbiology / Human Genetics / Medical Genetics / Molecular Biology / Genetics / Environmental Science / Environment Biotechnology / Genetics Engineering / Bioinformatics / Plant Biology & Biotechnology / Animal Cell & Biotechnology / Agriculture / B.Tech (Biotech)
4	M.Sc. Physics	B.Sc. Physics, B.Sc. Physics (CA) / B.Sc. Applied Sciences
5	M.Sc. Chemistry	B.Sc. Chemistry, Industrial Chemistry, Polymer Chemistry, B.Sc. Applied Sciences
6	M.Sc. Mathematics	B.Sc. Mathematics / B.Sc. Mathematics with Computer Applications, B.Sc. Applied Sciences
7	M.Sc. Computer Science	B.Sc. Computer Science / B.Sc Computer Science (Cognitive Systems)/ B.Sc Computer Science (AI&DS)/ B.Sc Computer Science (Cyber Security)/ Computer Technology / Information Technology / Electronics / Software Systems / BCA/ B.Sc. Applied Sciences
8	M.Com	B.Com. / B.Com.(CA) /B.Com (PA) / B.Com (Finance & Insurance) / B.Com. (e-Commerce) / B.Com.(IT) / B.B.M. /B.B.M. (CA) / B.B.A./ B.B.A (CA) / B.Com (CS), B.A. Co-operation / Bachelor's Degree in Bank Management/ B.A. Economics / B. Com Financial Analytics/ B. Com International Accounting and Finance
9	MA English	BA (English)/Any UG degree with Part II – English for four semesters.

2. DURATION OF THE PROGRAMMES

2.1. The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Sc., M.Com., MA	4	8

2.2. Each semester normally consists of 90 working days or 450 Instructional hours for full-time mode of study. End Semester Examination shall be conducted at the end of every semester for the respective courses.

3. CHOICE BASED CREDIT SYSTEM

Credits means the weightage given to each course of study by the experts of the Board of Studies concerned. All PG programmes are offered under Choice Based Credit System and students can earn a total of 92 credits.

4. STRUCTURE OF THE PROGRAMME

Every Programme will have a curriculum and syllabus consisting of core courses, elective courses, open elective, Internship and project work.

a. Major courses

Major courses consist of theory and practical and the examinations shall be conducted at the end of each semester.

b. Elective courses

Elective courses are to be chosen with the approval of the Head of Department concerned from the list of elective courses mentioned in the curriculum.

c. Project Work

The candidates shall undertake the project work in the Fourth Semester either in the Department concerned or in Industries, Research Institute or any other Organizations (National / International) and the project report has to be submitted at the end of the fourth semester.

If the candidate undertakes the Research Project work outside the Department, the faculty concerned within the Department shall be the Supervisor and the teacher/scientist of the host institute will be the Co-supervisor. The candidate shall bring the attendance certificate from the host institute.

The Head of the Department shall assign a project supervisor who shall monitor the student's project work(s). A Project Assessing Committee (PAC) shall be constituted with HoD and two senior faculty members of the Department. The PAC shall announce the dates for the reviews and

demonstration. The student shall make a presentation on the progress and demonstration of their project before the PAC in the presence of their supervisor on the scheduled dates.

d. Internship

The student shall undergo 15 days internship at the end of second semester. Internship report will be evaluated and marks will be awarded in the third semester. Students have to earn 2 credits for the Internship. The Internship will be assessed internally and marks will be awarded out of 100.

e. Open Elective

He / She may select one of the open elective courses from the list given below offered by other departments in the third semester. Students have to earn 2 credits for this course (The student cannot select a course offered by the parent department).

S.No.	Name of the offering Department	Course Code	Name of the Course
1	English	24EGPOE301	English for Competitive Examinations
2	Commerce	24CMPOE301	Personal Finance and Planning
3	Management	24MBAPOE301	Organizational Behavior
4	Computer Applications	24CAPOE301	Robotics Process Automation
5	Computer Science	24CSPOE301	Cyber Forensics
6	Mathematics	24MMPOE301	Coding theory
7	Physics	24PHPOE301	Electrical Appliances and Servicing
8	Chemistry	24CHPOE301	Industrial Chemistry
9	Microbiology	24MBPOE301	Fermentation Technology
10	Biotechnology	24BTPOE301	Nutrition and Dietetics

5. CREDIT TRANSFER THROUGH ONLINE PLATFORM / INTERNATIONAL STUDIES

Students are encouraged to enroll in courses offered by MOOC platforms and international institutions of higher learning, either virtually or in person. The equivalent credits for these courses will be determined by a committee named Subject Equivalency Committee comprising the Dean, Head of Department (HoD), and one faculty member nominated by the Vice Chancellor. The committee's decision will be submitted for ratification/approval by the Board of Studies (BoS) and the Academic Council. Additionally, the equivalent grade points for marks/grades/grade

points awarded by various MOOC platforms and international institutions of higher learning will be determined by a committee named Grade Equivalency Committee duly constituted by the Vice-Chancellor. The decisions of this committee will also be submitted for ratification/approval by the Academic Council. This shall be approved to be implemented from the even semester of the academic year 2024-25.

6. MEDIUM OF INSTRUCTION

The medium of instruction for all courses, examinations, seminar presentations, Internship and project/thesis/dissertation reports should be English.

7. MAXIMUM MARKS

The maximum marks assigned to different courses shall be as follows:

(i) Each of the theory and practical courses shall carry maximum of 100 marks. Out of which 40 marks are for Continuous Internal Assessment (CIA) and 60 marks are for End Semester Examinations (ESE).

(ii) Maximum Marks for Project work

S. No	Programme	Maximum Marks	CIA	ESE
1	M.Sc., M.Com., M.A	200	80	120

8. a. FACULTY MENTOR

To help students in planning their courses of study and for general advice on the academic programme, the HoD shall allot a certain number of students to a faculty who will function as mentor throughout their period of study. Faculty mentors shall advise the students and monitor their behavior and academic performance. Problems if any shall be counseled by them periodically. The faculty mentor is also responsible to inform the parents of their wards' progress. Faculty mentor shall display the cumulative attendance particulars of his / her students' periodically (once in 2 weeks) on the Notice Board to enable the students to know their attendance status and satisfy the **clause 8** of this regulation.

9. CLASS COMMITTEE

Every class shall have a Class Committee consisting of teachers of the class concerned, student representatives (Minimum two boys and 2 girls of various capabilities and Maximum of 6 students) and the HoD / senior faculty concerned as a Chairperson. The objective of the class committee Meeting is all about the teaching – learning process. The Class Committee shall be convened at least once in a month. The constitution and functions of the Class Committee shall include

1. The class committee shall be constituted during the first week of each semester.
2. The Class Committee of a particular class of any department is normally constituted by the HoD/Chairperson of the Class Committee. However, if the students of different departments are mixed in a class, the Class Committee shall be constituted by the respective Dean of the Faculty.
3. The HoD/Chairperson of the Class committee is authorized to convene the meeting.
4. The respective Dean of the Faculty has the right to participate in any Class committee meeting.
5. The Chairperson is required to prepare the minutes of every meeting, and submit the same to the Dean concerned within two days after having convened the meeting. Serious issues if any shall be brought to the notice of the Registrar by the HoD/Chairperson immediately.
6. Analyzing and solving problems experienced by students in the class room and in the laboratories.
7. Analyzing the performance of the students of the class after each test and finding the ways and means to improve the performance.

10. REQUIREMENTS TO APPEAR FOR THE END SEMESTER EXAMINATION

a. Every student is expected to attend all classes and secure 100% attendance. However, in order to allow for certain unavoidable circumstances, the student is expected to attend at least 75% of the classes and the conduct of the candidate should be satisfactory during the course.

b. A candidate who has secured attendance between 65% and 74% (both included), due to medical reasons (Hospitalization / Accident /

Specific Illness) or due to participation in University / District / State / National / International level sports or due to participation in Seminar / Conference / Workshop / Training Programme / Voluntary Service / Startup Activity / Extension activities or similar programmes with prior permission from the Registrar shall be given exemption from prescribed minimum attendance requirements and shall be permitted to appear for the examination on the recommendation of the Head of Department concerned and Dean to condone the shortage of attendance. The Head of Department has to verify and certify the genuineness of the case before recommending to the Dean concerned.

c. However, a student who has secured less than 65% in any of the semesters due to any reasons, shall not be permitted to appear for the End Semester Examinations. But he/she will be permitted to appear for his/her arrear examinations. In order to redo the semester with lack of attendance he/she has to attend the corresponding semester of the subsequent year(s) with approval of the Dean of the Faculty, Dean - Students Affairs and the Registrar.

11. PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

11.1. Every Faculty is required to maintain an **Attendance and Assessment Record (Log book)** which consists of attendance of students marked for each lecture/practical/ project work, the CIA and Seminar marks and the record of class work completed (topic covered), separately for each course. This should be submitted to the HoD once in a week for checking the syllabus coverage, records of test marks and attendance. The HoD shall sign with date after due verification. The same shall be submitted every fortnight to respective Dean. After the completion of the semester the HoD should keep this record in safe custody for five years as records of attendance and assessment shall be submitted for inspection as and when required by the KAHE/any other approved body.

11.2. Continuous Internal Assessment (CIA): The performance of students in each course will be continuously assessed by the respective faculty. Retest will be conducted and considered based on the requirements and recommendations by the Head of the Department. The guidelines for the Continuous Internal Assessment (CIA) are given below:

Theory Courses

S. No.	Category	Maximum Marks
1	Attendance	5
2	Test – I (2 ½ units)	10
3	Test – II (2 ½ units)	10
4	Journal Paper Analysis & Presentation*	15
	Total	40

*****Evaluated by two faculty members of the department concerned. Distribution of marks for one Journal paper analysis: Subject matter 5 marks, Communication/PPT Presentation 4 marks, Visual aid 2 marks and Question and Discussion 4 marks.

Practical Courses

S. No.	Category	Maximum Marks
1	Attendance	5
2	Observation work	5
3	Record work	5
4	Model practical examination	15
5	*Viva – voce* [Comprehensive]*	10
	Total	**40**

* *Viva - voce* conducted during model practical examination.

Every practical Exercise / Experiment shall be evaluated based on the conduct of Exercise/ Experiment and records maintained.

11.3 Portions for Test Question Paper

Portions for Internal Test – I : 2 ½ Units

Portions for Internal Test – II : 2 ½ Units

11.4 Pattern of Test Question Paper

Theory Courses:

Maximum Marks : 100 **Duration: 3 Hours**

Section	Marks
Part – A	Short Answer Answer ALL the Questions (10 x 2 = 20 Marks)
Part - B	Long Answer – 5 six mark questions 'either – or' type Answer ALL the Questions (5 x 6 = 30 Marks)
Part - C	Essay type Answer– 5 ten mark questions 'either – or 'type Answer ALL the Questions (5 x 10 = 50 Marks)

11.5 Attendance

Marks Distribution for Attendance

S. No.	Attendance (%)	Maximum Marks
1	91 and above	5.0
2	81 - 90	4.0
3	76 - 80	3.0
4	Less than or equal to 75	0

12. ESE EXAMINATIONS

12.1 End Semester Examination (ESE): ESE will be held at the end of each semester for each course. The question paper is for a maximum of 100 marks.

Pattern of ESE Question Paper

Theory Courses:

Maximum Marks: 100 **Duration: 3 Hours**

Section	Marks
Part – A	Short Answer Answer ALL the Questions (10 x 2 = 20 Marks)
Part - B	Long Answer – 5 six mark questions 'either – or' type Answer ALL the Questions (5 x 6 = 30 Marks)
Part - C	Essay type Answer– 5 ten mark questions 'either – or 'type Answer ALL the Questions (5 x 10 = 50 Marks)

The 100 Marks is converted to 60 Marks.

12.2 Practical Courses: There shall be combined valuation by the Internal and External examiners. The pattern of distribution of marks shall be as given below.

S. No.	Category	Maximum Marks
1.	Experiments	40
2.	Record work	10
3.	*Viva – voce* [Comprehensive]	10
	Total	**60**

Record Notebooks for Practical Examination

Candidate taking the Practical Examination should submit Bonafide Record Notebook prescribed for the practical examination, failing which the candidate will not be permitted to take the practical examination.

In case of failures in Practical Examination, the marks awarded for the Record at the time of first appearance of the Practical Examination shall remain the same at the subsequent appearance also by the candidate.

12.3. Evaluation of Project Work

12.3.1 The project shall carry a maximum marks as per (vide clause 6 (ii)). ESE will be a combined evaluation of Internal and External Examiners.

12.3.2 The project report prepared according to the approved guidelines and duly signed by the supervisor(s) shall be submitted to HoD.

Guidelines to prepare the project report

a. Cover page
b. Bonafide certificate
c. Declaration
d. Acknowledgement
e. Table of contents
f. Chapters
    - Introduction
    - Aim and Objectives
    - Materials and Methods (Methodology)
    - Results (Analysis of Data) and Discussion (Interpretation)
    - Summary
    - References

12.3.3 The evaluation of the project will be based on the project report submitted and *Viva-Voce* Examination by a team consisting of the supervisor, who will be the Internal Examiner and an External Examiner who shall be appointed by the COE. In case the supervisor is not available, the HoD shall act as an Internal Examiner.

12.3.4 If a candidate fails to submit the project report on or before the specified date given by Examination Section, the candidate is deemed to be failed in the project work and shall re-enroll for the same in a subsequent semester.

If a candidate fails in the *viva-voce* examinations he/she has to resubmit the project report within 30 days from the date of declaration of the results. For this purpose the same Internal and External examiner shall evaluate the resubmitted report.

12.3.5 Copy of the approved project report after the successful completion of *viva voce* examinations shall be kept in the KAHE library.

13. PASSING REQUIREMENTS

13.1 Passing minimum: A candidate needs to secure a minimum of 20 marks out of 40 marks in CIA and 30 marks out of 60 marks in ESE. The overall passing minimum in each course is 50 marks out of 100 marks (Sum of the marks in CIA and ESE examination).

13.2 If a candidate fails to secure a pass in a particular course (either CIA or ESE or Both) as per clause 13.1, it is mandatory that the candidate has to register and reappear for the examination in that course during the subsequent semester when examination is conducted for the same till, he / she receives pass both in CIA and ESE (vide Clause 2.1).

13.3 Candidate failed in CIA will be permitted to improve CIA marks in the subsequent semesters by writing tests and by re-submitting Assignments.

13.4 The CIA marks secured by the candidate in the first passed attempt shall be retained by the Office of the Controller of Examinations and considered valid for all subsequent attempts till the candidate secures a pass in ESE.

13.5 A Candidate who is absent in ESE in a Course / Practical / Project Work after having enrolled for the same shall be considered to have Absent (AAA) in that examination

14. IMPROVEMENT OF MARKS IN THE COURSE ALREADY PASSED

The Candidates desirous to improve the marks secured in a passed course in their first attempt shall reappear once (**only in ESE**) in the subsequent semester. **The improved marks shall be considered for classification but not for ranking.** If there is no improvement there shall be no change in the marks awarded earlier.

15. AWARD OF LETTER GRADES

All assessments of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying certain number of points, will be awarded as per the range of total marks (out of 100) obtained by the candidate in each course as detailed below:

Letter grade	Marks Range	Grade Point	Description
O	91 - 100	10	OUTSTANDING
A+	81 - 90	9	EXCELLENT
A	71 - 80	8	VERY GOOD
B+	66 - 70	7	GOOD
B	61 - 65	6	ABOVE AVERAGE
C	55 - 60	5	AVERAGE
D	50 - 54	4	PASS
RA	< 50	-	REAPPEARANCE
AAA	-	-	ABSENT

16. GRADE SHEET

After the declaration of the results, Grade Sheets will be issued to each student which will contain the following details:

i. The list of courses enrolled during the semester and the corresponding grade obtained.

ii. The Grade Point Average (**GPA**) for the semester and

iii. The Cumulative Grade Point Average (**CGPA**) of all courses enrolled from first semester onwards.

GPA of a Semester and CGPA of a programme will be calculated as follows.

GPA of a Semester = (Sum of the product of the GP by the corresponding credits of the courses offered in that Semester) / (Sum of the credits of the courses of that Semester)

i.e. **GPA** of a Semester = $\frac{\sum_i CiGPi}{\sum_i Ci}$

Sum of the product of the GPs by the corresponding credits of the courses offered for the entire programme

CGPA of the entire programme = ----------

Sum of the credits of the courses of the entire programme

i.e. **CGPA** of the entire programme = $$\frac{\sum_{n}\sum_{i} CniGPni}{\sum_{n}\sum_{i} Cni}$$

where,

Ci is the credit fixed for the course 'i' in any semester
GPi is the grade point obtained for the course 'i' in any semester
'n' refers to the Semester in which such courses are credited

Note: RA grade will be excluded for calculating **GPA** and **CGPA**.

17. REVALUATION

Candidate can apply for revaluation or retotaling of his / her semester examination answer script (**theory courses only**), within 2 weeks from the date of declaration of results, on payment of a prescribed fee. For the same, the prescribed application has to be sent to the Controller of Examinations through the HoD. **A candidate can apply for revaluation of answer scripts not exceeding 5 courses at a time.** The Controller of Examinations will arrange for the revaluation and results will be intimated to the candidate through the HODs concerned**.** Revaluation is not permitted for supplementary theory courses.

18.TRANSPARENCY AND GRIEVANCE COMMITTEE

Revaluation and Re-totaling are allowed on representation (clause 17). Student may get the Xerox copy of the answer script on payment of prescribed fee, if he / she wish. The student may represent the grievance, if any, to the Grievance Committee, which consists of Dean of the Faculty, (if Dean is HoD, the Dean of another Faculty nominated by the KAHE), the HoD of Department concerned, the faculty of the course and Dean from other discipline nominated by the KAHE and the CoE. If the Committee feels that the grievance is genuine, the script may be sent for external valuation; the marks awarded by the External examiner will be final. The student has to pay the prescribed fee for the same.

19. ELIGIBILITY FOR THE AWARD OF THE DEGREE

A student shall be declared to be eligible for the conferment of the Degree if he / she has

- Successfully completed all the components in clause 3 and gained the required number of total credits as specified in the curriculum corresponding to his / her Programme within the stipulated period.
- No pending disciplinary enquiry/ action against him/her.

- The award of the degree must be approved by the Board of Management.

20.CLASSIFICATION OF THE DEGREE AWARDED

20.1. Candidate who qualifies for the award of the Degree (vide clause 14) having passed the examination in all the courses in his / her first appearance, within the specified minimum number of semesters and securing a **CGPA not less than 8.0** shall be declared to have passed the examination in **First Class with Distinction.**

20.2 Candidate who qualifies for the award of the Degree (vide clause 14) having passed the examination in all the courses within the specified maximum number of semesters (vide clause 2.1), securing a **CGPA not less than 6.5** shall be declared to have passed the examination in **First Class**.

20.3 All other candidates (not covered in clauses 20.1 and 20.2) who qualify for the award of the degree (vide Clause 20) shall be declared to have passed the examination in **Second Class**.

21. RANKING

A candidate who qualifies for the PG Degree programme passing all the Examinations in the first attempt, within the minimum period prescribed for the programme of study from Semester I through Semester IV to the programme shall be eligible for ranking. Such ranking will be confined to 10% of the total number of candidates qualified in that particular programme of Study subject to a maximum of 10 ranks.
The improved marks will not be taken into consideration for ranking.

22. SUPPLEMENTARY EXAMINATION

Supplementary Examination will be conducted only for the final semester students within ten days from the date of publication of results for students who have failed in one theory course only. Such students shall apply with prescribed fee to the Controller of Examinations within the stipulated time.

23.DISCIPLINE

23.1. If a student indulges in malpractice in any of the Internal/External Examinations he/she shall be liable for punitive action as prescribed by the KAHE from time to time.

23.2. Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the KAHE. The erring students will be referred to the disciplinary committee constituted by the KAHE, to enquire into acts of indiscipline and recommend the disciplinary action to be taken.

24. KAHE ENTRANCE EXAMINATION

At the end of Fourth Semester, the KAHE Entrance Examinations will be conducted who are aspiring for Higher Education (Ph.D).

25. REVISION OF REGULATION AND CURRICULUM

Karpagam Academy of Higher Education may from time-to-time revise, amend or change the Regulations, Scheme of Examinations and syllabi if found necessary.

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Karpagam Innovation and Incubation Council (KIIC)

(A Section 8 Company)

Based on the 2019 National Innovation and Startup Policy and the 2019–2023 Tamil Nadu Startup Policy, KIIC has recommended to the KAHE students who are affiliated with the KIIC that it be incorporated in the university Program Regulations 2023-24 and implement from this academic year.

Norms to Student Start-Ups

a) Any (UG/PG /(Ph.D.) Research scholars, student, right from the first year of their program is allowed to set a startup (or) work part time/ full time in a startup or work as intern in a startup

b) Any (UG/PG / (Ph.D.) Research scholars) student right from the first year of their program is allowed to earn credit for working on Innovative prototypes/business Models/ Pre incubation (case to case basis).

c) Start Up activities will be evaluated based on the guidelines being given by the expert committee of the KIIC

d) Student Entrepreneurs may use the address of incubation center (KIIC) to register their venture while studying in KAHE.

e) Students engaged in startups affiliated with the KIIC or those who work for them may be exempted from KAHE's attendance requirements for academic courses under current regulations, up to a maximum of 30% attendance per semester, including claims for ODs and medical emergencies Potential Students who have been incubated at KIIC may be permitted to take their University semester exams even if their attendance is below the minimum acceptable percentage, with the proper authorization from the head of the institution.
(On case-to-case basis depends upon the applicability strength, societal benefits and quality of the Innovation and Subsequent engagement of the students with the/ her business)

f) Any Students Innovators/entrepreneurs are allowed to opt their startup in place mini project /major project, /seminar and summer training etc. (In plant training, Internship, value added Course.). The area in which the student wishes to launch a Startup may be interdisciplinary or multidisciplinary.

g) Student's startups are to be evaluated by Expert committee, formed by KIIC and KAHE

Guide lines to award Credits/ Marks to a Student startup

Student's startup stages are divided into five phases and these startup phases can be considered equally in place of the course title as mentioned below with the same credits allotted to the course title in a University curriculum.

Sl. No.	Description/Startup phases	In place of the Subject / Course title	Grades/Credits /Marks
1	**Idea stage/Problem Identification**	**Seminar**	**Same Marks/Credits can be awarded that are listed in the course title's curriculum for the respective startup phases.**
2	**Proof of Concept (POC) /Solution development**	**In-plant training /Internship**	
3	**Product Development (Lab scale) /Prototype Model/ Company Registered**	**Mini Project/ Value added Course**	
4	**Validation/Testing**	**Main Project phase I**	
5	**Business Model/Ready for Commercialization/Implementation**	**Main Project phase II,**	

PROGRAMME OUTCOMES (PO's)

1. Students have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
2. Graduates effectively communicate scientific ideas and findings through written reports, oral presentations, and visual aids to diverse audiences, demonstrating clarity, coherence, and professionalism.
3. Graduates critically evaluate scientific literature, experimental data, and theoretical models to identify assumptions, biases, limitations, and implications, fostering a mindset of skepticism and inquiry.
4. Graduates able to apply creative and systematic approaches to identify, analyze, and solve complex problems in chemistry, drawing upon disciplinary knowledge and critical thinking skills to propose innovative solutions.
5. Graduates demonstrate proficiency in analyzing experimental data, interpreting spectroscopic and chromatographic results, and applying statistical methods to draw meaningful conclusions and make evidence-based decisions.
6. Graduates possess the practical skills necessary to design, conduct, and evaluate scientific research projects, including literature review, experimental design, data collection, analysis, and interpretation.
7. Students able to function as a member of an interdisciplinary problem-solving team.
8. Graduates employ logical reasoning and scientific principles to formulate hypotheses, design experiments, and draw valid conclusions, fostering a systematic and empirical approach to problem-solving.
9. Graduates engage in self-assessment and reflective practice to evaluate their own learning, professional growth, and ethical conduct, identifying areas for improvement and implementing strategies for continuous development.
10. Graduates demonstrate proficiency in accessing, evaluating, and utilizing scientific information from diverse sources, including electronic databases, online repositories, and scholarly publications.
11. Graduates take initiative in identifying learning goals, acquiring new knowledge and skills, and pursuing professional development opportunities independently, demonstrating autonomy and lifelong learning habits.
12. Graduates recognize and appreciate cultural diversity in scientific communities, demonstrating sensitivity, inclusivity, and respect for diverse perspectives and contributions in their professional interactions.
13. Graduates uphold ethical standards and principles in scientific research, professional practice, and decision-making, demonstrating integrity, honesty, and accountability in their work.
14. Graduates exhibit leadership qualities such as vision, integrity, effective communication, and collaboration, empowering others and driving positive change in scientific research and professional organizations.

15. Graduates embrace a commitment to lifelong learning and professional development, staying abreast of advancements in chemistry, engaging in continuing education, and contributing to the advancement of the field throughout their careers.

PROGRAMME SPECIFIC OUTCOMES (PSO's)

1. Chemistry graduates possess sufficient knowledge how to synthesize, characterize and analyze chemical compounds using modern analytical tools and advanced technologies very skillfully.
2. The student is capable of handling advanced instruments and chemistry related software for chemical analysis, characterization of materials and in separation technology and are capable of doing research through appropriate questions, planning and reporting experimental investigation

DEPARTMENT OF CHEMISTRY

FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

PG PROGRAM (CBCS)

M.Sc., Chemistry (2024-2025 Batch and onwards)

Course Code	Name of the Course	Category	Outcomes		Instruction hours per week			Credits	Maximum Marks			Page No.
			PO	PSO	L	T	P		CIA	ESE	Total	
									40	60	100	
Semester-I												
24CHP101	Organic Chemistry-I (Reaction Mechanisms)	CC	1,3,4	1,2	4	0	0	4	40	60	100	1
24CHP102	Inorganic Chemistry-I (Nuclear Chemistry and Metallic Clusters)	CC	1,4,5,6,10	1,2	4	0	0	4	40	60	100	4
24CHP103	Physical Chemistry- I (Quantum Chemistry and Surface Chemistry)	CC	1,3,4	2	4	0	0	4	40	60	100	7
24CHP104	Molecular Spectroscopy	CC	1,3,5,6,9,15	1,2	4	0	0	4	40	60	100	10
24CHP105A	Green Chemistry	EC	1,3,4,6,8,11,13, 15	1	4	0	0	4	40	60	100	13
24CHP105B	Pharmaceutical Chemistry	EC	1,3,4,6,10, 11, 13	-								16
24CHP105C	Applied Chemistry	EC	1,3,4,6,9,14	1								19
24CHP111	Organic Chemistry Practical-I (Qualitative Analysis and Single Stage Preparations)	CC	1,3,7,9,14	1,2	0	0	4	2	40	60	100	21
24CHP112	Organic Chemistry Practical-II (Quantitative Analysis and Double Stage Preparations)	CC	1,4,6,7,11	1	0	0	4	2	40	60	100	23
	Journal Paper Analysis and Presentation		1,2,3,4,5,6	1,2	2	-	-	-	-	-	-	
	Semester Total				**22**	**0**	**8**	**24**	**280**	**420**	**700**	

Semester-II												
24CHP201	Organic Chemistry-II (Rearrangements, Reactions, Photochemistry and Pericyclic Reactions)	CC	1,3,4,6,8,15	-	4	0	0	4	40	60	100	25
24CHP202	Inorganic Chemistry-II (Co-ordination Chemistry)	CC	1,3,4,5,6	1	4	0	0	4	40	60	100	28
24CHP203	Physical Chemistry- II (Group Theory and Chemical Kinetics)	CC	1,3,5	1,2	4	0	0	4	40	60	100	31
24CHP204	Analytical Chemistry	CC	1,5,6,9,11	1	4	0	0	4	40	60	100	34
24CHP205A	Water Chemistry	EC	1,4,5	1,2	3	0	0	3	40	60	100	37
24CHP205B	Advanced Energy Devices	EC	1,3,6,8,11,14,15	-								40
24CHP205C	Computational Methods in Chemistry	EC	3,7,8,9,10,11	-								43
24CHP206	Community Engagement and Social Responsibility	CC	1,2,3,4,5,6,7,8,10,15	2	2	0	0	2	40	60	100	45
24CHP211	Inorganic Chemistry Practical-I (Qualitative Analysis and Preparations)	CC	1,4,7,8,13	1	0	0	4	2	40	60	100	48
24CHP212	Inorganic Chemistry Practical-II (Quantitative Analysis and Complex Preparations)	CC	1,4,5,7,8,13	1	0	0	4	2	40	60	100	50
	Journal Paper Analysis & Presentation		1,2,3,4,5,6	1,2	1	-	-	-	-	-	-	
	Semester Total				**22**	**0**	**8**	**25**	**320**	**480**	**800**	
Semester-III												
24CHP301	Organic Chemistry-III (Natural Products)	CC	1,4,5	1,2	4	0	0	4	40	60	100	52
24CHP302	Physical Chemistry-III (Thermodynamics)	CC	1,3,4	1	4	0	0	4	40	60	100	55
24CHP303	Physical Methods in Chemistry (Instrumentation**)**	CC	1,3,6	1	4	0	0	4	40	60	100	58
24CHP304	Polymer Chemistry	CC	1,6,9	1,2	4	0	0	4	40	60	100	61
24CHP305A	Industrial Organic Synthesis	EC	1,3,4,5,6	-	4	0	0	3	40	60	100	64

24CHP305B	Biocatalytic Processes in Chemical Industries	EC	1,3,6	1								67
24CHP305C	Nanochemistry	EC	1,6,11	1								70
24CHP311	Physical Chemistry Practical-I (Molecular Weight Determination and Conductometric Titrations)	CC	1,4,9	1	0	0	3	2	40	60	100	73
24CHP312	Physical Chemistry Practical-II (Chemical Kinetics and Potentiometric Titrations)	CC	1, 4,9	1	0	0	3	2	40	60	100	75
	Journal Paper Analysis and Presentation		1,2,3,4,5,6	1,2	1	-	-	-	-	-	-	
24XXPOE301	Open Elective	OEC	-	-	3	0	0	2	40	60	100	77-98
24CHP391	Internship*				0	0	0	2	100	0	100	99
	Semester Total				**24**	**0**	**6**	**27**	**420**	**480**	**900**	
Semester-IV												
24CHP491	Project and Viva-Voce		1,2,3,4,5,6	1,2	0	0	30	15	80	120	200	100
	*End of II Semester Internship for 15 days											
Semester Total					**0**	**0**	30	**15**	**80**	**120**	**200**	
Grand Total					**68**	**0**	**52**	**91**	**1100**	**1500**	**2600**	

CC-Core Course; EC-Elective Course; OEC-Open Elective Course

List of Elective Courses					
Elective-I		**Elective-II**		**Elective-III**	
Code	**Course**	**Code**	**Course**	**Code**	**Course**
24CHP105A	Green Chemistry	24CHP205A	Water Chemistry	24CHP305A	Industrial Organic Synthesis
24CHP105B	Pharmaceutical Chemistry	24CHP205B	Advanced Energy Devices	24CHP305B	Biocatalytic Processes in Chemical Industries
24CHP105C	Applied Chemistry	24CHP205C	Computational Methods in Chemistry	24CHP305C	Nanochemistry

List of Open Elective Courses

S. No.	**Name of the Offering Department**	**Course Code**	**Course Name**
1	English	24EGPOE301	English for Competitive Examinations
2	Commerce	24CMPOE301	Personal Finance and Planning
3	Management	24MBAPOE301	Organizational Behaviour
4	Computer Applications	24CAPOE301	Robotic Process Automation
5	Computer Science	24CSPOE301	Cyber Forensics
6	Mathematics	24MMPOE301	Coding Theory
7	Physics	24PHPOE301	Electrical Appliances and Servicing
8	Chemistry	24CHPOE301	Industrial Chemistry
9	Microbiology	24MBPOE301	Fermentation Technology
10	Biotechnology	24BTPOE301	Nutrition and Dietetics

Semester I

24CHP101 ORGANIC CHEMISTRY-I (REACTION MECHANISMS) 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam: 3 Hours

PREREQUISITE:

Critical understanding of fundamental Organic Chemistry at the B.Sc. level in general and, in particular, bonding, aromaticity, addition, elimination and substitution reactions.

COURSE OBJECTIVES (CO):

- To understand the aromaticity, its types and techniques in the determination of reaction mechanism.
- To apply addition, elimination, nucleophilic and electrophilic substitution reaction concepts involved in organic synthesis.
- To analyze the synthetically important reagents.

COURSE OUTCOMES (COs):
Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Interpret the concept of aromaticity and the main properties of aromatic compounds.	Understand
CO2	Discuss the mechanisms using rate law data predict whether or not a proposed mechanism is viable or not.	Create
CO3	Design multistep synthesis using retrosynthesis analysis.	Create
CO4	Apply concepts associated with these general reaction types to product predication, synthesis design and reaction mechanism.	Apply
CO5	Identify simple reagents to make/break a bond to synthesize a given target molecule.	Apply

UNIT I AROMATICITY AND CHEMICAL METHODS IN MECHANISMS 9 HOURS

Aromaticity: Introduction–Modern definitions of aromaticity, Huckel's rule & Craig's rule-non-aromatic, antiaromatic and homoaromatic compounds-aromaticity of benzenoid and heterocyclic compounds. Non-benzenoid aromatics-annulenes, azulene, ferrocene, fulvenes, tropolone and sydnones (synthesis not required).

Chemical methods in mechanisms: Kinetic methods of study of reaction mechanisms-Primary and secondary kinetic isotopic effects-limitations of kinetic methods. Non-kinetic methods of study of reaction mechanisms-Identification of products, study of intermediates, isotopic labeling, stereochemical studies, and cross over experiments. Hammond's postulate-

Kinetic and thermodynamic control.
Linear free energy relationship - Hammett equation and Taft equation.

UNIT II ADDITION REACTIONS AND CONCEPTS IN ORGANIC SYNTHESIS

11 HOURS

Addition reactions: Electrophilic, nucleophilic and free radical additions-addition to double and triple bonds- hydration, hydroxylation, Michael addition, hydroboration and epoxidation.

Addition reactions to carbonyl compounds-Mannich reaction, Meerwein Pondroff-Verley reduction, Grignard, Claisen, Dieckmann, Stobbe, Knovenagel, Darzen, Wittig, Thorpe and Benzoin reactions.

Concepts in organic synthesis: An introduction to Retrosynthesis, types of synthesis- linear and convergent synthesis.

UNIT III ELECTROPHILIC SUBSTITUTION REACTIONS 9 HOURS

Aromatic electrophilic substitution reactions-Arenium ion mechanism–orientation and reactivity in monosubstituted benzene rings and orientation in benzene rings with more than one substituent. Reactions involving nitrogen electrophiles: nitration, and diazonium coupling. Sulphur electrophiles: sulphonation. Halogen electrophiles: chlorination and bromination. Carbon electrophiles: Friedel-Crafts alkylation, and acylation reactions. Formylations-Gattermann, Gattermann Koch, Riemer Tiemann and Vilsmeier-Haack reactions. Kolbes, Bischler-Napieralski and Hofmann-Martius reactions.

Aliphatic electrophilic substitution reactions-SE1, SE2 and SEi mechanisms-structure reactivity relationship, typical electrophilic substitution reactions-Friedel crafts acylation at olefinic carbon, Stork enamine reaction and decarboxylation of aliphatic acids.

UNIT IV NUCLEOPHILIC SUBSTITUTION REACTIONS 8 HOURS

Aliphatic nucleophilic substitution reactions-S_N1, S_N2, ion pairs and S_Ni mechanisms-nucleophilic substitution at vinyl carbon. Stereochemistry of nucleophilic substitution reaction - effect of substrate structure-solvent effects-leaving group effect-nucleophilicity, ambident nucleophiles and ambident substrates- neighbouring group mechanism-neighbouring group participation by π and σ bonds.

Aromatic nucleophilic substitution reactions-benzyne mechanism, intermediate complex mechanism and S_N1 mechanism, structure reactivity relationship. Ziegler alkylation and Chichibabin reaction.

UNIT V ELIMINATION REACTIONS AND REAGENTS IN ORGANIC SYNTHESIS

11 HOURS

Elimination reactions: E1, E2, Ei and E1cB mechanisms-stereochemistry of eliminations. Hofmann rule-Saytzeff rule-Bredts rule-Substitution versus Elimination. Typical elimination

reaction-Chugaev reaction, Hofmann degradation and Cope elimination.

Carbenes and nitrenes-structure, generation and reactions.

Reagents in organic synthesis: Preparations and synthetic applications of DDQ, DBU, Dimethyl sulfoxide, Trimethylsilyl iodide, Osmium tetroxide, Selenium dioxide, Dicyclohexylcarbodiimide (DCC), LDA, DIBAL-H and Mercuric acetate.

TOTAL:48 HOURS

TEXT BOOKS

1. Smith, M. B. (2015). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure* (VII Edition). New Jersey: John Wiley & Sons, Inc., Hoboken.
2. Peter Sykes, (1995). *A Guidebook to Mechanism in Organic Chemistry* (VI Edition). New York: John Wiley & sons Inc.
3. Warren, S., & Wyatt, P. (2008). *Organic Synthesis: The Disconnection Approach* (II Edition). John Wiley & Sons Ltd., Chichester.

REFERENCE BOOKS

1. Sanyal, S. N. (2014). *Reactions, Rearrangements and Reagents* (IV Edition). New Delhi: Bharathi Bhawan (Publishers and Distributors).
2. Tewari, N. (2011). *Advanced Organic Reaction Mechanism* (III Edition). Kolkata: Books and Allied (P) Ltd.
3. Clayden, J., Greeves, N. & Warren, S. (2012). *Organic Chemistry* (II Edition). Oxford University Press, Oxford.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PSO1	PSO2
CO1	2	-	1	3	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	-	3	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	-	3	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO5	3	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1	2
Average	**2.8**	**-**	**2.2**	**2.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.2**	**1.8**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester I

24CHP102 INORGANIC CHEMISTRY-I (NUCLEAR CHEMISTRY AND METALLIC CLUSTERS) 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**
End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of various inorganic chemistry principles at the B. Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the diversity and structure of inorganic rings, cages, clusters and organometallic compounds.
- To explore the synthesis, structure, bonding, and reactivity of organometallic complexes.
- To understand the behavior of atomic nuclei through the study of nuclear structure, radioactive decay, and reactions, emphasizing their applications in energy, medicine, and scientific research.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the fundamentals of metallic clusters, boranes and related compounds.	Evaluate
CO2	Categories the various defects and its application on inorganic crystals.	Analyze
CO3	Apply the concepts acquired in the field of organometallic compounds to design the catalyst and to synthesis the chemicals.	Apply
CO4	Evaluate the stability of nuclei and predict modes of radioactive decay based on nuclear structure and properties.	Evaluate
CO5	Discuss the principles of nuclear reactions to understand energy generation, isotope production, and advanced applications in nuclear chemistry.	Create

UNIT I INORGANIC RINGS, CAGES AND CLUSTERS 10 HOURS

Inorganic chains – rings - cages and clusters (definition and structure)-metal-metal bonding-metal clusters - dinuclear clusters - trinuclear clusters - tetranuclear clusters - hexanuclear clusters - organometallic clusters. Silicates and siloxanes. Fullerens and their similar compounds.

Boranes, boron hydrides (structure and properties)-carboranes, Applications of metal clusters (metalloboranes)-metallocarboranes-Wade's theory-closo-nido and arachno structures-borazines, phosphazenes -sulphur- nitrogen ring compounds. Isopoly and heteropoly acids of V, Cr, Mo and W.

UNIT II METALLIC STATE AND ORGANOMETALLIC CHEMISTRY 9 HOURS

Metallic state: Free electron, band and zone theories - non stoichiometry - point defects in solids - Schottky and Frenkel defects - linear effects - dislocation - effects due to dislocation - electrical properties of solids - insulators-intrinsic semiconductors - n and p type and super conductors - ceramics elementary treatment.

Organometallic Chemistry: Types of Organometallic compounds – classification of ligands and their uses- basic principles of ligand-field theory- molecular orbital theory – 16 and 18-electron rule-limitations and its applications, synthesis, bonding structure and reactivity, Organometallics in homogeneous catalysis.

UNIT III HETEROGENEOUS CATALYTIC REACTIONS 9 HOURS

Synthesis, structure, bonding and reactivity of metal complex with alkenes, cyclopentadienyl (Metallocenes & benzenoid system)-Organometallic compounds in homogeneous catalytic reactions-coordinative unsaturation, acid-base behavior reaction–migration of atoms or groups from metal to ligand– insertion reaction–reactions of coordinated ligands–catalytic reactions of alkenes– isomerisation of alkenes –carboxylation of methanol and hydrogenation of unsaturated organic compounds- hydroformylation and hydrosilation of alkenes alkene polymerization and oligomerisation – fluxional molecules.

UNIT IV NUCLEAR CHEMISTRY 10 HOURS

Nuclear Chemistry - the nucleus - subatomic particles and their properties, Nuclear binding energy- Nuclear structure- liquid model- shell model. N/P ratios in stable and meta stable nuclei - nuclear forces. Modes of radioactive decay-α, β and γ decay radiation, electron capture, nuclear isomerism and internal conversion. Thermo nuclear reactions.

UNIT V NUCLEAR REACTIONS 10 HOURS

Nuclear reactions - Bethe's notation, Q-value, columbic barrier, cross section, different types of nuclear reactions with accelerated particles-projectiles capture - particle emission, spallation, fragmentation, fission, fusion, theories of fission, use of fission products, fissile and fertile isotopes- U^{233},U^{235}, Pu^{239}, Th^{232}, Radio analytical technique and activation analysis, magnetic confinement. Atomic power projects in India, stellar energy, synthetic elements - application of radio isotopes - Hot atom chemistry**.**

TOTAL:48 HOURS

TEXT BOOKS:

1. Huheey, J. E., Keitler, E. A., & Keitler, R. L. (2011). *Inorganic Chemistry- Principles of Structure and Reactivity* (IV Edition). Singapore: Pearson Education.
2. Shekar, C. V. (2014). *A Text Book of Nuclear Chemistry* (I Edition). New Delhi: Dominant publishers and Distributors (P) Ltd.
3. Arnikar, H. J. (2011). *Essentials of Nuclear Chemistry* (IV Edition). New Delhi: New Age International Publishers Pvt. Ltd.
4. Gupta, B. D. (2013). *Basic Organometallic Chemistry: Concepts, Syntheses and Applications*. Universities Press.
5. Glasstone, S. (2014). *Sourcebook on Atomic Energy* (III Edition). New Delhi: East West Press.
6. Madan, R. D. (2019). *Modern Inorganic Chemistry*. New Delhi: S. Chand & Co.
7. Puri, B. R., Sharma, L. R. & Kalia, K. C. (2017). *Principles of Inorganic Chemistry* (33rd Edition). New Delhi: Shoban Lal & Co.

REFERENCE BOOKS:

1. Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). *Advanced Inorganic Chemistry* (VI Edition). New York: John Wiley & Sons.
2. Malik, W. C., Tuli, G.D. &Madan. R.D. (2010). *Selected Topics in Inorganic Chemistry*. New Delhi. S. Chand & Co.
3. Gurdeep Raj, (2014). *Advanced Inorganic Chemistry* Vol. I (24th Revised Edition). Meerut: Goel Publishing House.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	2	1	2	-	-	-	1	-	-	-	-	-	2	-
CO2	3	-	-	2	1	1	-	-	-	1	-	-	-	-	-	1	2
CO3	3	-	-	2	1	-	-	-	-	1	-	-	-	-	-	1	-
CO4	3	-	-	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	-	2	3	-	-	-	-	-	-	-	-	-	-	2	-
Average	**3**	**-**	**-**	**2**	**1.6**	**1.5**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1.6**	**2**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester I

24CHP103 PHYSICAL CHEMISTRY- I (QUANTUM CHEMISTRY AND SURFACE CHEMISTRY) 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of various physical chemistry principles at the B. Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the fundamentals and applications of classical mechanics and quantum chemistry.
- To know about the wave nature of particles, derivation of Schrodinger wave equations and their applications.
- To know about the different types of catalysis in surface reactions.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the concepts of quantum mechanics and how to apply them to model systems.	Evaluate
CO2	Develop connection between quantum mechanical operators and observables, probability and amplitude.	Create
CO3	Elaborate the methods from differential equation to solve the time-independent Schrodinger equation for model systems.	Create
CO4	Apply approximation methods to obtain energies and wave functions for quantum mechanics systems where Schrodinger equation does not have an exact solution.	Apply
CO5	Justify the essential facts, principles and theories across the modelling isotherm, theories of catalysis and preparation of colloids.	Evaluate

UNIT I FAILURE OF CLASSICAL MECHANICS AND OPERATORS 11 HOURS

Failure of classical mechanics and the success of quantum theory in explaining black body radiation and photoelectric effect.

The time dependent and time independent Schrodinger equations - Born's interpretation of the wave function. Requirements of the acceptable wave function.

Algebra of operators. Sums and products of operators - commutator - linear operators- eigen

functions and eigen values - correspondence between physical quantities in classical mechanics and operators in quantum mechanics - Hamiltonian operator - angular momentum operator. Quantization of angular momentum and its spatial orientation - average values - postulates of quantum mechanics.

UNIT II SCHRODINGER EQUATION 9 HOURS

Particle in a one-dimensional box - quantization of energy - normalization of wave function - orthogonality of the particle in a one-dimensional box wave functions. Illustration of the uncertainty principle and correspondence principle with reference to the particle in a one-dimensional box - particle in a three dimensional box - separation of variables.

Solving of Schrodinger equation for one-dimensional harmonic oscillator. Harmonic oscillator model of a diatomic molecule. Illustration of the uncertainty principle and correspondence principle with reference to harmonic oscillator. Solving of Schrodinger equation for a rigid rotor. Rigid rotor model of a diatomic molecule.

UNIT III APPROXIMATION METHODS 9 HOURS

Schrodinger equation for the H-atom (or H-like species)- separation of variables - energy levels. Radial distribution functions - orbitals and orbital shapes. Probability density and radial distribution functions.

Need for approximation methods. The perturbation theory- application of perturbation method to systems such as anharmonic oscillator and He-atom.

The variation method - application of variation method to systems such as anharmonic oscillator and He-atom.

UNIT IV SURFACE CHEMISTRY 10 HOURS

Adsorption by solids - Chemisorption - Applications of adsorption - Adsorption of gases by solids - Factors influencing adsorption – The Freundlich adsorption isotherm – The Langmuir theory of adsorption – BET theory of multilayer adsorption – Derivation of the BET equation – Types of adsorption isotherms – Adsorption from solution – The Gibbs adsorption isotherm – Insoluble surface films on liquids.

UNIT V CATALYSIS IN SURFACE CHEMISTRY II 9 HOURS

Characteristics of catalytic reactions – Acid-base catalysis – Enzyme catalysis – Mechanism and kinetics of enzyme-catalyzed reactions – The Michaelis– Menten equation – Effect of temperature on enzyme catalysis – Heterogeneous catalysis: Surface reactions – Kinetics of Surface reactions – Unimolecular surface reactions – Bimolecular surface reactions – pH-dependence of rate constants of catalyzed reactions – Autocatalysis and oscillatory reactions.

Micelle formation - Macroemulsions – Factors determining stability of emulsions – Microemulsions – Theories of emulsions.

TOTAL:48 HOURS

TEXT BOOKS:

1. Prasad, R. K. (2014). *Quantum Chemistry* (IV Revised Edition). New Delhi: New Age International Publishers Pvt. Ltd.
2. Chandra, A. K. (2017). *Quantum Chemistry* (IV Edition). New Delhi: Tata McGraw – Hill Publishing Company Ltd.
3. House, J. E. (2004). *Fundamental of Quantum Chemistry* (II Edition). New Delhi: Academic Press.
4. Puri, B. R., Sharma, L. R., Pathania, M. S. (2020). *Principles of Physical Chemistry* (47th Edition). Jalandar: Vishal Publishing Co.

REFERENCE BOOKS

1. Levine, I. N. (2016). *Quantum Chemistry* (VII Edition). New Delhi: Pearson Education Pvt. Ltd.
2. Atkins, P., & De Paula, J. (2014). *Atkins Physical Chemistry* (X Edition). Oxford: Oxford University Press.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO5	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Average	**3**	**-**	**1.8**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester I

24CHP104 MOLECULAR SPECTROSCOPY 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of spectroscopic principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To understand about UV, IR, NMR spectroscopy and its application
- To analyze about the Mass spectroscopy and its various types of fragmentation process.
- To know about basic principles of Mossbauer spectroscopy and evaluate the invaluable tools in chemistry

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the electronic spectroscopy and their applications.	Evaluate
CO2	Apply IR and NMR spectroscopic techniques to determine/elucidate the structure of organic molecules.	Apply
CO3	Predict the outcome of organic reactions and design synthesis for organic molecules.	Create
CO4	Compare the various types of fragmentation process in Mass spectroscopy.	Evaluate
CO5	Interpret UV, IR, NMR and MS spectra of sample organic molecules.	Evaluate

UNIT I ULTRAVIOLET AND VISIBLE SPECTROSCOPY 9 HOURS

Introduction- laws of photochemistry- Instrumentation-Theory of electronic spectroscopy-Types of electronic transition-Electronic spectra of diatomic molecules -correlation of electronic structure with molecular structure - The chromophore concept-Auxochrome-Absorption and intensity shifts-Types of absorption bands-Solvent effects-effects of conjugation-Woodward-Fisher rules for α, β unsaturated carbonyl compounds & dienes - aromatic systems with extended conjugation - applications to organic and inorganic compounds.

UNIT II INFRARED SPECTROSCOPY 8 HOURS

Introduction- Theory of molecular vibrations- Vibrational frequency-Number of fundamental vibrations-Instrumentation-The vibrating diatomic molecules-the simple harmonic oscillator and anharmonic oscillator - the diatomic rotor - factors influencing vibrational frequencies - identification of fundamental groups. Fingerprint region-application to organic and inorganic

compounds.

UNIT III NMR SPECTROSCOPY 12 HOURS

Introduction-Principle of NMR spectroscopy-relaxation process-number of signals- description of the PMR instrument, chemical shift equivalence and magnetic equivalence –chemical shift-factors affecting chemical shifts- splitting of the signals - coupling constant- spin-spin coupling - first order and non-first order spectra - hetero nuclear coupling in ^{1}HNMR - deuterium exchange - high field spectra - double resonance-shift reagents-applications to organic and inorganic compounds.

^{13}C NMR spectroscopy-broad band and off resonance decoupling- applications in organic chemistry. 2D-NMR- Correlation spectroscopy ^{1}H^{1}H COSY, ^{1}H^{13}C HETEROCOSY and DEPT techniques.

UNIT IV MASS SPECTROSCOPY 9 HOURS

Principles of mass spectrometry – resolution - description of single focusing and double focusing electron impact mass spectrometers - presentation and analysis of spectra - determination of molecular formulae - Nitrogen rule- Stevenson's rule - isotope abundance analysis - meta stable ions and peaks the molecular ion peak - fragmentation processes - Retro Diels - Alder rearrangement - McLafferty rearrangement - ortho effect-fragmentation associated with functional groups - aldehydes, ketones, carboxylic acids, esters, amides, alcohols, thiols, amine, ethers, sulphides and halides..

UNIT V MOSSBAUER & PROBLEMS 10 HOURS

Mossbauer spectroscopy – principles - spectrometer - isomer shift - quadrupole interaction - nuclear zeeman splitting – applications.

Problems involving UV, IR, NMR, Mass spectral data (for compounds not more than 10 carbon atoms).

TOTAL:48 HOURS

TEXT BOOKS:

1. Jag Mohan. (2018). *Organic Spectroscopy: Principles and Applications* (II Edition). New Delhi: Narose Publishing House.
2. Kemp, W. (2017). *Organic Spectroscopy* (III Edition). New York: Palgrave Macmillan.
3. Sharma, Y. R. (2017). *Elementary Organic Spectroscopy: Principles and Chemical Applications* (Revised Edition). New Delhi: S. Chand & Company Limited.
4. Banwell. (2017). *Fundamentals of Molecular & Spectroscopy* (IV Edition), McGraw-Hill Education (India) Pvt. Limited.
5. Kalsi, P. S. (2002). *Spectroscopy of Organic compounds* (5th Edition), New Age International (P) Limited, Publishers.

REFERENCE BOOKS:

1. Silverstein, R. M., Webster, F. X., & Kiemle, D. (2014). *Spectroscopy of Organic Compounds* (VIII Edition). New York: John Wiley & Sons.
2. Drago, R. S. (2012). *Physical Methods in Inorganic Chemistry*. New York: East- West Press Pvt. Ltd.
3. Sharma., B. K. (2012). *Instrumental Methods of Chemical Analysis* (28th Edition) Meerut: Krishna Prakashan Media (p) Ltd.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PSO1**	**PSO2**
CO1	3	-	1	-	2	1	-	-	1	-	-	-	-	-	1	1	2
CO2	3	-	1	-	2	1	-	-	1	-	-	-	-	-	1	1	2
CO3	3	-	1	-	2	1	-	-	1	-	-	-	-	-	1	1	2
CO4	3	-	1	-	2	1	-	-	1	-	-	-	-	-	1	1	2
CO5	3	-	1	-	2	1	-	-	1	-	-	-	-	-	1	1	2
Average	**3**	**-**	**1**	**-**	**2**	**1**	**-**	**-**	1	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester I

24CHP105A **GREEN CHEMISTRY** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.

COURSE OBJECTIVES (CO):

- To understand about the concept of green chemistry and its principles.
- To know about sustainable chemical processes and products by minimizing environmental impact, reducing waste generation, and enhancing efficiency.
- To build the application of greener routes to improve industrial processes to produce important products.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Apply the principles of green chemistry to chemical related problems and waste reduction.	Evaluate
CO2	Propose the green chemistry synthesis.	Create
CO3	Assess chemical products and process and design greener alternatives when appropriate.	Evaluate
CO4	Support the principles of green chemistry to improve chemical manufacturing process.	Evaluate
CO5	Analyze toxicological data, material properties and regulatory requirements to choose safer chemicals to product formulation and process industry.	Analyze

UNIT I INTRODUCTION TO GREEN CHEMISTRY AND PRINCIPLES OF GREEN CHEMISTRY **9 HOURS**

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ obstacles in the pursuit of the goals of Green Chemistry. Twelve principles of Green Chemistry with their explanations. Synthesis involving basic principles of green chemistry–synthesis of styrene, green chemistry in day-today life-dry cleaning of clothes, versatile bleaching agents.

UNIT II DESIGNING A GREEN CHEMICAL SYNTHESIS 10 HOURS

Designing a Green synthesis using these principles: prevention of waste/by products; maximum incorporation of the materials used in the process into the final products, atom economy, and calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.

UNIT III ALTERNATIVE SOURCES OF ENERGY AND GREEN SYNTHESIS/REACTION 10 HOURS

Alternative sources of energy: Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. Microwave assisted reactions in water: Hofmann elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents. Diels-Alder reaction and decarboxylation reaction. Ultrasound assisted reactions: Sonochemical Simmons-Smith Reaction (Ultrasonic alternative to iodine).

Green synthesis/reaction: Green starting materials, Green reagents, Green solvents, reaction conditions, Green catalysis and Green synthesis- synthesis of disodium iminodiacetate, urethane, aromatic amines, and benzyl bromide (alternative to Strecker synthesis).

UNIT IV HAZARD ASSESSMENT AND MITIGATION IN CHEMICAL INDUSTRY 9 HOURS

Future trends in Green Chemistry-oxidation-reduction reagents and catalysts; biomimetic, multifunctional reagents; Combinatorial Green Chemistry; Proliferation of solvent less reactions; Noncovalent derivatization. Biomass conversion, emission control and bio-catalysis.

UNIT V APPLICATION OF GREEN CHEMISTRY: EXAMPLES OF REAL-WORLD CASES 10 HOURS

Introduction, Selected examples of Real-World applications of Green Chemistry-Greener synthetic pathway for the synthesis of Ibuprofen, application of surfactants for liquid carbon dioxide, development of environmentally benign marine antifoulant (ibutyltin oxide (TBTO) and sea nine (DCOI)), use of genetically engineered microbes as environmentally benign catalyst (adipic acid, catechol and BHT), polylactic acids as Green alternate of plastics (polyethylene, polypropylene and polyacetic acid). Rightfit™ Pigments: A Green replacement of toxic organic and inorganic pigments, healthier fats and oils by enzymatic interesterification.

TOTAL:48 HOURS

TEXT BOOKS:

1. Ahluwalia, V. K., & Kidwai, M. (2012). *New Trends in Green Chemistry* (II Edition). Germany: Kluwer Academic Publisher.
2. Ahluwalia, V. K. (2012). *Green Chemistry-Environmentally Benign Reactions*. New Delhi: Ane Books Pvt Ltd.
3. Tiwari, V. K., Kumar, A., Rajkhowa, S., Tripathi, G., Singh, A. K. (2022). *Green Chemistry: Introduction, Application and Scope.* Singapore: Springer Nature Singapore Pte Ltd.
4. Das, A. K. (2022). *Environmental Chemistry with Green Chemistry* (I Edition). Kolkata: Books & Allied (P) Ltd.
5. Matlack, A. S. (2001). *Introduction to Green Chemistry*. New York: Marcel Dekker.
6. Cann, M. C., & Connely, M. E. (2000). *Real-World Cases in Green Chemistry*. Washington: American Chemical Society.
7. Ryan, M. A., & Tinnesand, M. (2002). *Introduction to Green Chemistry*. Washington: American Chemical Society.

REFERENCE BOOKS:

1. Anastas, P. T., & Warner, J. C. (1998). *Green Chemistry: Theory and Practice*. Oxford: Oxford University Press.
2. Lancaster, M. (2010). *Green Chemistry: An Introductory Text* (II Edition). Cambridge: RSC Publishing.
3. Clark, J. H, & Macquarrie, D. J. (2002). *Handbook of Green Chemistry & Technology*. Abingdon: Blackwell Publishing.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	2	-	0	-	-	1	-	2	-	-	1	-	1	-	2	1	-
CO2	2	-	1	-	-	1	-	2	-	-	1	-	-	-	-	1	-
CO3	2	-	1	2	-	1	-	2	-	-	1	-	-	-	-	1	-
CO4	2	-	2	2	-	1	-	3	-	-	1	-	-	-	-	1	-
CO5	3	-	2	2	-	1	-	2	-	-	1	-	-	-	-	1	-
Average	**2.2**	**-**	**2**	**1.2**	**-**	**1**	**-**	**2.2**	**-**	**-**	**1**	**-**	**1**	**-**	**2**	**1**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP105B **PHARMACEUTICAL CHEMISTRY** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of the design and synthesis of compounds that are effective, safe, and targeted for therapeutic use.

COURSE OBJECTIVES (CO):

- To understand the principles of physical properties and analysis of drug molecules.
- To illustrate the drug dosage and development of new drugs.
- To explore the process of drug design through structure-activity relationship and quantitative structure activity relationship

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Determine physicochemical properties of drug molecules and analyze how to use them in formulation development.	Evaluate
CO2	Apply the principles of radiopharmaceuticals and physicochemical properties of drugs to evaluate the drug action.	Apply
CO3	Explain the principles of drug dosage forms, drug delivery systems, and drug regulation.	Evaluate
CO4	Analyze the methodologies involved in the development of new drugs.	Analyze
CO5	Develop proficiency in utilizing computers for analytical chemistry tasks, including programming in high-level languages like C++ to implement numerical method.	Apply

UNIT I PHYSICAL PROPERTIES IN PHARMACEUTICALS **9 HOURS**

Physical properties of drug molecule: physical properties. Refractive index- Definition, explanation, formula, importance, determination, specific & molar refraction. Optical activity\rotation- monochromatic & polychromatic light, optical activity, angle of rotation, specific rotation examples, measurement of optical activity. Dielectric constant & Induced Polarization- Dielectric constant explanation & determination. Rheology of pharmaceutical systems: Introduction, Definition, Applications, concept of viscosity, Newton's law of flow, Kinematic, Relative, Specific, Reduced & Intrinsic viscosity. Newtonian system, non-Newtonian system- Plastic flow, Pseudoplastic flow, Dilatant flow. Viscosity measurements- selection of viscometer for Newtonian and non-Newtonian system.

UNIT II ISOTOPIC DILUTION ANALYSIS 9 HOURS

Principle and applications, Neutron activation analysis: Principle, advantages and limitations, Scintillation counters: Body scanning. Introduction to radiopharmaceuticals. Properties of various types of radiopharmaceuticals, Radiopharmaceuticals as diagnostics, as therapeutics, for research and sterilization. Physico Chemical Properties and drug action. Physico chemical properties of drugs (a) Partition coefficient, (b) solubility (c) surface activity, (d) degree of ionization.

UNIT III DRUG DOSAGE AND PRODUCT DEVELOPMENT 10 HOURS

Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms. Drug dosage and product development. Introduction to drug dosage Forms & Drug Delivery system –Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms.

UNIT IV DEVELOPMENT OF NEW DRUGS 10 HOURS

Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isosterism, bioisosterism, spatial considerations, biological properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory, Quantitative structure activity relationship (QSAR): Development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator-variables.

UNIT V COMPUTERS IN PHARMACEUTICAL CHEMISTRY 10 HOURS

Need of computers for chemistry. Computers for Analytical Chemists-introduction to computers: Organization of computers, CPU, Computer memory, I/O devices, information storage, software components. Application of computers in chemistry: Programming in high level language (C+) to handle various numerical methods in chemistry –least square fit, solution to simultaneous equations, interpolation, extrapolation, data smoothing, numerical differentiation and integrations.

TOTAL:48 HOURS

TEXT BOOKS:

1. Bahl B. S., Tuli & Arun Bahl (2020). *Essentials of Physical Chemistry*. New Delhi: S. Chand and Co.
2. Subrahmanyam, C.V. S. (2018). *Text Book of Physical Pharmaceutics* (II edition). Publisher: Vallabh Prakashan.

3. Chatwal G.R. (2022). *Medicinal Chemistry (Organic Pharmaceutical Chemistry).* Himalaya Publishing House.
4. Jayshree Ghosh (2012). *Textbook of Pharmaceutical Chemistry*. S. Chand & Company Ltd.
5. Raman K.V. (1993). *Computers in Chemistry*. Tata Mc.Graw-Hill.
6. Pundir S. K., & Bansal, A. (2018). *Computers for Chemists* (II Edition). Meerut: Pragate Prakashan.
7. Allen Popvich, Ansel, (2004). *Pharmaceutical Dosage Forms and Drug Delivery System*. Indian edition-B.I. Publication Pvt. Ltd.

REFERENCE BOOKS:

1. Hubert H. Willard (1988). *Instrumental Method of Analysis* (VII Edition). Wadsworth Publishing Company.
2. Patrick J. Sink (2006). *Martin's Physical Pharmacy and Pharmaceutical Sciences* (VI Edition). Philadelphia: Lippincott Williams & Wilkins.
3. Carter S. J. (2005). *Cooper and Gunn's Tutorial Pharmacy* (VI Edition). CBS Publisher Ltd.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	1	-	2	2	-	1	-	-	-	-	2	-	1	-	-	-	-
CO2	1	-	2	2	-	2	-	-	-	-	2	-	1	-	-	-	-
CO3	1	-	2	2	-	2	-	-	-	-	2	-	3	-	-	-	-
CO4	1	-	2	2	-	2	-	-	-	-	2	-	1	-	-	-	-
CO5	1	-	2	2	-	2	-	-	-	2	2	-	1	-	-	-	-
Average	**1**	**-**	**2**	**2**	**-**	**1.8**	**-**	**-**	**-**	**2**	**2**	**-**	**1.4**	**-**	**-**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP105C **APPLIED CHEMISTRY** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**: 60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Basic level understanding of dairy and leather chemistry, ceramics, lubricants and fuels.

COURSE OBJECTIVES (CO):

- To understand the chemistry of dairy and leather processing
- To acquire knowledge about ceramic products and lubricants
- To learn about explosives and rocket fuels.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Analyze the structure, composition and properties of milk components and factors affecting milk quality, functionality and composition in milk products.	Analyze
CO2	Propose the sequential operations followed in tanning, post tanning and finishing operation on leather.	Create
CO3	Choose a raw material used in industrial processes and explain their chemical conversions.	Apply
CO4	Discuss the lubrication principles, including an understanding of their functions and practical applications.	Create
CO5	Develop a comprehensive understanding of explosives and rocket propellants.	Apply

UNIT I DAIRY CHEMISTRY **10 HOURS**

Composition of Milk, factors affecting the composition of milk, microflora of raw milk, milk fat/ proteins/sugar flavour and aroma, physical properties, effect of heat, milk processing – clarification, pasteurization, homogenization. Milk products- Cream, Butter, Ice cream and milk powder. Adulteration of milk

UNIT II LEATHER CHEMISTRY **10 HOURS**

Introduction, structure of hides and skin, leather processing – process before tanning-flaying and curing (drying, salt curing and brine curing and pickling), soaking, liming, fleshing, unhairing, deliming and bathing. Tanning processes – vegetable, synthetic, chrome and aldehyde tanning. Tannery effluents and byproducts – primary and secondary treatments.

UNIT III CERAMIC INDUSTRIES **9 HOURS**

Basic raw materials- chemical conversions including basic ceramic chemistry, whitewares, structural clay products, refractories – specialized ceramic products, vitreous enamel, and kilns.

UNIT IV LUBRICANTS **10 HOURS**

Introduction, functions, requirements, mechanism of lubrication, classification of lubricants, properties of lubricating oil – viscosity, viscosity index, oiliness, flash and fire points, cloud and pour points, carbon residue, aniline point, volatility, corrosion and decomposition stabilities

UNIT V EXPLOSIVES AND ROCKET FUELS **9 HOURS**

Introduction, characteristics, classification – primary, high and low, requirements of explosives, rocket propellants, characteristics, classification – solid and liquid propellants with examples

TOTAL:48 HOURS

TEXT BOOKS

1. Dhar, D. N. (2010). *Applied Chemistry*-II. Vayu Education of India.
2. Srilakshmi, B. (2014). *Food Science*. New Age International Publishers.
3. Ghosh, J. (2006). *Fundamental Concepts of Applied Chemistry* (I Edition). S. Chand & Co.
4. Karunanithi, M., Ramachandran, T., Venkataraman, H., & Ayyaswamy, N. (2006). *Applied Chemistry*. Anuradha Agencies.

REFERENCE BOOKS:

1. Adams, M. R., & Maurice O. Moss, (2007). *Food Microbiology* (III Edition). RSC, Publishers.
2. George T. Austin Shreve (1984). *Chemical Process Industries* (V Edition). McGraw-Hill Book Co.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO2	3	-	2	2	-	1	-	-	-	-	-	-	-	2	-	3	-
CO3	3	-	2	2	-	1	-	-	-	-	-	-	-	2	-	3	-
CO4	3	-	2	2	-	-	-	-	1	-	-	-	-	2	-	3	-
CO5	3	-	2	2	-	1	-	-	1	-	-	-	-	2	-	3	-
Average	**3**	**-**	**2**	**2**		**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1.8**	**-**	**3**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester I

24CHP111 ORGANIC CHEMISTRY PRACTICAL-I
(QUALITATIVE ANALYSIS AND SINGLE STAGE PREPARATIONS)

4H-2C

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**: 40** External**: 60** Total**: 100**
End Semester Exam: 4 Hours

PREREQUISITE:

Elementary level understanding of organic chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the principles behind the qualitative analysis by semi micro-qualitative analysis method.
- To apply the techniques to prepare the organic compounds.
- To evaluate the functional groups with their special tests.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the two-component organic mixtures and characterize them.	Evaluate
CO2	Propose to synthesis organic compounds in one stage process.	Create
CO3	Discuss the mechanistic aspects relevant to reaction outcomes.	Create
CO4	Compare and identify the relative merits of various synthetic methods.	Analyze
CO5	Design and carryout synthetic experiments, accurately reused and analyze the results of synthesis.	Create

Contents

Analysis of two-component mixtures: Separation and characterization of compounds.

Note: Each student should analyze a minimum of six organic mixtures.

Preparations involving one stage comprising of the following process: Nitration, acylation, halogenation, diazotisation, rearrangement, hydrolysis, reduction, alkylation and oxidation and one preparation illustrating the following: Benzoin condensation, Canizzaro reaction, Perkin reaction, Reimer-Tiemann reaction, Sandmayer reaction, Fries rearrangement, and Skraup synthesis- single stage.

Note: Each student should do a minimum of six preparations involving single stage.

TOTAL:48 HOURS

TEXT BOOKS:

1. Thomas, A. O., (2013). *Practical Chemistry*. Cannanore: Scientific Book Center.
2. Bansal, R. K, (2008). *Laboratory Manual of Organic Chemistry* (IV Edition). New Delhi: New Age Publishers.
3. Arun Sethi, (2010). *Systematic Lab Experiments in Organic Chemistry*. New Delhi: New Age Publisher.

REFERENCE BOOK:

1. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R., (2004). *Vogel's Textbook of Practical Organic Chemistry* (V Edition). Singapore: Pearson Education Ltd.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	-	2	-	-	-	-	-	-	1	-	2	-
CO3	3	-	3	-	-	-	-	-	-	-	-	-	-	1	-	2	-
CO4	3	-	2	-	-	-	2	-	2	-	-	-	-	1	-	2	2
CO5	3	-	2	-	-	-	2	-	2	-	-	-	-	1	-	2	2
Average	**3**	**-**	**2.2**	**-**	**-**	**-**	**2**	**-**	2	**-**	**-**	**-**	**-**	**1**		**2**	**2**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP112 ORGANIC CHEMISTRY PRACTICAL-II
(QUANTITATIVE ANALYSIS AND DOUBLE STAGE PREPARATIONS)

4H-2C

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**: 40** External**: 60** Total**: 100**
End Semester Exam: 4 Hours

PREREQUISITE:

Elementary level understanding of organic chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the basic principles and systematic procedure in quantitative analyses.
- To apply the systematic procedure for estimation of organic compounds.
- To analyze the different methods of extraction of natural products.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the basic principles and systematic procedure in quantitative analyses.	Evaluate
CO2	Experiment with the estimation of various organic compounds.	Apply
CO3	Determine and analyze iodine value, saponification and acetyl value of an oil.	Evaluate
CO4	Categorize the different methods of extraction of natural products.	Analyze
CO5	Plan to synthesis of organic compounds involving two stage preparations.	Create

Contents

I. Quantitative Estimation:

1. Estimation of phenol.
2. Estimation of ethyl methyl ketone.
3. Estimation of glucose.
4. Estimation of nitro compound.
5. Estimation of amino compound.
6. Estimation of methoxy groups.
7. Unsaturation of an organic compound.

II. Analysis of oils

1. Iodine value of an oil (Reichert- Meissl value).
2. Saponification value of an oil.
3. Acetyl value of an oil.

III. Double stage preparations

1. Anthranilic acid and pthalimides.

IV. Extraction from Natural Products (Extraction and estimation of active constituents) only for learning purpose and demo (**Not for exam)**

1. Lactose from milk.
2. Caffeine from tea.
3. Nicotine from tobacco extract.
4. Citric acid or ascorbic acid from a tablet or from a natural source.
5. Curcumin from turmeric.
6. Lycopene from tomato.

TOTAL:48 HOURS

TEXT BOOKS

1. Arun Sethi, (2010). *Systematic Lab Experiments in Organic Chemistry*. New Delhi: New Age Publisher.
2. Bansal, R. K, (2008). *Laboratory Manual of Organic Chemistry* (IV Edition). New Delhi: New Age Publishers.
3. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R., (2004). Vogel's *Textbook of Practical Organic Chemistry* (V Edition). Singapore: Pearson Education Ltd.

REFERENCE BOOK:

1. Mendham, J., Denney, R. C., Barnes, J.D., & Thomas, M. (2002). *Vogel's textbook of quantitative Chemical Analysis* (VI Edition). Singapore: Pearson Education Ltd.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	2	-	-	2	-	-	-	-	-	-	-	-	2	-
CO2	3	-	-	2	-	1	2	-	-	-	1	-	-	-	-	2	-
CO3	3	-	-	2	-	1	2	-	-	-	1	-	-	-	-	2	-
CO4	3	-	-	2	-	1	2	-	-	-	1	-	-	-	-	2	-
CO5	3	-	-	2	-	1	2	-	-	-	1	-	-	-	-	2	-
Average	3	-	-	2	-	1	2	-	-	-	1	-	-	-	-	2	-

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP201 ORGANIC CHEMISTRY-II

(REARRANGEMENTS, REACTIONS, PHOTOCHEMISTRY AND PERICYCLIC REACTIONS)

4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Critical understanding of fundamental Organic Chemistry at the B.Sc. level in general and, in particular stereochemistry, and very fundamental thermal and photochemical reactions.

COURSE OBJECTIVES (CO):

- To gain a versatile knowledge on the various forms of radical reactions and the rearrangements.
- To analyze the principles of conformational analysis and stereochemistry of organic compounds.
- To understand the concepts in organic photochemistry and various theories in pericyclic reactions

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Propose the mechanism of rearrangement reactions that are important for synthesis.	Create
CO2	Distinguish between different types of isomers, including enantiomers and diastereomers, use R & S descriptors to describe enantiomers and identification of conformers.	Analyze
CO3	Elaborate the advanced knowledge of structure and chemical behaviours of free radicals and to identify the process of oxidation and reduction.	Create
CO4	Explain the concepts of organic photochemistry.	Evaluate
CO5	Categorize the various theories in pericyclic reactions, cycloaddition and sigmatropic reactions.	Analyze

UNIT I MOLECULAR REARRANGEMENTS **10 HOURS**

Intramolecular 1,2 - shifts - Wagner - Meerwein and Pinacol-Pinacolone rearrangements. Migration to carbonyl carbon- Demyanov Neber and Benzil-Benzilic acid rearrangements. Rearrangements to electron deficient nitrogen and oxygen–Baeyer–Villiger, Dienone-Phenol, Favorskii, Fries, Wolff, Benzidine, Hoffmann, Beckmann and Stevens rearrangements. Non-cyclic rearrangements–Chapman and Wallach rearrangements**.**

UNIT II CONFORMATIONAL ANALYSIS AND STEREOCHEMISTRY 9 HOURS

Stereochemistry of sulphur and nitrogen compounds, stereo-selective and stereo-specific reactions - R/S-notation of optically active carbon compounds. Optical isomerism of biphenyls, allenes and spiranes. Planar chirality-cyclophanes and ansa compounds-geometrical isomerism - E/Z notation-configuration in aldoximes and ketoximes.
Conformation in cyclic system–decalins, perhydrophenanthrene and perhydroanthracene. Conformation and reactivity of cyclohexanes.

UNIT III RADICAL REACTIONS 10 HOURS

Configuration and generation of short lived free radicals-characteristics of free radical reactions – radical substitution, radical additions and rearrangement of free radicals. Typical reactions such as Sandmeyer, Gomberg, Pechmann, Ullmann, Pschorr and Hunsdiecker reactions.
Oxidation and reductions- mechanisms – aromatisation, oxidation of alcohols and glycols, ozonolysis, Sommelet reaction and selectivity in reduction-metal hydride reduction- reduction of nitro compounds and acyloin condensation.

UNIT IV ORGANIC PHOTOCHEMISTRY 9 HOURS

Introductory theory of light absorption-Jablonski diagram-Modified Jablonski diagram-photophysical processes-excimers and exciplexes-energy transfer-geometry of excited states–quantum efficiency- photochemical reaction of ketones- Norrish type-I and type-II reactions. Paterno Buchi reaction- cis and trans isomerisation-Photo-Fries rearrangement- Ene reaction-Di-pi-methane rearrangement- oxa and aza Di-pi-methane rearrangements-Barton reaction-Formation of reactive intermediates by molecular elimination-photoreduction of ketones.

UNIT V PERICYCLIC REACTIONS 10 HOURS

Definition-classification-characteristic features- the electrocyclic reaction-Woodward–Hofmann rules- orbital correlation diagram- the Frontier molecular orbital theory- electrocyclic conversion of 1,3-dienes and 1,3,5-trienes. Cycloaddition–[2+2] addition-Diel's Alder reaction-stereochemistry of Diel's-Alder reaction. Sigmatropic reactions–[1,3], [1,5] and [3,3] sigmatropic shifts – Cope, Oxy-Cope and Aza-Cope and Claisen rearrangements.

TOTAL:48 HOURS

TEXT BOOKS:

1. Smith, M. B. (2015). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure* (VII Edition). New Jersey: John Wiley & Sons, Inc., Hoboken.
2. Nasipuri, D. (2014). *Stereochemistry of Organic Compounds: Principles and Applications* (III Edition). New Delhi: New Age International (P) Ltd.
3. Mukherji, S. M., & Singh, S. P. (2014). *Reaction Mechanism in Organic Chemistry* (III Edition). New Delhi: Laxmi Publications Pvt. Ltd.

REFERENCE BOOKS:

1. Tewari, N. (2011). *Advanced Organic Reaction Mechanism* (III Edition). Kolkata: Books and Allied (P) Ltd.
2. Sanyal, S. N. (2014). *Reactions, Rearrangements and Reagents* (IV Edition). New Delhi: Bharathi Bhawan (Publishers and Distributors).
3. Ramesh, P. (2005). *Basic Principles of Organic Stereochemistry* (I Edition). Madurai: Meenu Publications.
4. Depuy, C. H., & Chapman, O. L. (1975). *Molecular Reactions and Photochemistry* (II Edition). New Delhi: Prentice-Hall of India Private Limited.
5. Coxon, J. M., & Halton, B. (2011). *Organic Photochemistry* (II Edition). New Delhi: Cambridge University Press.
6. Nicholass, J. T., Scaiano J. C., & Ramamurthy, V. (2010). *Modern Molecular Photochemistry of Organic Molecules* (I Edition). United States: University Science Books.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	3	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
CO2	3	-	1	-	-	2	-	1	-	-	-	-	-	-	1	-	-
CO3	3	-	1	2	-	2	-	1	-	-	-	-	-	-	1	-	-
CO4	3	-	1	2	-	2	-	1	-	-	-	-	-	-	1	-	-
CO5	3	-	1	2	-	2	-	1	-	-	-	-	-	-	1	-	-
Average	**3**	**-**	**1**	**2**		**1.8**		**1**	-	**-**	**-**		**-**	**-**	**1**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester II

24CHP202 INORGANIC CHEMISTRY- II (CO-ORDINATION CHEMISTRY)

4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of various inorganic chemistry principles at the B. Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the theories of bonding in coordination compounds and electronic spectra of the complexes.
- To gain the knowledge on metal carbonyls and organometallic chemistry.
- To study the types of co-ordination chemistry reactions and their application in biological system.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Elaborate the theories of bonding to coordination compounds and identify their magnetic behaviour.	Create
CO2	Apply the electronic spectra to determine the characteristics of coordination compounds.	Apply
CO3	Determine the strength of bonds, stability of various metal carbonyls.	Evaluate
CO4	Examine stability and structure of alkyl, alkene and cyclopentadienyl compounds.	Analyze
CO5	Classify the types of co-ordination chemistry reactions and its existence in our biological system.	Analyze

UNIT I COORDINATION CHEMISTRY AND BONDING **10 HOURS**

Nomenclature, isomerism and methods of preparation of coordination complexes- types of ligands. Bonding: Valence bond theory- Crystal field theory–Crystal field effects in tetrahedral, octahedral and square planar symmetries. Crystal field stabilization energy - weak and strong fields-calculation of 10Dq and B′ for octahedral complexes of Co(II) and Ni(II)-spectrochemical series. Molecular orbital theory: based on group theoretical approach. M.O. diagram of Oh. Td & square planar symmetries involving pi bonding-experimental evidence for the presence of pi bonding. Magnetic behaviour of the transition metal ions in crystal field and molecular orbital theories.

UNIT II ELECTRONIC SPECTRA OF COMPLEXES 9 HOURS

Term symbols for d configuration. Russell-Sander's coupling, L-S coupling and microstate table- determination of terms for p^2, d^1,d^2 and d^3 configurations. Hund's rule in the determination of lowest energy state. Characteristics of d-d transition - selection rules for electronic spectra. Weak and strong field limits. Orgel diagram and Tanabe – Sugano energy level diagrams. Spectrochemical series- Jahn-Teller tetrahedral distortion and spin orbit couplings. Nephelauxetic effect -charge transfer spectra. Luminescence spectra.

UNIT III METAL CARBONYLS 10 HOURS

Definition of organometallic compound - 18 electron rule - effective atomic number rule classification of organometallic compounds - the metal carbon bond types - ionic bond - sigma covalent bond - electron deficient bond - delocalised bond - dative bond - metal carbonyl complexes - synthesis - structure and reactions of metal carbonyls - the nature of M- CO bonding - binding mode of CO and IR spectra of metal carbonyls - metal carbonyls- metal carbonyl anions - metal carbonyl hydrides - metal carbonyl halides - metal carbonyl clusters - Wades rule and isolobal relationship - metal nitrosyls - dinitrogen complexes - dioxygen complexes.

UNIT IV METAL ALKYL, ALKENE AND CYCLOPENTADIENYL COMPLEXES

10 HOURS

Metal alkyl complexes: Stability and structure - synthesis by alkylation of metal halides - by oxidative addition - by nucleophilic attack on coordinated ligands - metal alkyl and 18 electron rule - reactivity of metal alkyls - M-C bond cleavage reactions - insertion of CO to M-C bonds - double carbonylation.

Metal alkene complexes: Synthesis of alkene complexes by ligand substitution - by reduction and by metal atom synthesis - bonding of alkenes to transition metals - bonding in diene complexes - reactivity of alkene complexes - ligand substitution - reactions with nucleophiles - olefin hydrogenation - hydrosilation - Wacker process - C-H activation of alkenes.

Cyclopentadienyl complexes: Metallocenes - synthesis of metallocenes - bonding in metallocenes - reactions of metallocenes - Cp_2Fe/Cp_2Fe+ couples in biosensors - bent sandwich complexes - bonding in bent sandwich complexes - metallocene halides and hydrides.

UNIT V REACTIONS OF COORDINATION COMPOUNDS AND BIOINORGANIC CHEMISTRY 9 HOURS

Reactions of coordination compounds: Substitution reactions in square planar and octahedral complexes - Trans effect - mechanism of redox reactions. Theories of Electron transfer reactions-outer spear mechanism-Marcus theory, inner spear mechanism, electron transfer in metalloproteins.

Bioinorganic Chemistry: Oxygen carriers-Haemoglobin and Myoglobin. Biological redox system: Cytochromes-classification, Cytochrome a, b and c and Cytochrome P-450. Non-hems oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur peoteins-Rubredoxin and Ferredoxin-structure and classification. Photosynthesis: Photosystem-I and Photosystem-II-Chlorophyll- structure and functions.

TOTAL:48 HOURS

TEXT BOOKS:

1. Huheey, J. E., Keitler, E. A., & Keitler, R. L. (2012). *Inorganic Chemistry- Principles of Structure and Reactivity* (IV Edition). Singapore: Pearson Education.
2. Malik. Wahid. U, Tuli. G. D and Madan, R.D. (2009). *Selected Topics in Inorganic Chemistry*. New Delhi: S. Chand and Co.
3. Sarn, K. (2005). *Co-ordination Chemistry* (I Edition). New Delhi: Rajat Publications.
4. Catherine, E. H., & Alan G. S. (2012). *Inorganic Chemistry* (IV Edition). England: Pearson Education Limited, Harlow.
5. Cotton, F. A., Wilkinson, G., & Paul. L. (2007). *Basic Inorganic Chemistry* (III Edition). New York: John Wiley & Sons.
6. Chakraburty, D. K. (2012). *Inorganic Chemistry*. (II Revised Edition) New Delhi: New Age International Publishing Pvt. Ltd.

REFERENCE BOOKS:

1. Aktins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F., & Hagerman, M. (2010). *Shriver & Atkins' Inorganic Chemistry* (V Edition). Britain: Oxford University Press.
2. Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). *Advanced Inorganic Chemistry* (VI Edition). New York: John Wiley & Sons.
3. Drago, R. S. (2012). *Physical Methods in Inorganic Chemistry*. New York: Rein Gold Publishing Corporation.
4. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, (2013). *Inorganic Chemistry*, Pearson

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	1	3	3	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	2	1	1	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	-	2	1	1	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	2	1	1	1	-	-	-	-	-	-	-	-	-	2	-
Average	**3**	**-**	**2.**	**1**	**1.4**	**1.6**	**-**	**-**	-	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

M.Sc. Chemistry **2024-2025**

Semester II

24CHP203 **PHYSICAL CHEMISTRY- II**

(GROUP THEORY AND CHEMICAL KINETICS) **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of physical chemistry principles at the B.Sc. level.

COURSE OBJECTIVES (CO):

- To knowledge about the symmetry of elements and matrices.
- To understand the fundamental knowledge of chemical kinetics and to establish a relationship between the rate of reaction and the concentration of the reactants.
- To analyze the various types of reactions in solution and its effects.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Classify molecules into point groups and able to construct character tables.	Analyze
CO2	Determine the character for irreducible representations for C_{2v} and C_{3v} point groups and also to determine the selection rules for vibrational spectra.	Evaluate
CO3	Explain the fundamental knowledge of chemical kinetics.	Evaluate
CO4	Categorize the various types of reactions in solution and its effects.	Analyze
CO5	Distinguish the different methods of fast reaction and kinetic theory of gases.	Analyze

UNIT I SYMMETRY ELEMENTS AND MATRICES **10 HOURS**

Symmetry elements and symmetry operations - definition of identical and equivalent elements configurations - effect of performing successive operations commutative and non-commutative - inverse operations.

Groups and their basic properties - definition of a group - basic properties of a group- definition of abelian - cyclic- isomorphic, finite, infinite groups and subgroup. Symmetry classification of molecules into point groups-Schoenflies symbol (only-difference between point group and space group).

Matrices- Definition of matrix, square matrix, diagonal matrix, null matrix, unit matrix, row matrix, column matrix, symmetric matrix, skew symmetric matrix and conjugate matrix. Multiplication, commutative and non commutative-determination of inverse of a matrix, block multiplication of matrices-addition and subtraction of matrices.
Matrix notations for symmetry operations of C_{2v} and C_{3v} groups-construction of character tables for C_{2v} and C_{3v} point groups**.**

UNIT II GROUP THEORY 9 HOURS

Definition of reducible and irreducible representations - irreducible representations as orthogonal vectors - direct product rule, the great orthogonality theorem and its consequences - determinations of the characters for irreducible representation of C_{2v} and C_{3v} point groups using the orthogonality theorem.

Group theory and Vibrational spectroscopy - vibrational modes as basis for group representation - symmetry selection rules for IR and Raman spectra, Mutual exclusion principle - classification of vibrational modes.

UNIT III CHEMICAL KINETICS AND THEORIES OF REACTION RATE 9 HOURS

Chemical kinetics: Rates of chemical reactions, kinetics of first, second and third order reactions and complex methods of determining rate laws, order and molecularity concepts.

Theories of reaction rates: Arrhenius theory- hard - sphere collision theory. Activated Complex Theory or Absolute reaction rate theory (ARRT). Unimolecular reaction rate theories –the simple Lindemann treatment – Hishelwood's theory– Rice, Ramsperger and Kassel (RRK) theory –Advanced unimolecular theory – Marcus theory or Rice, Ramspergcr, Kassel and Marcus (RRKM) theory.

UNIT IV REACTIONS IN SOLUTION 10 HOURS

Comparison between gas-phase and solution reactions. The influence of the solvent on the reactions between ions, reactions between ions and neutral molecules. Influence of ionic strength on rates of reactions in solution - primary salt effect-influence of pressure on rate of reactions in solution -significance of volume and entropy of activation. Secondary salt effect.
Parallel reactions of the same order (first and second, parallel first and second order reactions). Reversible reaction of the same order (first or second order). First order forward and second order backward. Consecutive first order reactions, steady state and rate determining step (or equilibrium) approximation of complex reactions. Chain reactions and explosions.

UNIT V FAST REACTIONS AND KINETIC THEORY OF GASES 10 HOURS

Fast reactions: Study of fast reactions by Flow methods, pulse methods, relaxation methods, shock-tube method and nuclear magnetic resonance method.
Kinetic theory of gases: Postulates-Maxwell distribution of molecular velocities-expressions for most probable velocity, average velocity, root mean square velocity. Collision diameter, collision frequency, Mean free path. Transport properties of gases-thermal conductivity,

viscosity, diffusion-principle of equipartition of energy.

TOTAL:48 HOURS

TEXT BOOKS

1. Raman, K.V. (2002). *Group Theory and Its Applications to Chemistry*. New Delhi: Tata McGraw Publishing Company.
2. Veera Reddy, K. (2009). *Symmetry and Spectroscopy of Molecules*. New Delhi: New Age International Pvt. Ltd.
3. Bahl, A., Bahl, B. S., & Tuli, G. D, (2014). *Essentials of Physical Chemistry* (V Edition). New Delhi: S. Chand & Company.
4. Puri, B.R., Sharma, L.R., & Pathania, M.S. (2015). *Elements of Physical Chemistry*. Jalandhar: Vishal Publishing House.
5. Gurdeep Raj, (2019). *Chemical Kinetics*. Meerut: Goel Publishing House.

REFERENCE BOOKS:

1. Cotton, F. A. (2003). *Chemical Applications of Group Theory* (III Edition). Texas: A Wiley Inter Science Publication.
2. Laidler, K. J. (2004). *Chemical Kinetics* (III Edition). New Delhi: Pearson Education Publishing. Indian Branch.
3. Frost, A. A., & Pearson, R. G. (1953). *Kinetics and Mechanism*. New York: Wiley Eastern, Pvt. Ltd.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	3	-	2	-	-	-	-	-	-	-	-	-	-	2	2
CO5	3	-	3	-	2	-	-	-	-	-	-	-	-	-	-	2	2
Average	**3**	**-**	**2.6**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP204 **Semester II**

ANALYTICAL CHEMISTRY **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of analytical chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the fundamentals of instrumentation techniques.
- To gain knowledge on the solvent extraction and separation techniques.
- To analyze the electro analytical techniques and its applications.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Classify, determine and minimize errors in chemical analysis.	Analyze
CO2	Develop the calibration methods of the instruments and validate the analytical methods.	Create
CO3	Apply the knowledge of extraction and separation of mixtures of organic compounds by various chromatographic methods.	Apply
CO4	Estimate the chemicals using various electroanalytical techniques.	Create
CO5	Inspect and estimate the concentration of solutions by volumetric methods.	Analyze

UNIT I ERRORS IN CHEMICAL ANALYSES **9 HOURS**

Replicate analysis, reliability of analytical data, mean and median & range precision and accuracy, methods of expressing precision and accuracy: deviation, mean deviation, relative mean deviation, and standard deviation. Errors, absolute error, relative error. Determinate errors, classification of determinate errors and their minimization, indeterminate error and normal frequency distribution curve.

UNIT II CALIBRATION OF INSTRUMENTS AND VALIDATION OF ANALYTICAL METHODS **10 HOURS**

Calibration of instruments: Burette Calibration, pipette Calibration, thermometer calibration, UV Spectrophotometer –absorption and wavelength calibration, HPLC-flow rate calibration, absorption and wavelength calibration, theoretical plate calculation etc.

Validation of analytical methods: Accuracy, linearity and range, precision, specificity, limit of detection, limit of quantitation, ruggedness and robustness-explanation specific to minimum 3 examples.

UNIT III SEPARATION TECHNIQUES 9 HOURS

Solvent extraction-methods of extraction and applications of solvent extraction. Chromatography-thin layer chromatography, ion exchange chromatography and size exclusion chromatography–HPLC-outline study of instrument modules. Gas chromatography - basic instrumental set up-carriers, columns, detectors and comparative study of TCD, FID, ECD and NPD. Theory & applications-electrophoresis-theory and applications.

UNIT IV ELECTROANALYTICAL TECHNIQUES 10 HOURS

Potentiometry-electrode systems, direct potentiometric titrations-null-point potentiometry and applications. polarography, stripping voltammetry & Amperometric techniques- diffusion currents, half-wave potentials, construction & characteristics of the DME-quantitative analysis-amperometric titrations and applications of polarography– electrogravimetry and coulometry-coulometry at constant potential, coulometric titrations-conductometric titrations.

UNIT V VOLUMETRIC ANALYSIS 10 HOURS

Types of titrations: Acid base, complexometric, precipitation, and redox titrations.
Theories of indicators: Common indicators used in acid base, complexometric, precipitation and redox titrations.
Concentration: Molarity, Molality, Normality, including exercises on how to prepare different concentrations of various solutes.
Standardization of volumetric solutions, using primary standards. Calculations in volumetric Analysis.

TOTAL:48 HOURS

TEXT BOOKS:

1. Geeffery, G. H., (1989). *Vogel's Text Book of Quantitative Chemical Analysis*. ELBS Edn.
2. Skoog, A., Holler, E.J., & Crouch, S.R. (2007). *Principles of Instrumental Analysis* (VI Edition). Thomson Brooks Cole.
3. Fifield, F.W., & Kealey, D. (1983). *Principles and Practice of Analytical Chemistry* (II Edition). London: International Book Company.
4. Willard, H.H., Merrit, L.L., Dean, J.A., & Settle, F.A. (1986). *Instrumental Methods of Analysis*. New Delhi: CBS Publishers.

REFERENCE BOOKS:

1. Skoog, A.K., West, D.M., Holler, F.J., & Crouch, S.R. (2004). *Fundamentals of Analytical Chemistry* (VIII Edition). Thomson Brooks Cole.
2. Rouessac, F., & Rouessac, A. (2013). *Chemical Analysis: Modern Instrumentation Methods and Techniques* (II Edition). John Wiley and Sons.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	3	1	-	-	1	-	1	-	-	-	-	1	-
CO2	3	-	-	-	3	1	-	-	1	-	1	-	-	-	-	1	-
CO3	3	-	-	-	3	1	-	-	1	-	1	-	-	-	-	1	-
CO4	3	-	-	-	3	1	-	-	1	-	1	-	-	-	-	1	-
CO5	3	-	-	-	3	1	-	-	1	-	1	-	-	-	-	1	-
Average	**3**	**-**	**-**	**-**	**3**	**1**	**-**	**-**	1	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

M.Sc. Chemistry **2024-2025**

Semester II

24CHP205A **WATER CHEMISTRY**

3H-3C

Instruction Hours/week: L:3 T 0 P:0 **Marks:** Internal**:40** External**: 60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Fundamental understanding of the chemical composition, properties, and behavior of water molecules and their interactions with other substances.

COURSE OBJECTIVES (CO):

- To know about general properties of water and understand water resources and water conservation.
- To understand important parameters for measuring water quality.
- To apply methods for the determination of water quality parameters.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the vital role of water in the human body, including its functions in various cellular processes.	Evaluate
CO2	List out the factors influencing dissolved gases in natural waters and methods for comprehensive water quality analysis.	Analyze
CO3	Analyze and determine the water quality parameters.	Analyze
CO4	Determine the quality of water before supplying to a community.	Evaluate
CO5	Apply the type of treatment required with respect to water quality.	Apply

UNIT I WATER FOR HUMAN BODY **7 HOURS**

The Water in You: Water and the Human Body -vital nutrient to cell- role of water -regulating body temperature -water for mineral transportation–digestion- keep mucosal membrane moist- flushing waste- water from saliva-as lubricants in joints-water therapy.

UNIT II WATER CHEMISTRY 7 HOURS

Dissolved gasses: Factors affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples .Measurement of temperature, transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Elements, radicals, and compounds –physical and chemical properties-Chemical water analysis Hydrogen ion concentration and pH-Alkalinity-Colloids and coagulation- Organic compounds Organic matter in wastewater- Laboratory chemical analyses. Water Quality Parameters

UNIT III DETERMINATION OF WATER QUALITY PARAMETERS 8 HOURS

Chemistry of waste water – water pollution, pollutants in water, water quality requirement, potable water standards, wastewater effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants-sulphides, chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water. Sources of water – Molecular structure and physical properties – Hydrogen Bonding – Water as a solvent – Quality characteristics of water: total acidity and alkalinity, hardness of water – methods of determination of hardness, total solids, disadvantages of using hard water – Comparative account on physical and chemical properties of H2O and D2O. total solids (TDS, TSS, TVS, TVDS).

UNIT IV WATER QUALITY AND POLLUTION 7 HOURS

Properties of pure water, fresh water Quality of surface waters- Water quality in flowing waters -Water quality in stored waters Groundwater quality- Water quality standards-Microbiological quality of drinking water -Chemical quality of drinking water.

UNIT V WATER TREATMENT FOR DRINKING PURPOSE 7 HOURS

Drinking water or Municipal water – Standard of potable water as per Indian Standard purification of water for domestic use – Removal of suspended impurities – Removal of microorganisms – Methodology in various commercial domestic Water Purifiers (Water Doctor, Auro PureIt, Aqua guard, Kent etc

TOTAL:36 HOURS

TEXT BOOKS:

1. Jain & Jain (2017). *Engineering Chemistry* (XVI Edition). New Delhi: Dhanpat Rai Publishing Company.
2. Mahan, B. M. (2009). *University Chemistry* (IV Edition). California: Addison-Wesley Publishing Company.
3. Viessman Jr, Hammer J. M., Perez, E.M., & Chadik, P. A. (2009). *Water Supply and Pollution Control*. New Delhi: PHI Learning.

4. Peavy, H.S., Rowe, D. R., & Tchobonoglous, G. (1985). *Environmental Engineering*. McGraw Hill.

REFERENCE BOOKS:

1. Williams, P. T., (2005). *Waste Treatment and Disposal* (II Edition). Wiley.
2. Rao M. N., Datta A. K. (2008). *Wastewater Treatment* (III Edition). New Delhi: Oxford & IBH Publishing Co.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PSO1**	**PSO2**
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	2	2	-	-	-	-	-	-	-	-	-	-	3	3
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3	1
Average	**2.2**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	-	**-**	**-**	**-**	**-**	**-**	**-**	**2.6**	**2**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP205B **ADVANCED ENERGY DEVICES** **3H-3C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Comprehensive understanding of principles in electrochemistry, materials science, particularly in energy conversion at B.Sc. level.

COURSE OBJECTIVES (CO):

- To understand the basic theories and concepts in electrochemistry.
- To understand the different types of energy storage devices.
- To analyze the technology terms behind the battery and its application on electric and hybrid vehicles.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Analyze technical characteristics of electrochemical systems.	Analyze
CO2	Apply the mathematical equations to determine the properties of batteries.	Apply
CO3	Compare the charging and discharging times, energy efficiency of batteries.	Analyze
CO4	Identify the requirement and various parameters of an energy storage system.	Apply
CO5	Design and compare various energy storage technologies on the basis of technical characteristics.	Create

UNIT I ELECTROCHEMISTRY-I **8 HOURS**

Conductance-transport number - Debye-Huckel-Onsager equation - Falkenhagen effect, Wein effect-ionic strength, Debye-Huckel limiting law and its verifications - electrode potential - concentration cells - liquid junction potential

Electrokinetic phenomena- theories of double layer– Helmholtz-Perrin, Guoy Chapmann & Stern theories - Theories of over voltage and zeta potential - electrodics - mechanism of electrode reactions - polarization and over potential - Butler Volmer equation- electrophoresis and electro osmosis.

UNIT II ELECTROCHEMISTRY-II **7 HOURS**

The reaction quotient, Q for a chemical reaction-The potential, E for non-standard conditions using the Nernst Equation - Rates of reactions and types of over-voltages in galvanic and electrolytic cells and the Tafel Equation- Calomel-Filter equation. Efficiency of chemical energy conversion: batteries versus heat engines.

UNIT III INTRODUCTION TO ENERGY STORAGE **7 HOURS**

Necessity of energy storage-types of energy storage-comparison of energy storage technology-application. Electrical and magnetic energy storage: Capacitors, electromagnets and battery storage system such as primary, secondary, lithium, solid state and molten solvent batteries. Factors affecting battery performance-supercapacitor.

Mechanism involved in primary and secondary batteries-battery charging and discharging curves for secondary batteries

UNIT IV BATTERIES FOR ELECTRIC AND HYBRID VEHICLES **7 HOURS**

Specific power and specific energy, Ragone plot- Energy efficiency of batteries, energy out during discharge, energy in during charge, battery packs: Role of positive, negative electrode and carbon, voltage and state of charge, coulomb counting-energy in a battery (kW h) and charge in a battery (A h); C-rate of charging and discharging, storage density, energy density and safety issues, Peukert Equation-Coulombic efficiency of batteries and battery lifetime - Battery pack control module.

UNIT V ADDITIONAL ENERGY STORAGE DEVICES AND RENEWABLE ENERGY **7 HOURS**

Hydrogen and fuel cells: Types of fuel cells - construction and operation of fuel cells- Proton Exchange Membrane (PEM) fuel cells using hydrogen for powering vehicles. Hydrogen fueling system and hydrogen storage aboard vehicles-comparison of fuel cells and batteries for powering electric vehicles. Capacitors: storing charge-flywheels: storing kinetic energy - compressed air: storing potential energy-Renewable energy and synergy with electric vehicles. Dye sensitized solar cell (DSSC), solid oxide fuel cell (SOFC) and hydrogen peroxide fuel cell.

TOTAL:36 HOURS

TEXT BOOKS:

1. David Linden & Thomas B. Reddy (2002). *Handbook of Batteries* (III Edition). Mcgraw Hill.
2. Aubrecht, G. (2005). *Energy: Physical, Environmental, and Social Impact* (III Edition). San Francisco, CA: Pearson Addison-Wesley.
3. Giancoli, D. G. (2014). *Physics: Principals with Applications* (VII Edition). Upper Saddle River, NJ: Prentice Hall.

REFERENCE BOOKS:

1. David Wenzhong Gao (2015). *Energy Storage for Sustainable Microgrid*. Elsevier Publication.
2. McMurry, J. E., & Fay, R. C. (2012*). Chemistry* (VI Edition). Upper Saddle River, NJ: Prentice Hall.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	3	-	2	-	-	2	-	-	2	2	-	-
CO3	3	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	2	-	-	3	-	2	-	-	2	-	-	2	2	-	-
CO5	3	-	2	-	-	3	-	2	-	-	2	-	-	2	2	-	-
Average	**3**	**-**	**2**	**-**	**-**	**2.2**	**-**	**2**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester II

24CHP205C COMPUTATIONAL METHODS IN CHEMISTRY 3H- 3C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of a solid foundation in theoretical chemistry, mathematics (especially calculus and linear algebra), and programming skills.

COURSE OBJECTIVES (CO):

- To understand and apply c programming fundamentals.
- To analyze and solve kinetics and crystallography problems.
- To develop numerical and computational skills.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Analyze the foundational programming skills, including data type manipulation and control structures.	Analyze
CO2	Apply principles of rate equations, thermodynamics, spectroscopy, group theory, and crystallography to solve relevant problems.	Apply
CO3	Utilize numerical methods such as Newton-Raphson, Gauss elimination, Runge-Kutta, and curve fitting to analyze thermodynamic systems effectively.	Apply
CO4	Explain advanced theoretical methods in molecular modeling and their applications.	Evaluate
CO5	Discuss the computational chemistry techniques for molecular modeling and simulation.	Create

UNIT I C– SYNTAX **7 HOURS**

Character set-constants and variables, data types and sizes, declarations, operators-expressions -conditional expressions, precedence and order of evaluation, statements and blocks, if-else, if-else-if and switch statements, while, for and Do - while loops, break and continue statements, Goto and labels, basics of functions and types, header files, recursion, arrays – 1D and 2D, file handling concepts.

UNIT II KINETICS **8 HOURS**

Solving rate equations, thermodynamics -heats of reactions, heat capacity, entropy, spectroscopy-moment of inertia, wave numbers of stokes and anti-stokes Raman lines, masses

of isotopes from rotational and vibrational spectroscopic data - Group theory -Huckel MO calculations of delocalisation energy, hybridisation schemes and symmetries of vibrations in non - linear molecules. Crystallography - d spacings for an orthorhombic crystal, Fourier synthesis of electron density using structure factor, axial angles of a triclinic crystal.

UNIT III SOLVING POLYNOMIAL EQUATIONS 7 HOURS

Newton -Raphson method, solutions of simultaneous equations - Gauss elimination, Jacobi iteration and matrix diagonalisation, numerical differentiation and integration - Simpson's rule, trapezoidal rule- determination of entropy, solution of differential equations -Runge-Kutta method- theory and application to thermodynamics, linear and non-linear curve fitting.

UNIT IV FORCE FIELD AND ELECTRONIC STRUCTURE METHODS 7 HOURS

Force field energy and parameterization, electronic structure methods- SCF techniques, semi-empirical methods, basis sets and their classification, density functional theory and methods.

UNIT V GEOMETRY CONVERGENCE 7 HOURS

Energy convergence, dipole moment convergence, vibrational frequencies convergence, bond dissociation curve, angle bending curve, transition state modeling using Chemoffice and Gaussian software- demo on docking software.

TOTAL:36 HOURS

TEXT BOOKS:

1. Balagurusamy, E. (1997). *Programming in C*. Tata McGraw Hill Publishing Company Limited.
2. Raman, K. V. (1993). *Computers in Chemistry*. Tata McGraw Hill Publishing Company Limited
3. Jensen, F. (2003). *Introduction to Computational Chemistry*. John Wiley & Sons.

REFERENCE BOOK:

1. Jain, M. K. (1995). *Numerical Methods for Scientific and Engineering Computation*. Wiley Eastern Ltd.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	-	-	3	-	-	-	2	1	2	1	1	-	-	-	-	-	-
CO2	-	-	3	-	-	-	2	-	2	1	1	-	-	-	-	-	-
CO3	-	-	3	-	-	-	2	1	2	1	1	--	-	-	-	-	-
CO4	-	-	3	-	-	-	2	1	2	1	1		-	-	-	-	-
CO5	-	-	3	-	-	-	2	1	2	1	1	-	-	-	-	-	-
Average	-	-	3	-	-	-	2	1	2	1	1	-	-	-	-	-	-

1-Low, 2-Medium, 3-High, '-' No Correlation

M.Sc. Chemistry **2024-2025**

Semester II

24CHP206 COMMUNITY ENGAGEMENT AND SOCIAL RESPONSIBILITY

2H-2C

Instruction Hours/week: L:2 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Not required

COURSE OBJECTIVES (CO):

- To gain insights into the structures, challenges, and opportunities within communities
- To explore ethical frameworks and dilemmas related to community engagement and social responsibility
- To develop skills in monitoring, evaluating, and reporting on the outcomes of community engagement efforts to ensure effectiveness and accountability.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Understand the concept, ethics, and spectrum of community engagement.	Understand
CO2	Recognize the significance in local community development and rural culture.	Understand
CO3	Know the rural development programs, and institutions.	Understand
CO4	Analyze the role of local administration in fostering community involvement and social networking.	Analyze
CO5	Develop skills in conducting community engaged research with a focus on ethics, rural distress, poverty alleviation, and disaster mitigation.	Apply

UNIT I INTRODUCTION AND PRINCIPLES **5 HOURS**

Concept, Ethics and Spectrum of Community engagement, Local community, Rural culture and Practice of community engagement - Stages, Components and Principles of community development, Utility of public resources. Contributions of self-help groups

UNIT II RURAL DEVELOPMENT **5 HOURS**

Rural Development Programs and Rural institutions Local Administration and Community Involvement-Social contribution of community networking, Various government schemes. Programmes of community engagement and their evaluation.

UNIT III COMMUNITY AND RESEARCH **4 HOURS**

Community Engaged Research and Ethics in Community Engaged Research Rural Distress, Rural Poverty, Impact of COVID-19 on Migrant Laborers, Mitigation of Disaster.

UNIT IV SOIL ANALYSIS **5 HOURS**

Introduction, Types of soil, Soil pollutants, role of soil testing, Collection of soil sample for testing, determination of soil parameters viz., pH, EC, Organic carbon, NPK, soil testing for micronutrients, Gypsum requirement of soil, Lime requirement of soil, Uses of soil analysis.

UNIT V WATER ANALYSIS **5 HOURS**

Introduction, Types of Water, Water pollutants, role of water testing, Common Sampling tools and accessories, sample collection procedure, water quality parameters viz., pH, electrical conductivity, chlorides, sulphates, calcium, magnesium, sodium, potassium, Water quality indices and suitability.

TOTAL:24 HOURS

TEXT BOOK:

1. *Principles of Community Engagement*, (2011).2nd Edition, NIH Publication No. 11-7782.

WEBSITES:

1. https://youtu.be/-SQK9RGBt7o
2. https://www.uvm.edu/sites/default/files/community_engagement_handout.pdf (Community Engagement)
3. https://www.atsdr.cdc.gov/communityengagement/pce_concepts.html (Perspectives of Community)
4. https://egyankosh.ac.in/bitstream/123456789/59002/1/Unit1.pdf (community concepts)
5. https://sustainingcommunity.wordpress.com/2013/07/09/ethics-and-community-engagement/(Ethics of community engagement)
6. https://www.preservearticles.com/sociology/what-are-the-essential-elements-of-community/4558 (Elements of Community)
7. https://www.yourarticlelibrary.com/sociology/rural-sociology/rural-community-top-10-characteristics-of-the-rural-community-explained/34968 (features of rural community)
8. https://www.mapsofindia.com/my-india/government/schemes-for-rural-development-launched-by-government-of-india (Government programmes for rural development)
9. https://www.yourarticlelibrary.com/sociology/rural-sociology/rural-community-top-10-characteristics-of-the-rural-community-explained/34968 (rural lifestyle)
10. https://www.insightsonindia.com/social-justice/issues-related-to-rural-development/government-schemes-for-rural-development-in-india/ (schemes for rural development)
11. https://www.mpgkpdf.com/2021/09/community-development-plan-in-hindi.html?m=1
12. https://images.app.goo.gl/sNF2HMWCuCfkqYz56
13. https://images.app.goo.gl/VaMNNMEs77XyPMrP7.

CO, PO, PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2
CO1	3	3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	-	3	-	2	1	-	2	-	-	-	-	-	-	1
CO3	3	-	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	2	-	-	2	-	1	-	3	-	-	-	-	2	-	1
CO5	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**2.5**	**2**	**2**	**3**	**2**	**2**	**1**	**-**	**2.5**	**-**	**-**	**-**	**-**	**2**	**-**	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

24CHP211 **INORGANIC CHEMISTRY PRACTICAL–I (QUALITATIVE ANALYSIS AND PREPARATIONS)** **Semester II** **4H-2C**

Instruction Hours/week: L:0 T:0 P:4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 4 Hours

PREREQUISITE:

Elementary level understanding of inorganic chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To understand the qualitative analysis by semi-micro qualitative analysis method.
- To identify and quantify the components of the mixtures using appropriate analytical techniques.
- To gain hands-on experience with the preparation of various organometallic and coordination compounds.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Identify the substances present in a mixture by semi-micro qualitative analysis.	Apply
CO2	Plan the experiments to identify the elements in a systematic way.	Create
CO3	Develop synthetic methods for the preparation of inorganic compounds.	Create
CO4	Experiment with the step wise procedure to predict the anions along with metals.	Apply
CO5	Compare and contrast the d-block elements with their special tests.	Analyze

Contents

Thallium, Tungsten, Selenium, Tellurium, Molybdenum, Cerium, Thorium, Titanium, Zirconium, Vanadium, Beryllium, Uranium and Lithium.

Note: Each student should analyze a minimum of six inorganic mixtures.

About ten preparations involving different techniques selected from the following:

Lead tetra acetate, dipyridinium hexaplumbate, hydroxylamine hydrochloride, ortho and para-hydroxy phenyl mercuric chloride, potassium cupric chloride, chrome alum, copperI chloride, tris(thio urea) copper (I) Chloride, potassium trioxalato- aluminato (III), potassium trioxalato-chromate (III), potassium trioxalato- ferrate (III), hexammine cobalt (III) chloride, chloropentammine chromium (III), chloro aquo pentammine chromium (III) nitrate,

tetrammine copper (II) sulphate, ammonium hexa chloro stanate (IV).

Note: Each student should do a minimum of ten preparations.

TOTAL:48 HOURS

TEXT BOOKS:

1. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications.
2. Siddhiqui, Z. N. (2002). *Practical Industrial Chemistry* (I Edition). New Delhi: Anmol Publications Pvt. Ltd.
3. Mendham, J. R., Denney, C., Barnes, J. D., & Thomas, M. (2002). *Vogel's Textbook of Quantitative Chemical Analysis* (VI Edition). Singapore: Pearson Education Ltd.
4. Lepse, P. A., & Peter, L. B. (1986). *Lab Manual for Lingren's Essentials of Chemistry*. New Delhi: Prentice Hall.

REFERENCE BOOKS:

1. Srivastava,T.N., & Kamboj, P. C. (2013). *University Practical Chemistry*. New Delhi. Milestone Publishers and Distributors.
2. Ramanujam, V. V. (2004). *Inorganic Semi-micro Qualitative Analysis* (III Edition). Chennai: The National Publishing Company.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	2	2	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	2	2	-	-	-	-	2	-	-	-	-
CO4	3	-	-	-	-	-	2	2	-	-	-	-	2	-	-	-	-
CO5	3	-	-	2	-	-	2	2	-	-	-	-	2	-	-	-	-
Average	**3**	**-**	**-**	**2**	**-**	**-**	**2**	**2**	-	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP212 INORGANIC CHEMISTRY PRACTICAL–II

(QUANTITATIVE ANALYSIS AND COMPLEX PREPARATIONS)

4H-2C

Instruction Hours/week: L: 0 T:0 P:4 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 4 Hours

PREREQUISITE:

Elementary level understanding of inorganic chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To master analytical techniques in volumetry, gravimetry, and titrimetry.
- To acquire proficiency in chromatographic and colorimetric techniques.
- To explore coordination complexes and cement analysis.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Design experiments to estimate mixture of ions volumetrically and gravimetrically.	Create
CO2	Estimate inorganic salts by titrimetry.	Create
CO3	Develop appropriate chromatographic methods for separations.	Create
CO4	Evaluate the quantity of substance by colorimetric methods.	Evaluate
CO5	Identify the correct synthetic method to prepare inorganic co-ordination complexes.	Apply

Contents

I. Analysis of mixture of ions-Volumetry and Gravimetry.

1. Estimation of copper and nickel.
2. Estimation of calcium and barium.
3. Estimation of copper and zinc.

II. Titrimetry

1. Oxidation using ceric salts.

III. Chromatography

1. Column chromatography
2. Paper chromatography
3. Thin layer chromatography

IV. Colorimetric analysis

Estimation of copper, nickel, zinc, lead, chromium, and iron.

V. Preparation, analysis and study of co-ordination complexes.

TOTAL:48 HOURS

TEXT BOOKS:

1. Lepse, P. A., & Peter, L. B. (1986). *Lab Manual for Lingren's Essentials of Chemistry*. New Delhi: Prentice Hall.
2. Mendham, J. R., Denney, C., Barnes, J. D., & Thomas, M. (2002). *Vogel's Textbook of Quantitative Chemical Analysis* (VI Edition). Singapore: Pearson Education Ltd.
3. Siddhiqui, Z. N. (2002). *Practical Industrial Chemistry* (I Edition). New Delhi: Anmol Publications Pvt. Ltd.
4. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications.

REFERENCE BOOKS:

1. Srivastava, T. N., & Kamboj, P. C. (2013). *University Practical Chemistry*. New Delhi.Milestone Publishers and Distributors.
2. Ramanujam, V. V. (2004). *Inorganic Semi-micro Qualitative Analysis* (III Edition). Chennai: The National Publishing Company.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	2	2	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	2	-	2	2	-	-	-	-	2	-	-	-	-
CO4	3	-	-	-	2	-	2	2	-	-	-	-	2	-	-	-	-
CO5	3	-	-	2	2	-	2	2	-	-	-	-	2	-	-	-	-
Average	**3**	-	-	**2**	**2**	-	**2**	**2**	-	-	-	-	**2**	-	-	-	-

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester III

24CHP301 ORGANIC CHEMISTRY- III (NATURAL PRODUCTS) 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of organic chemistry principles at the B.Sc. level.

COURSE OBJECTIVES:

- Understand the fundamental concepts to determination the structure of terpenoids, steroids and alkaloids.
- Apply the concept to elucidate the structure and biosynthesis of terpenoids, steroids and alkaloids.
- Comprehensive understanding of amino acids, proteins, and enzymes.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Identify and elucidate the structure of various classes of natural products by their structure.	Apply
CO2	Analyze and discuss the information and data related to the various classes of natural products.	Analyze
CO3	Predict a logical process based on well-established scientific principle and demonstrate the ability to use problem-solving techniques to solve the synthesis/determination of structure of terpenoids, steroids, alkaloids, proteins and nucleic acids.	Create
CO4	Design and solve organic chemical problems and explore new area of research.	Create
CO5	Elaborate the importance of terpenoids, steroids, alkaloids, proteins and nucleic acids in medicinal field and its synthesis.	Create

UNIT I TERPENOIDS **10 HOURS**

Introduction-General properties of terpenoids- Isolation-Isoprene rule-Gem-dialkyl rule-Classification of terpenoids–general methods of determining structure of terpenoids–structural elucidation and synthesis of Zingiberene, Eudesmol, Abietic acid, Caryophyllene and Santonin-biosynthesis of monoterpenoids**.**

UNIT II STEROIDS **10 HOURS**

Introduction – structural elucidation and synthesis of Cholesterol (synthesis not necessary), Ergosterol, Vitamin D, Stigmasterol, Oestrone, Testosterone and Progesterone. Bile acids– biosynthesis of sterols.

UNIT III ALKALOIDS **9 HOURS**

Definition of an alkaloid-extraction of alkaloids-general properties - general methods of determining structure of alkaloids – structural elucidation and synthesis of Atropine, Morphine and Quinine -biosynthesis of quinoline alkaloids.

UNIT IV AMINO ACIDS, PROTEINS AND ENZYMES **10 HOURS**

Amino acids: Classification and general methods of preparation. General properties of the amino acids.

Proteins: General nature of proteins - classification of proteins–the peptide linkage-the primary structure of peptides-synthesis of peptides–oxytocin-insulin. The spatial arrangements of protein molecules-introduction-secondary, tertiary, and structure of proteins-quaternary structure of proteins.

Enzymes: General nature of enzymes-nomenclature and classification-cofactors– specificity of enzyme action- mechanism of enzyme action-enzyme inhibitors and lock and key principle for enzyme action.

UNIT V NUCLEIC ACIDS **9 HOURS**

Introduction-classification of nucleic acids-relation among nucleic acids, nucleotides and nucleosides-isolation of nucleic acids-components of nucleic acids- constitution of nucleic acids-structure of nucleosides- structure of nucleotides-sequence of nucleic acids-structure of DNA- structure of RNA.

TOTAL:48 HOURS

TEXT BOOKS:

1. Chatwal, G. R. (2015). *Organic Chemistry of Natural Products Vol. II*. New Delhi: Himalaya Publishing House.
2. Finar, I. L. (2013). *Organic Chemistry Vol. II: Stereochemistry and the Chemistry of Natural Products* (V Edition). New Delhi: Pearson Education, Ltd.
3. Chatwal, G. R. (2015). *Organic Chemistry of Natural Products. Vol. I*. New Delhi: Himalaya Publishing House.

REFERENCE BOOK:

1. Saluja, M. P., Raj Kumar & Anuja Agarwal (2017). *Advanced Natural Products* (Revised IV Edition). Meerut: Krishna Prakashan Media (P) Ltd.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	-	-	2	2	-	-	-	-	-	-	-	-	-	-	3	3
CO3	3	-	-	2	3	-	-	-	-	-	-	-	-	-	-	3	3
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**-**	**-**	**2**	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.6**	**2.6**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester III

24CHP302 PHYSICAL CHEMISTRY-III (THERMODYNAMICS) 4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of various physical chemistry principles at the B. Sc. Level.

COURSE OBJECTIVES:

- To understand the thermodynamics, non-ideal systems and third law of thermodynamics and its need.
- To analyze the classical Maxwell-Boltzman statistics and quantum statistics of gases.
- To evaluate the thermodynamic properties of different types of atomic gases based on partition functions and various theories and importance of heat capacity of solids.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Analyze the connection between thermodynamics potentials and the underlying statistical ensembles at the atomic and molecular level.	Analyze
CO2	Apply statistical mechanical methods to describe the thermodynamics behaviour of gases, liquids and solids.	Apply
CO3	Examine a general approach based on statistical thermodynamics to address chemical thermodynamics (reactions and phase transitions).	Analyze
CO4	Determine the thermodynamic properties of different types of atomic gases based on partition functions.	Evaluate
CO5	Discuss the various theories and importance of heat capacity of solids.	Create

UNIT I THEMODYNAMICS AND NON-IDEAL SYSTEMS 9 HOURS

Chemical potential and the definition of fugacity. Determination of fugacity of gases by graphical method and from equations of state. Variation of fugacity with temperature. Fugacity and the standard states for non ideal gases.

Definition of activity. Activity coefficient. Temperature coefficient of activity. Standard states. Applications of activity concept to solutions. The rational and practical approaches. Measurement of activity of solvent from elevation of temperature and depression in freezing point. Determination of activity of solute.

UNIT II THIRD LAW OF THERMODYNAMICS 9 HOURS

Probability and third law. Need for third law. Nernst heat theorem and other forms stating third law. Thermodynamic quantities at absolute zero. Statistical meaning of third law and apparent exception. Entropy changes in chemical reactions, entropies of real gases, residual entropy.

Mathematical Introduction: Theories of permutation & combination, laws of probability. Distribution laws. Gaussian distribution.

UNIT III CLASSICAL MAXWELL – BOLTZMANN STATISTICS AND QUANTUM STATISTICS 11 HOURS

Classical Maxwell– Boltzmann Statistics: Maxwell distribution law for molecular velocities and molecular speeds in an ideal gas. Velocity and speed distribution functions. Experimental verification of Maxwell distribution law. Evaluation of average speed, root mean square speed and most probable speed from distribution law. Distribution function in terms of the kinetic energy of an ideal gas. The principle of equipartition of energy and the calculation of heat capacities of ideal gases. Limitations of the principle of equipartition of energy.

Quantum statistics: Maxwell-Boltzmann statistics. Thermodynamic probability. Thermodynamic probabilities of systems in equilibrium. Boltzmann expression for entropy. Stirling's approximation. State of maximum thermodynamics probability. Lagrangian multipliers. Thermodynamic probabilities of systems involving energy levels. Maxwell-Boltzmann distribution law. Evaluation of alpha and beta in MB distribution law.

UNIT IV PARTITION FUNCTION 9 HOURS

Definition, justification of nomenclature, microcanonical and canonical ensembles. Molecular partition and canonical function. The relation between the total partition function of a molecule and the separate partition functions. Translational partition function, rotational partition function. Effect of molecular symmetry on rotational partition function. Ortho and para hydrogen. Vibrational partition function. Electronic partition function. Evaluation of thermodynamic properties E, H, S, A, G, C_v and C_p from monoatomic and diatomic ideal gas molecules partition functions. Thermodynamic properties of polyatomic ideal gases. Calculation of equilibrium constants of reaction involving ideal gases from partition functions.

UNIT V HEAT CAPACITIES OF SOLIDS 10 HOURS

Einstein's and Debye's theories of heat capacities of solids. Bose-Einstein and Fermi-Dirac Statistics: Bose Einstein distribution law- Entropy of Bose Einstein gas. Planck distribution law of black body radiation. Fermi-Dirac distribution law. Entropy of a Fermi-Dirac gas. Heat capacities of the electron gas and the heat capacities of metals. Negative absolute temperature.

TOTAL:48 HOURS

TEXT BOOKS:

1. Kapoor, K. L. (2015). *Text Book Physical Chemistry Vol. V*. New Delhi: MacMillan India Ltd.
2. Lavin, I. N. (2002). *Physical Chemistry* (V Edition). New Delhi: Tata-McGraw Hill Publishing Company.
3. Whittakar, A. G. (2001). *Physical Chemistry*. New Delhi: Mount & Heal Viva Books Pvt. Ltd.
4. Puri, B.R., Sharma, L.R., & Pathania, M.S. (2013). *The Principles of Physical Chemistry*. Vishal Publishing Co.

REFERENCE BOOKS:

1. Glasstone, S. (2008). *Thermodynamics for Chemists*. New York: Litton Edition Publishing.
2. Atkins, P., & De Paula, J. (2014). *Atkins Physical Chemistry* (X Edition). Oxford: Oxford University Press.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	2	-	-	-		-	-	-	-	-	-	-	2	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP303 PHYSICAL METHODS IN CHEMISTRY (INSTRUMENTATION)

4H-4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of spectroscopic principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To analyze samples through electron spectroscopy and various methods in thermal analysis.
- To study about the diffraction methods, Raman spectroscopy and electron spin resonance spectroscopy.
- To know about the concepts and instrumentation of atomic spectrometry.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the theoretical principles underlying the instrumental techniques and their applications.	Evaluate
CO2	Assess the appropriateness of the instrumental methods for the analysis of sample.	Evaluate
CO3	Analyze and present the results and draw sound conclusions.	Analyze
CO4	Organize the concept and techniques in instrumental analysis and correlate to relevant applications.	Apply
CO5	Relate the g factor, nuclear spin, and hyperfine coupling constant with structure of the complexes.	Understand

UNIT I MICROSCOPIC TECHNIQUES 7 HOURS

Scanning and transmission electron microscopy, scanning probe microscopies**:** Atomic force, scanning tunneling microscopy, diffraction and scattering techniques, vibrational spectroscopy, surface techniques.

UNIT II THERMAL ANALYSIS AND ELECTRON SPECTROSCOPY 12 HOURS

Thermal analysis: Differential thermal analysis DTA and differential scanning calorimetry DSC - basic principles - thermo gravimetric analysis. Thermo mechanical analysis (TMA) and Dynamic mechanical analysis (DMA)-Instrumentation and applications

Electron spectroscopy: ESCA XPS: Principle, chemical shifts - description of ESCA

spectrometer, X-ray sources, samples, analysis, detectors and recording devices- applications. Auger electron spectroscopy AES and Ultra-Violet photo electron spectroscopy UPS/PES principles and applications.

UNIT III DIFFRACTION METHODS AND RAMAN SPECTROSCOPY 10 HOURS

Diffraction Methods: Single crystal and Powder X–ray diffraction and their applications for inorganic compounds, neutron diffraction and electron diffraction.

Raman spectroscopy: Stokes and anti-Stokes lines. Polarizability ellipsoids. Rotational and vibrational. Selection rules. Rule of Mutual Exclusion. Polarization of Raman lines.

UNIT IV ESR SPECTROSCOPY 8 HOURS

Theory - derivative curves - g shift - hyperfine splitting-isotropic and anisotropic systems-zero field splitting and Kramer degeneracy. Identification of free radicals–applications to copper complexes and application to organic compounds.

UNIT V ATOMIC SPECTROMETRY 11 HOURS

Atomic absorption spectroscopy (AAS): Absorption of characteristic radiation, instrumentation, Hollow cathode lamp – sampling- quantitative measurements and interferences – atomic emission- instrumentation, plasma sources – instrumentation – inductively coupled plasma–mass spectrometry (ICP-MS) – principles & Instrumentation and applications of flame emission spectrometry – flame characteristics & processes – applications of flame photometry and flame atomic emission spectrometry.

TOTAL:48 HOURS

TEXT BOOKS:

1. Gopalan, V., Subramanian, P. S., & Rangarajan, K. (2003). *Elements of Analytical Chemistry*. New Delhi: S. Chand and Sons.
2. Usharani, S. (2002). *Analytical Chemistry*. Chennai: MacMillan India Ltd.
3. Sharma, B. K. (2019). *Instrumental Methods of Chemical Analysis* (27th Edition). Meerut: Krishna Prakashan Media (P) Ltd.
4. Ewing, G. W. (1988). *Instrumental Methods of Chemical Analysis* (III Edition). Singapore: McGraw Hill International Edition.
5. Gurdeep. R. Chatwal, & Sham K Anand. (2018). *Instrumental Methods of Chemical Analysis* (V Edition). New Delhi: Himalaya Publishing House.

REFERENCE BOOKS:

1. Drago, R. S. (2012). *Physical Methods in Inorganic Chemistry*. New York: Reinhold Publishing Corporation.
2. Skoog, D. A., & West, D. M. (2004). *Fundamentals of Analytical Chemistry* (VIII Edition). Singapore: Thomson Book Store.
3. Svehla, G. (2002). *Vogel's Qualitative Inorganic Analysis* (VII Edition). Singapore. Pearson Education.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	2	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	2	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	2	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	-	2	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO5	3	-	2	-	-	3	-	-	-	-	-	-	-	-	-	2	-
Average	**3**	**-**	**2**	**-**	**-**	**2.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.6**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP304 **POLYMER CHEMISTRY** **4H-4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of organic chemistry, chemical bonding, molecular structure, and reaction mechanisms, along with knowledge of polymerization techniques and characterization methods at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To know about the basic concept of polymerizations and coordination polymerization and apply the Ziegler-Natta catalyst in polymer synthesis.
- To analyze the various methods of molecular weight determination.
- To know about the polymer processing technique to prepare the polymer products and the types of commercial polymers and its application.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Distinguish different polymerization reactions and how to analyze polymerization data.	Analyze
CO2	Classify the types of co-ordination polymerization and utilize the Ziegler-Natta catalyst in polymer synthesis.	Analyze
CO3	Determine polymer molecular weight and molecular weight distribution from different experiments.	Evaluate
CO4	Justify the connection between polymer molecular weight, viscoelastic properties and processing conditions.	Evaluate
CO5	Design features of a product which relate directly to the materials used in its constitution.	Create

UNIT I POLYMER BASIC CONCEPTS **9 HOURS**

Monomers, repeat units, degree of polymerization, linear, branched and network polymers. Condensation polymerization: Mechanism of stepwise polymerization. Kinetics and statistics of linear stepwise polymerization. Addition polymerization: Free radical, cationic and anionic polymerization. Polymerization conditions. Polymerization in homogeneous and heterogeneous systems.

UNIT II CO-ORDINATION POLYMERIZATION 9 HOURS

Kinetics, mono and bimetallic mechanism of co- ordination polymers. Zeigler Natta catalyst, co-polymerization: Block and graft co- polymers, kinetics of copolymerization. Types of co-polymerization. Reactivity ratio.

UNIT III MOLECULAR WEIGHT AND PROPERTIES 12 HOURS

Polydispersion – average molecular weight concept, number, weight and viscosity average molecular weights. Measurement of molecular weights. Viscosity, light scattering, osmotic and ultracentrifugation methods. Polymer structure and physical properties – crystalline melting point Tm. The glass transition temperature. Determination of Tg. Relationship between Tm and Tg.

UNIT IV POLYMER PROCESSING 9 HOURS

Plastics, elastomers and fibres. Compounding, processing techniques: calendering, die casting, rotational casting, film casting, injection moulding, blow moulding extrusion, moulding, thermoforming, foaming, reinforcing and fibre spinning.

UNIT V PROPERTIES OF COMMERCIAL POLYMERS 9 HOURS

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers, fire retarding polymers and electrically conducting polymers. Biomedical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

TOTAL:48 HOURS

TEXT BOOKS:

1. Billmeyer, F. W. (2003). *Text Book of Polymer Science* (III Edition). New York: John Wiley.
2. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (2015). *Polymer Science* (II Edition). New Delhi: New Age International Private Ltd.
3. Flory, P. J. (1953). *Principles of Polymer Chemistry.* New York: Cornell University Press.
4. Odian, G. (2004). *Principles of Polymerization* (IV Edition). New York: John Wiley & Sons.
5. Arora, M.G. & Singh, M. (2001) *Polymer Chemistry* (I Edition). New Delhi: Anmol Publications Pvt Ltd.
6. Bahadur, P. and Sastry, N.V. (2005). *Principles of polymer Science* (II Edition). Delhi: N.K. Mehra for Narsa publishing house, Retika Press Pvt Ltd.

REFERENCE BOOKS:

1. Stevens, M. P. (2012). *Polymer Chemistry an Introduction* (III Edition, Indian Edition). New York: Oxford University Press.
2. Alcock, H. R., Lampe, F. W., & Mark, J. E. (2003). *Contemporary Polymer Chemistry* (III Edition). NJ: Prentice Hall Englewood Cliffs.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	2	-	-	2	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-
CO4	3	-	-	-	-	2	-	-	2	-	-	-	-	-	-	3	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Average	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	2	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester III

24CHP305A INDUSTRIAL ORGANIC SYNTHESIS 4H-3C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Understanding of organic chemistry principles, including reaction mechanisms, functional group transformations, reagents and catalyst at the B.Sc. level.

COURSE OBJECTIVES (CO):

- To know about the principles of selectivity in organic synthesis-chemo-, regio-, stereo-, and enantioselectivity to achieve precise control over reaction outcomes.
- To Develop proficiency in target-oriented synthesis, employing retrosynthetic analysis and the disconnection approach, and comparing linear versus convergent synthesis strategies.
- To Explore diversity-oriented synthesis concepts, emphasizing forward-synthetic analysis and strategies for achieving stereochemical diversity in organic molecules.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Analyze and design synthetic methods for various organic molecules.	Analyze
CO2	Justify the construction and working of various equipment's used in reactions, distillation, extraction, filtration and characterization.	Evaluate
CO3	Categories the various forms of protecting group.	Analyze
CO4	Utilize important reagents used in chemical industries.	Apply
CO5	Determine the reaction mechanisms of various name reactions.	Evaluate

UNIT I DESIGN AND SYNTHESIS OF ORGANIC MOLECULES 9 HOURS

Selectivity in organic synthesis: chemo-, regio, stereo- and enantioselectivity. Target oriented synthesis: Designing organic synthesis, retrosynthetic analysis, disconnection approach, linear and convergent synthesis. Diversity-oriented synthesis: concept of forward-synthetic analysis and stereochemical diversity. Asymmetric Synthesis: Use of chiral auxiliaries, chiron approach. Principles and use of enzymes in the synthesis of industrially important chemicals.

UNIT II LABORATORY ON SYNTHESIS **10 HOURS**

Single, double and multi-stage preparation of organic, inorganic and organometallic compounds; experiments involving the concepts of protecting groups and selectivity; identification of compounds through thin-layer chromatography and their purification by column chromatography. Characterization of synthesized compounds using IR, UV, 1H-NMR and mass spectromteric techniques. Separation techniques. Extraction, countercurrent distribution, gas chromatography, column and plane chromatographic techniques, electrophoresis, ultracentrifugation.

UNIT III PROTECTING GROUPS **10 HOURS**

Protection of hydroxyl, carboxyl, carbonyl, amino groups. Umpolung reagents, definition of umpolung, acyl anion equivalent, protection of carbon-carbon multiple bonds. Methods of asymmetric induction-substrate, reagent and catalyst controlled reactions. Determination of enantiomeric and diastereomeric excess. Enantio-discrimination. Resolution-Optical kinetic.

UNIT IV ORGANIC REAGENTS **10 HOURS**

Use of the following reagents in organic synthesis and functional group transformation, 1,3-Dithianes, *N*-Bromosuccinimide, Organolithium reagents, Sodamide, Organosilicon compounds, Diazomethane, Periodic acids, Pyridinium chlorochromate (Corey's reagent), Lead tetraacetate, Fenton's reagent, Phase transfer catalyst, Crown ethers, Merrifield resin, Wilkinson's catalyst and Baker yeast.

UNIT V NAME REACTIONS IN ORGANIC SYNTHESIS **9 HOURS**

Peterson olefination, McMurry, Shapiro reaction, Bomford-Stevens reaction, Palladium based reactions- Suzuki, Heck, Sonogashira, Hiyama, Stille, Glaser-Eglinton coupling, Henry reaction, Birch reduction, Clemmensen reduction, Dess-Martin oxidation, Hofmann-Loffler-Freytag reaction, Etard reaction, Baylis Hillman reaction, and Wolff- Kishner reduction.

TOTAL:48 HOURS

TEXT BOOKS:

1. Renuga, S. (2016). *Name Reactions and Reagents in Organic Synthesis*. Jalandhar-Delhi: Vishal Publishing Co.
2. Nasir Hussain & Saba Khan, (2016). *Reactions and Reagents*. New Delhi: Himanshu Publications.
3. Sanyal, S. N. (2014). *Reactions, Rearrangements and Reagents* (IV Edition). New Delhi: Bharathi Bhawan (Publishers and Distributors).
4. Smith, M. B. (2015). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure* (VII Edition). New Jersey: John Wiley & Sons, Inc., Hoboken.

REFERENCE BOOKS:

1. Clayden, J., Greeves, N. & Warren, S. (2012). *Organic Chemistry* (II Edition). Oxford: Oxford University Press.
2. Warren, S. (2010). *Organic Synthesis the Disconnection Approach*. Wiley and Sons.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	2	-	-	-	-	-	-	--	-	-	-	-
CO4	3	-	-	-	-	2	-	-	-	-		-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**-**	**3**	**3**	**3**	**2**	**-**	**-**	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP305B BIOCATALYTIC PROCESSES IN CHEMICAL INDUSTRIES 4H-3C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Foundational understanding of vitamins, microorganisms and fermentation process at the B.Sc level.

COURSE OBJECTIVES (CO):

- To understand the cell biology of bacteria, yeast, molds, and actinomycetes, including their metabolic processes.
- To investigate fermentation of hydrocarbons for the production of anti-tumor agents, emphasizing industrial-scale applications and challenges.
- To understand the fundamentals of preventing and controlling microorganisms in industrial settings, including the principles and applications of physical and chemical agents for microbial control.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the comprehensive understanding of cell biology of bacteria, yeast, molds, and actinomycetes.	Evaluate
CO2	Assess the significance and various methods of enzyme immobilization.	Evaluate
CO3	Apply knowledge of fermentation processes for the production of anti-tumor agents	Apply
CO4	Evaluate waste treatment techniques in industry, utilizing microbial-driven processes	Evaluate
CO5	Utilize analytical skills to assess the diverse roles of microbial enzymes in industry.	Apply

UNIT I INDUSTRIAL MICROORGANISMS **9 HOURS**

Differentiation between procaryotes and eucaryotes; Bacteria, Yeast, Molds and Actinomycetes – Cell Structure and Function – Metabolism. Bioprocessing -Fermentation Techniques: Screening procedures; Detection and assay of fermentation products; Fermentation media – down stream processing product regulation and safety – Bioreactors Design and operation.

UNIT II VITAMINS **10 HOURS**

Microbial production of Vitamins (vitamin B12, Riboflavin); Amino acids (Glutamic acid, Lysine); Organic acids (citric acid, Acetic acid and lactic acid- Production of microbial enzymes-Proteases, Amylases, single cell protein Application of immobilized enzymes – Prodcution of Organic Acids and amino acids. – production of Alkaloids – steroids and Vaccines.

UNIT III FERMENTATION **9 HOURS**

Manufacture of food and beverage fermentations – Alcohol based fermentation industries - Production of Vinegar- Manufacture of Bread- Manufacture of Dairy products-Fermented food products - Microbial production of antibiotics – Penicillin, Streptomycin, Microbial transformation of steroids and sterol, Fermentation of hydrocarbon – Production of anti-tumor agents

UNIT IV MICROBIAL CONTAMINATION **10 HOURS**

Microbial contamination and spoilage Bio deterioration of textiles, paper, leather, wood, and rubber -Spoilage of milk, alcoholic beverages, fruits -Spoilage of meat, poultry, eggs and fish. Conversion of Renewable resources to Biofuels and fine chemicals. – Waste treatment in industry.

UNIT V MICROBIAL ENZYMENS **10 HOURS**

Prevention and control of microorganisms in industry – Fundamentals, control by physical agents and chemical agents. Microbial Enzymes in Industry– Biocatalysts –Immobilized enzymes and immobilized cells – Mining microbiology

TOTAL:48 HOURS

TEXT BOOKS:

1. Sanjai Saxena (2016). *Applied Microbiology*, India: Springer Private Ltd.
2. El-Mansi, E. M. T., Bryce, C. F. A., Dahhou, B., Sanchez, S., Demainm, A. L., Allman, A. R. (2012*). Fermentation microbiology and biotechnology*, 3rd Edn, CRC Press.
3. Anantha Narayan, R. and Jayaram Panicker, C. K. (2022). *Textbook of Microbiology*, New Delhi: Universities Press (India) Pvt. Ltd.
4. Barrow, W. (1973). *Textbook of Microbiology*, Philadelphia: W.B. Saunders Company.
5. Casida, L. E. (2019). *Industrial Microbiology*, New Age International Private Limited.
6. Thomas D. Brock, Katherine M. Brock and David M. Ward. (1986). *Basic Microbiology with applications*. Prentice Hall.

REFERENCE BOOKS:

1. Waites, M. J., Morgan, N. L., Rockey, J. S. & Higton, G. (2001). *Industrial Microbiology, An Introduction*, 1st Edition, Blackwell Science
2. Akoenova, L. and Lisovskaya (1980). *Microbiology*, Moscow: Mir Publishers.
3. Bull, M. J. (1982). *Industrial Microbiology*, New York: Elsevier Scientific Publishing Co.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	2	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	-	2	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	2	-	-	2	-	-	-	-	-	-	-	-	-	2	-
Average	**3**	**-**	**2**	**-**	**-**	**2**	**-**	**-**	-	**-**	**-**	**-**	**--**	**-**	**-**	**2**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester III

24CHP305C **NANOCHEMISTRY** **4H-3C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of physical chemistry, particularly in areas such as quantum mechanics, surface chemistry, and materials science at the B.Sc level.

COURSE OBJECTIVES (CO):

- To know about the fundamentals-size and scale units of nanomaterials
- To learn about the various types of synthesis method of nanoparticles and its stabilization.
- To study about the various types of properties of nanomaterials and nano technology occurred in nature and application of nanomaterials.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Compare the properties of nanomaterials and solid materials.	Evaluate
CO2	Explain principles of growth, preparation, modification and functionalization of nanomaterials.	Evaluate
CO3	Examine the various form carbon of nanoparticles and its application.	Analyze
CO4	Categories the various types of properties of nanomaterials.	Analyze
CO5	Discuss the existence of nano technology in nature and the application of nanomaterials.	Create

UNIT I FUNDAMENTALS- SIZE & SCALE UNITS **9 HOURS**

Definitions and course organization, historical development of nanomaterials, classification of nanomaterials.

Scaling atoms, molecules, clusters and supramolecules. Structure and bonding in nanomaterials -chemical bonds (types and strength), intermolecular forces molecular and crystalline structures, hierarchical structures bulk to surface transition, surface reconstruction.

UNIT II NANOMATERIAL SYNTHESIS **10 HOURS**

Nanomaterial Synthesis: Chemical routes, electrochemical methods, vapor growth, **Thin films methods:** chemical vapor deposition, physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth, **Mechanical methods:** ball milling, mechanical

attrition, Sol-gel methods, special nanomaterials: carbon nanotubes, nanowires, porous silicon, bio-inspired synthesis nanocomposite fabrication, nanolithography, cryochemical synthesis, stabilization of nanoparticles.

UNIT III CARBON NANOTUBES AND NANOSENSORS 10 HOURS

Carbon nanostructures: Introduction. Fullerenes, C60, C80 and C240 nanostructures. Properties & applications (mechanical, optical and electrical). Functionalization of carbon nanotubes, reactivity of carbon nanotubes. **Nanosensors:** Temperature sensors, smoke sensors, sensors for aerospace and defence. Accelerometer, pressure sensor, night vision system, nano tweezers, nano-cutting tools, integration of sensor with actuators and electronic circuitry biosensors.

UNIT IV PROPERTIES AND SIZE DEPENDENCE OF PROPERTIES 9 HOURS

Chemical, optical, vibrational, thermal, electrical, magnetic mechanical, surface and quantum confinement effect and surface reactivity.

UNIT V APPLICATIONS OF NANOMATERIALS AND NANOTECHNOLOGY IN NATURE 10 HOURS

Applications of nanomaterials: Applications of nanoparticles in Solar cells-smart materials-molecular electronics- biosensors-various fundamental research, industries, medical field and environmental issues. Biosafety and ethical issue in application of nanoparticles. Toxicity of nano materials.

Nanotechnology in Nature: The science behind the nanotechnology in lotus effect-self cleaning property of lotus-gecko foot climbing ability of geckos-water strider-antiwetting property of water striders-spider silk mechanical properties of the spider silk.

TOTAL:48 HOURS

TEXT BOOKS:

1. Br'echignac, C., Houdy., & Lahmani, M. (2007). *Nanomaterials and Nanochemistry*. New York: Springer Berlin Heidelberg.
2. Hosokawa, M., Nogi, K., Naito, M., & Yokoyama, T. (2012). *Nanoparticle Technology Handbook* (II Edition). Elsevier.
3. Theodore, L. (2006). *Nanotechnology: Basic Calculations for Engineers and Scientists*. Hoboken: John Wiley & Sons. Inc., Publication.

REFERENCE BOOKS:

1. Dutta, J., Tibbals, H. F. & Hornyak, G. L. (2008). *Introduction to Nanoscience*. Boca Raton: CRC Press.
2. Sulabha K. Kulkarni, (2014). *Nanotechnology: Principles and Practices*. Springer Publisher.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	2	-	-	-	-	3	-	-	-	-	-	-
Average	**3**	**-**	**-**	**-**	**-**	**2.5**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP311 PHYSICAL CHEMISTRY PRACTICAL–I

(MOLECULAR WEIGHT DETERMINATION AND CONDUCTOMETRIC TITRATIONS)

3H-2C

Instruction Hours/week: L:0 T:0 P:3 **Marks**: Internal**: 40** External**: 60** Total**: 100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of physical chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To analyze the heat of solution, determination of molecular weight and distribution coefficient.
- To apply the conductometric method for the solutions and measure its conductivity.
- To evaluate distribution co-efficient influence, the solubility of various systems.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the basic concepts of conductometric titrations.	Evaluate
CO2	Utilize the basic concepts of conductometric titrations to determine the ionic strength.	Apply
CO3	Discuss the conductometric method for the solutions and measure its conductivity.	Create
CO4	Apply the Debye-Huckel Onsager equation to predict the behavior of electrolyte solutions.	Apply
CO5	Determine the distribution co-efficient influence the solubility of various systems.	Evaluate

Contents

1. Determination of the heat of solution of a substance by solubility method.
2. Determination of the solubility of $CuSO_4.5H_2O$ in water by gravimetric method at several temperatures.
3. Determination of neutralization enthalpy of HCl and CH_3COOH by NaOH.
4. Determination of hydrolysis constant of aniline hydrochloride.
5. Determination of dissociation constant of a weak acid by pH metric titration.
6. pH metric titration of mixture of weak acid and strong acid against strong base.
7. Setting up of various cells and measurement of their values, Examples: Zn /0.1M $ZnSO_4$/ KCl / Hg_2Cl_2 / Hg / Ag / AgCI / 0.l M KCl / Hg_2Cl_2/ Hg/ Hg_2Cl_2/ KCl/ 0.1 M $CuSO_4$/ Cu.
8. Determination of standard electrode potentials, activity coefficient and acid dissociation constant from Hamed Cell e.m.f's, (Hamed Cell is Pt / H_2/ HCl/AgCl, AgBr).

9. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
10. Determination of equivalent conductance, degree of dissociation and dissociation constant of a strong electrolyte.
11. Verification of Debye-Huckel Onsager equation.
12. Verification of Ostwald dilution law.
13. Verification of Kohlraush law for weak electrolytes.
14. Conductometric titration of a mixture of a weak acid and strong acid against a strong base.
15. Determination of the solubility of a sparingly soluble salt.
16. Conductometric titration: Acid-base and precipitation titrations including mixture of halides.

TOTAL:36 HOURS

TEXT BOOKS:

1. Lepse, P. A., & Lyle B. P. (1986). *Lab Manual for Lingren's Essentials of Chemistry*. New Delhi: Prentice Hall.
2. Pandey, O. P., Bajpai, D. N. & Giri, S. (2001). *Practical Chemistry* (VIII Edition). New Delhi: S. Chand Publications.
3. Santi Rajan Palit & Sadhan Kumar, (1971). *Practical Physical Chemistry* (I Edition). Calcutta: Joy Publishers.
4. Siddhiqui, Z. N. (2002). *Practical Industrial Chemistry* (I Edition). New Delhi: Anmol Publications Pvt. Ltd.
5. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications.

REFERENCE BOOKS:

1. Thomas, A. O. (2003). *Practical Chemistry*. Cannanore: Scientific Book Center.
2. Srivastava.T. N., & Kamboj. P. C. (2013). *University Practical Chemistry*. New Delhi: Milestone Publishers and Distributors.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	-	-	1	-	-	-	-	-	-	2	-
CO3	3	-	-	2	-	-	-	-	1	-	-	-	-	-		-	-
CO4	3	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-
CO5	3	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-
Average	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	1	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24CHP312 PHYSICAL CHEMISTRY PRACTICAL-II (CHEMICAL KINETICS AND POTENTIOMETRIC TITRATIONS) 3H-2C

Instruction Hours/week: L:0 T:0 P:3 **Marks:** Internal**:40** External**: 60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of physical chemistry principles at the B.Sc. Level.

COURSE OBJECTIVES (CO):

- To know the applications of chemical kinetics and potentiometric titrations.
- To evaluate the pH, pKa and redox potential by using potentiometry
- To analyze the ionic strength of the acids by using potentiometry.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the applications of chemical kinetics and potentiometric titrations.	Evaluate
CO2	Determine the pH, pKa and redox potential by using potentiometry.	Evaluate
CO3	Discuss the ionic strength of the acids by using potentiometry.	Create
CO4	Examine the chemical kinetics in various organic/inorganic compounds.	Analyze
CO5	Estimate the metal concentration in water samples using adsorption technique.	Evaluate

Contents

1. Electromotive force determination of standard potentials of Cu, Zn and Ag.
2. Determination of pH and pKa values using hydrogen and quinhydrone electrodes and glass electrode pH meter- potentiometric acid-base titrations.
3. Determination of formal redox potential of a redox system and redox titrations.
4. Determination of solubility product of a sparingly soluble salt concentration cell and chemical cell.
5. Determination of activity co-efficients from emf data. Precipitation titration of a mixture of halides.

Chemical kinetics:

I. Evaluation of Arrhenius parameters using acid hydrolysis of an ester.
II. Base catalyzed hydrolysis of an ester conductometrically.
III. Rate of reaction between persulphate and iodide ions study of salt over the persulphate-iodide reaction.

IV. Evaluation of catalytic constants for weak acids and verification of Bronsted catalysis law.

Adsorption Experiments:

Adsorption of oxalic acid and acetic acid on activated charcoal-Fruendlich isotherm.

TOTAL:36 HOURS

TEXT BOOKS:

1. Lepse, P. A., & Lyle B. P., (1986). *Lab Manual for Lingren's Essentials of Chemistry*. New Delhi: Prentice Hall.
2. Pandey, O. P, Bajpai, D. N., & Giri, S. (2001). *Practical Chemistry* (VIII Edition). New Delhi: S. Chand Publications.
3. Santi Rajan Palit & Sadhan Kumar (1971). *Practical Physical Chemistry* (I Edition). Calcutta: Joy Publishers.
4. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications

REFERENCE BOOKS:

1. Siddhiqui, Z. N. (2002). *Practical Industrial Chemistry* (I Edition). New Delhi: Anmol Publications Pvt. Ltd.
2. Thomas, A.O, (2003). *Practical Chemistry*. Cannanore: Scientific Book Center.

CO, PO, PSO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PO 14**	**PO 15**	**PS O1**	**PS O2**
CO1	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-
CO3	3	-	-	2	-	-		-	1	-	-	-	-	-	-	-	-
CO4	3	-	-	2	-	-	-	-	1		-	-	-	-			-
CO5	3	-		2	-	-	-	-	1	-	-	-	-	-	-	-	-
Average	**3**	-	-	**2**	-	-	-	-	**1**	-	-	-	-	-	-	-	-

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester III

24EGPOE301 ENGLISH FOR COMPETITIVE EXAMINATIONS 3H-2C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Not required

COURSE OBJECTIVES (CO):

- To train learners to crack competitive exams.
- To enhance their ability to speak in English and face an interview.
- To make the student apply, prepare and clear the competitive exams.
- To prepare the student to concentrate, stay positive and confident.
- To take even failure at ease and continue the target of clearing competitive exams.

Course Outcomes (COs):

Upon the completion of this course, students will be able to:

COs	Course Outcomes	Blooms Level
CO1	Execute the grammatical elements in competitive exams	Apply
CO2	Identify the various skills to build a strong outer relationship	Understand
CO3	Analyze logical reasoning questions	Analyze
CO4	Execute the process of sharing the general knowledge with use of proper communication	Apply
CO5	Translate the correct structure of sentence from one language to other	Understand

UNIT I Grammar **8 HOURS**

Number-Subject, Verb and Agreement-Articles-Sequences of Tenses-Common Errors

UNIT II Word Power **7 HOURS**

Idioms and Phrases-One word substitution-Synonyms-Antonyms-Words often confused

UNIT III Paragraph **7 HOURS**

Expansion of an idea

UNIT IV Writing **7 HOURS**

Essay- Letters-Memos-Agenda-Resume writing

UNIT V Speaking **7 HOURS**

Public Speaking-Group Discussion-Interview-Spoken English

TOTAL:36 HOURS

TEXT BOOK:

1. Saraswathi,V. and Maya K. Mudbhatkal (2014). *English for Competitive Examinations*. Chennai: Emerald Publication.

WEBSITES:

1.https://www.ef.com/wwen/english-resources/english-idioms/
2. https://www.talkenglish.com/speaking/listbasics.aspx

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PSO 1	PSO 2
CO1	-	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Average	**-**	**2.5**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

Semester III

24CMPOE301 PERSONAL FINANCE AND PLANNING 3H-2C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Basic understanding of financial management principles.

COURSE OBJECTIVES (CO):

- To familiarize students with the concept of Investment Planning and its methods.
- To examine the scope and methods of Personal Tax Planning.
- To analyze Insurance Planning and its relevance.

COURSE OUTCOMES (COs):

Upon the completion of this course, students will be able to:

COs	Course Outcomes	Blooms Level
CO1	Familiarize with regard to the concept of Investment Planning and its methods	Understand
CO2	Examine the scope and ways of Personal Tax Planning;	Analyze
CO3	Analyze Insurance Planning and its relevance	Analyze
CO4	Develop an insight in to retirement planning and its relevance.	Create
CO5	Construct an optimal portfolio in real life situations	Create

UNIT I INTRODUCTION TO FINANCIAL PLANNING 7 HOURS

Financial goals, Time value of money, steps in financial planning, personal finance/loans, education loan, car loan & home loan schemes. Introduction to savings, benefits of savings, management of spending & financial discipline, Net banking and UPI, digital wallets, security and precautions against Ponzi schemes and online frauds such as phishing, credit card cloning, skimming.

UNIT II INVESTMENT PLANNING 7 HOURS

Process and objectives of investment, Concept and measurement of return & risk for various assets class, Measurement of portfolio risk and return,Diversification & Portfolio formation. Gold Bond; Real estate; Investment in Greenfield and brownfield Projects; Investment in fixed income instruments- financial derivatives & Commodity market in India. Mutual fund schemes including SIP; International investment avenues.

UNIT III PERSONAL TAX PLANNING 7 HOURS

Tax Structure in India for personal taxation, Scope of Personal tax planning, Exemptions and deductions available to individuals under different heads of income and gross total income, Special provision u/s 115BAC vis-à-vis General provisions of the Income-tax Act, 1961. Tax avoidance versus tax evasion.

UNIT IV INSURANCE PLANNING **7 HOURS**

Need for Protection planning. Risk of mortality, health, disability and property. Importance of Insurance: life and non-life insurance schemes. Deductions available under the Income-tax Act for premium paid for different policies.

UNIT V RETIREMENT BENEFITS PLANNING **8 HOURS**

Retirement Planning Goals, Process of retirement planning, Pension plans available in India, Reverse mortgage, New Pension Scheme. Exemption available under the Income-tax Act, 1961 for retirement benefits.

TOTAL: 36 HOURS

TEXT BOOKS:

1. Indian Institute of Banking & Finance. (2017). *Introduction to Financial Planning*, Taxmann Publication., New Delhi.
2. Pandit, A. (2014). *The Only Financial Planning Book that You Will Ever Need*, Network Publications Ltd., Mumbai.

REFERENCE BOOKS:

1. Sinha, M. (2008). *Financial Planning: A Ready Reckoner*, McGraw Hill Education, New York.
2. Halan, M. (2018). *Let's Talk Money: You've Worked Hard for It, Now Make It Workfor You*, Harper Collins Publishers, New York.
3. Tripathi, V. (2017). *Fundamentals of Investment*, Taxmann Publication, New Delhi.

CO, PO, PSO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**P011**	**P012**	**P013**	**P014**	**P015**	**PSO1**	**PSO2**
CO1	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	3	3
CO2	3	-	-	-	3	-	-	-	-	-	3	-	-	-	3	-	-
CO3	3	-	-	-	3	-	-	-	2	-	3	-	-	-	3	3	3
CO4	3	-	-	-	3	-	-	-	2	-	3	-	-	-	3	3	3
CO5	3	-	1	-		-	-	-	2	-	3	-	-	-	3	-	-
Average	**3**	-	**1**	-	**3**	-	-	-	**2**	-	**3**	-	-	-	**3**	**3**	**3**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester III

24MBAPOE301 ORGANIZATIONAL BEHAVIOUR 3H-2C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Not Required

COURSE OBJECTIVES (CO):

- To understand the basic concepts of organizational behavior.
- To analyze the individual behavior traits required for performing as an individual or group.
- To obtain the perceiving skills to judge the situation and communicate the thoughts and ideas.
- To evaluate how to perform in group and team and how to manage the power, politics and conflict.
- To recognize the importance of organizational culture and organizational change, group and team work to managing the conflict between members of the organization.

COURSE OUTCOMES (COs):

Upon the completion of this course, students will be able to:

COs	Course Outcomes	Blooms Level
CO1	Connect organizational behavior issues in the context of the organizational behavior theories and concepts.	Understand
CO2	Assess the behavior of the individuals and groups in organization and manage the stress.	Apply
CO3	Categorize team, power, politics and conflict arising between the members.	Analyze
CO4	Explain how organizational change and culture affect the working relationship within organizations.	Evaluate
CO5	Plan and exhibit the communications kills to convey the thoughts and ideas of case analysis to the individuals and group.	Analyze

UNIT I ORGANIZATION BEHAVIOR: INTRODUCTION 7 HOURS

Organization Behavior: Meaning and definition - Fundamental concepts of Organization Behavior - Contributing disciplines to the Organization Behavior field – Organization Behavior Model - Significance of Organization Behavior in the organization success - Challenges and Opportunities for Organization Behavior.

UNIT II BEHAVIOUR AND PERSONALITY **7 HOURS**

Attitudes – Sources - Types - Functions of Attitudes – Attitude and Job satisfaction, Emotions and Moods – Emotional Intelligence – Organization Behavior Applications of Emotions and Moods, Learning – Theories of Learning. Personality – Determinants of personality- Theories of Personality - psycho-analytical, social learning, job-fit, and trait theories.

UNIT III PERCEPTION **7 HOURS**

Perception – factors influencing perception - Person Perception – Attribution Theory – Frequently Used Shortcuts in Judging Others- Perceptual Process- Perceptual Selectivity - Organization Errors of perception – Linkage between perception and Decision making.

UNIT IV GROUP AND STRESS MANAGEMENT **7 HOURS**

Foundation of Group Behavior - Concept of Group - Types of Groups - Stages of Group Development - Group Norms - Group Cohesiveness – Stress- Causes of Stress- Effects of Occupational stress- Coping strategies for stress.

UNIT V ORGANIZATION CULTURE AND CHANGE AND STRESS MANAGEMENT **8 HOURS**

Organizational culture- Definitions and Characteristics of Culture- Types of Culture – Creating and Maintaining an Organizational Culture. Organizational change –Meaning- Forces for Change- Managing Planned Change - Factors in Organizational Change - Resistance to change- Overcoming resistance to change.

TOTAL: 36 HOURS

TEXT BOOKS:

1. Fred Luthans. (2017). *Organizational Behavior: An Evidence-Based Approach* (XII Edition). New Delhi: Mcgraw Hill Education.
2. Steven Mcshane and Mary Ann Von Glinow (2017). *Organizational Behavior* (V I Edition). New Delhi: McGraw Hill Education.
3. Robbins,S. P, and Judge, T. A. (2016). *Organizational Behaviour* (16th Edition). New Delhi: Prentice Hall of India.

REFERENCE BOOKS:

1.Laurie J. Mullins (2016). *Management and Organizational behaviour* (10th Edition). New Delhi: Pearson Education.
2.Robbins, S. P, and Judge,T.A. (2016). *Essentials of Organizational Behavior* (13th Edition). New Delhi: Pearson Education.

WEB SITES:

https://nptel.ac.in/courses/110/105/110105033/

CO, PO, PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2
CO1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2	-
Average	-	-	**2**	**3**	**2**	-	**3**	-	-	-	-	-	-	-	-	**2.5**	-

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester III

24CAPOE301 ROBOTICS PROCESS AUTOMATION

3H-2C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Not Required

COURSE OBJECTIVES (CO):

- To enable the understanding of RPA and the types of variables.
- To create expertism in handling the User Events and various types of Exceptions and strategies.
- To demonstrate the Deployment of the Robot and to maintain the connection.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the RPA and the ability to differentiate it from other types of automation.	Understand
CO2	Analyze the different types of variables, Control Flow and data manipulation techniques.	Analyze
CO3	Summarize Image, Text and Data Tables Automation.	Understand
CO4	Evaluate the User Events and its types of Exceptions and strategies.	Evaluate
CO5	Illustrate the deployment of the robot and to maintain the connection.	Apply

UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 8 HOURS

Scope and techniques of automation, Robotic process automation - What can RPA do?, Benefits of RPA, Components of RPA, RPA platforms, The future of automation.

RPA Basics: History of Automation - What is RPA - RPA vs Automation - Processes & Flowcharts - Programming Constructs in RPA - What Processes can be Automated - Types of Bots - Workloads which can be automated - RPA Advanced Concepts - Standardization of processes - RPA Development methodologies - Difference from SDLC - Robotic control flow architecture - RPA business case - RPA Team - Process Design Document/Solution Design Document – Industries best suited for RPA - Risks & Challenges with RPA - RPA and emerging ecosystem.

UNIT II RPA TOOL INTRODUCTION AND BASICS 7 HOURS

Introduction -The User Interface - Variables - Managing Variables - Naming Best Practices - The Variables Panel - Generic Value Variables - Text Variables True or False Variables - Number

Variables - Array Variables - Date and Time Variables Data Table Variables - Managing Arguments - Naming Best Practices - The Arguments Panel - Using Arguments - About Imported Namespaces - Importing New Namespaces- Control Flow - Control Flow Introduction - If Else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts - About Control Flow - Control Flow Activities - The Assign Activity - The Delay Activity - The Do While Activity - The If Activity - The Switch Activity - The While Activity - The For Each Activity - The Break Activity - Data Manipulation- Data Manipulation Introduction - Scalar variables, collections and Tables -Text Manipulation - Data Manipulation - Gathering and Assembling Data

UNIT III ADVANCED AUTOMATION CONCEPTS & TECHNIQUES 7 HOURS

Recording Introduction - Basic and Desktop Recording - Web Recording - Input/Output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors - RPA Challenge - Image, Text & Advanced Citrix Automation - Introduction to Image & Text Automation - Image based automation - Keyboard based automation - Information Retrieval - Advanced Citrix Automation challenges - Best Practices - Using tab for Images - Starting Apps - Excel DataTables & PDF - Data Tables in RPA - Excel and Data Table basics - Data Manipulation in excel – Extracting Data from PDF - Extracting a single piece of data - Anchors - Using anchors in PDF.

UNIT IV HANDLING USER EVENTS & ASSISTANT BOTS, EXCEPTION HANDLING 7 HOURS

What are assistant bots? - Monitoring system event triggers - Hotkey trigger - Mouse trigger - System trigger - Monitoring image and element triggers - An example of monitoring email - Example of monitoring a copying event and blocking it - Launching an assistant bot on a keyboard event.

Exception Handling -Debugging and Exception Handling - Debugging Tools - Strategies for solving issues - Catching errors.

UNIT V DEPLOYING AND MAINTAINING THE BOT 7 HOURS

Publishing using publish utility - Creation of Server - Using Server to control the bots - Creating a provision Robotfrom the Server - Connecting a Robot to Server - Deploy the Robot to Server - Publishing and managing updates - Managing packages - Uploading packages - Deleting packages.

TOTAL: 36 HOURS

TEXT BOOKS:

1.Alok Mani Tripathi (2018). *Learning Robotic Process Automation*, Packt Publishing.

2. Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston (2015). *Introduction to Robotic Process Automation: A Primer, Institute of Robotic Process Automation,*1st Edition.

3. Richard Murdoch. (2018). *Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant,* Independently Published, 1st Edition.

REFERENCE BOOKS:

1. Srikanth Merinda. (2018). *Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation*, Consulting Opportunity Holdings LLC, 1st Edition.

2. Lim Mei Ying. (2018). *Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes*, Packt Publishing, 1st Edition.

WEBSITE LINKS:

1.https://www.uipath.com/rpa/robotic-process-automation

2. https://www.academy.uipath.com

CO, PO, PSO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PSO 1	PSO 2
CO1	3	-	-	-		2	-	-	2	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-
CO3	-	-	-	3	-	-	2	-	3	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	2	1	2	-	-	-	-	-	-	-	-
CO5	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**2.5**	**2**	**1**	**2.5**	**-**	**2.5**	**2**	**1**	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester III

24CSPOE301 **CYBER FORENSICS** **3H-2C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

- Basics of Cyber Security.

COURSE OBJECTIVES (CO):

- To understand about computer forensics and investigations.
- To know about digital evidence, e-mail investigation, and Mobile device forensics.
- To analyse and validate forensics data.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain various investigation procedures and summarize duplication of digital evidence.	Evaluate
CO2	Apply the knowledge of digital evidences.	Apply
CO3	Design and develop various forensics tools and analyse the network forensics.	Analyze
CO4	Determine the systematic study of high-tech forensics	Evaluate
CO5	Analyze and validate digital evidence data	Analyze

UNIT I COMPUTER FORENSICS AND INVESTIGATIONS **7 HOURS**

Computer forensics and investigations as a profession – Preparing for computer investigations – Taking a systematic approach–Procedures for corporate high-tech investigations–Data recovery work stations and software– Conducting an investigation.

UNIT II DATA ACQUISITION **7 HOURS**

Data acquisition – Storage formats for digital evidence – Validating data acquisitions – Processing crime and incident scenes–Identifying digital evidence–Collecting evidence in private sector incident scenes – Preparing for search-seizing digital evidence at the scene-storing digital evidence –Reviewing a case.

UNIT III COMPUTER FORENSICS TOOLS **7 HOURS**

Current computer forensics tools–Software tools–Hardware tools–The Macintosh file structure and boot process – Computer forensics analysis and validation – Addressing data –Hiding techniques.

UNIT IV NETWORK FORENSICS **7 HOURS**

Virtual machines – Network forensics – Developing standard procedures – Live acquisitions – email investigations – Investigating e-mail crimes and violations – Understanding e-mail servers – Cell phone and mobile device forensics.

UNIT V MOBILE DEVICE FORENSICS **8 HOURS**

Understanding mobile device forensics – Acquisition procedures –Report writing for high-tech investigations – Importance of reports – Guidelines for writing reports –Expert testimony in high-tech investigations.

TOTAL:36 HOURS

TEXT BOOKS:

1. Bill Nelson, Amelia Phillips and Christopher Steuart (2018). *Computer Forensics and Investigations*, Cengage Learning, 5th Edition.
2. Eoghan Casey. (2017). *Handbook of Digital Forensics and Investigation*, 1st Edition, Academic Press.
3. John R Vacca, (2016). *Computer Forensics*, 2nd Edition, Cengage Learning.

REFERENCE BOOKS:

1. John R. Vacca, (2005), *Computer Forensics: Computer Crime Scene Investigation*, 2nd Edition Cengage Learning.
2. Marjie T Britz, (2008), *Computer Forensics and Cyber Crime: An Introduction*, 2nd Edition, Pearson Education.
3. Mari E-Helen Maras, (2014). *Computer Forensics: Cybercriminals, Laws, and Evidence*, 2nd Edition Jones & Bartlett Learning.

WEBSITES:

1. www.cps.brockport.edu/~shen/cps301/figures/figure1.pdf
2. www.forensicsguru.com/devicedataextractionsimcell.php
3. www.nptel.ac.in/courses/106101060
4. www.samsclass.info/121/ppt/ch11.ppt
5. www.garykessler.net/library/role_of_computer_forensics.html
6. www.ukessays.com/essays/information-technology/computer-forensics-and-crime investigations-information-technology-essay.php.

CO, PO, PSO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**
CO1	-	-	3	-	-	-	-	-	-	-	2	-	-	-	-	2	-
CO2	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO5	3	-	3	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Average	**3**	**-**	**3**	**-**	**1**	**1**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester III

24MMPOE301 **CODING THEORY** **3H-2C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

- Algebra, Probability and Statistics, Digital Communication, Programming Skills.

COURSE OBJECTIVES (CO):

- To understand the communication channels and the importance of error correction.
- To explore the linear codes, self-orthogonal codes, and self-dual codes.
- To learn about the cyclic codes, their properties, and decoding methods.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Understand the fundamental concepts of error detection, correction, and decoding in communication channels.	Understand
CO2	Apply the concepts of generator matrix and parity check matrix in encoding and decoding linear codes.	Apply
CO3	Analyze different types of codes, including Binary and q-ary Hamming codes, Golay codes, and MDS codes, for their error-correcting capabilities.	Analyze
CO4	Understand the definitions and properties of cyclic codes.	Understand
CO5	Apply BCH codes and Reed Solomon codes to various coding problems.	Apply

UNIT I ERROR DETECTION, CORRECTION AND DECODING **7 HOURS**

Communication channels – Maximum likelihood decoding – Hamming distance – Nearest neighbourhood minimum distance decoding – Distance of a code.

UNIT II LINEAR CODES **7 HOURS**

Linear codes – Self orthogonal codes – Self dual codes – Bases for linear codes – Generator matrix and parity check matrix – Encoding with a linear code – Decoding of linear codes – Syndrome decoding.

UNIT III BOUNDS IN CODING THEORY **8 HOURS**

The main coding theory problem – lower bounds - Sphere covering bound – Gilbert Varshamov bound – Binary Hamming codes – q-ary Hamming codes – Golay codes – Singleton bound and MDS codes – Plotkin bound.

UNIT IV CYCLIC CODES **7 HOURS**

Definitions – Generator polynomials – Generator matrix and parity check matrix – Decoding of Cyclic codes.

UNIT V SPECIAL CYCLIC CODES **7 HOURS**

BCH codes – Parameters of BCH codes – Decoding of BCH codes – Reed Solomon codes.

TOTAL: 36 HOURS

TEXT BOOKS:

1. Hill, H. (1986). *A first course in Coding theory*, OUP.
2. San Ling and Chaping Xing, (2004). *Coding Theory: A first course*, Cambridge University Press.

REFERENCE BOOKS:

1. Berlekamp, E.R. (1968). *Algebraic Coding Theory*, Mc Graw – Hill.
2. Lin, S. and Costello, D. J. (1983). *Error control Coding: Fundamentals and Applications*, Prentice – Hall, Inc., New Jersey.
3. Vera Pless, (1982). *Introduction to the Theory of Error Correcting Codes*, Wiley, New York.

WEBSITES:

1. https://nptel.ac.in/courses/108104092
2. https://nptel.ac.in/courses/117106031

CO, PO, PSO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PSO 1	PSO 2
CO1	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO3	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO5	3	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Average	**2.4**	**1.4**	**1**	**-**	**-**	**-**	**1**	**-**	-	-	-	**-**	-	-	-	-	**1**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

24PHPOE301 ELECTRICAL APPLIANCES AND SERVICING 3H-2C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Not Required

COURSE OBJECTIVES (CO):

- To create awareness about types and handling of domestic appliances
- To acquire knowledge about principle of operation, working and application of various domestic appliances.
- To gain the skills in assembly, repair, installation, testing and maintenance of domestic appliances.
- To acquire skills in entrepreneurship

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Repair maintenance of the basic electrical and electronics appliances	Apply
CO2	Identification to protective devices	Understand
CO3	Repair and maintenance of the split Vacuum Cleaner and washing machine	Analysis
CO4	Repair and maintenance of the electric fan & hair drier	Apply
CO5	Acquire knowledge about tools, equipment and Instruments	Understand

UNIT I INSTRUMENTS AND TESTING 8 HOURS

Introduction – voltage tester screwdriver – continuing test – insulation test – measurement of power for dc & ac circuits.

Electrical Cooking Appliances introduction – types – construction – electric toaster – types – automatic and non-automatic.

Electric Iron Box types – non-automatic – automatic – construction and working – comparison – trouble shooting – Steam iron box.

UNIT II WATER HEATERS & COFFEE MAKERS 7 HOURS

Water heater – function – types – electric kettle – immersion water heater – construction and working – storage water heaters – non pressure type – pressure type – construction and working – repairs & remedies – coffee maker – types – construction and working of percolator type.

UNIT III ELECTRIC MIXER & EGG BEATERS 7 HOURS

Electric maker – function and its construction – general operating instruction – caution –

cleaning – repairs and remedies – egg beaters – hand operated crank type – electric type and its construction.

UNIT IV VACUUM CLEANER AND WASHING MACHINE 7 HOURS

Vacuum cleaner – function – principle – main components – features – types - working – accessories - filters – repairing. washing machine – function – types – semi and fully automatic – top and front loading – washing technique – working cycle – construction and working of washing machine – comparison of top and front-loading machines – problems and remedies.

UNIT V ELECTRIC FAN & HAIR DRIER 7 HOURS

Fan – function – terminology – construction and working of ceiling & table fans –exhaust fan – general fault and remedy. hair drier – function – types – construction and working – safety features – repairs & remedies.

TOTAL:36 HOURS

TEXT BOOKS:

1. *Electrical Practical, Directorate General of employment & training (DGET)*,(2018) .Arihant Publisher.
2. *Handbook of Repair and Maintenance of Domestic Electronics Appliances handbook* By Shashi Bhushan Sinha, BPB Publications.

REFERENCE BOOKS:

1. Dixon and Graham, *Electrical Appliance Manual–Hardcover*, ISBN 13: 9781859608005.
2. Graham and Dixon, (1995). *Electrical Appliances: The Complete Guide to the Maintenance and Repair of Domestic Electrical Appliances* (Haynes for Home DIY S.).
3. Shashi Bhushan Sinha, *Handbook of Repair and Maintenance of Domestic Electronics Appliances.*

WEBSITES:

1. https://alison.com/courses?query=Electrical%20Appliance%20and%20Servicings#.
2. https://www.scribd.com/document/269725441/Electrical-Appliances-PDF.
3. https://www.unitec.ac.nz/career-and-study-options/electrical-and-electronics-engineering/electrical-appliance-serviceperson-eas.

CO, PO, PSO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PO14**	**PO15**	**PSO1**	**PSO2**
CO1	-	-	3	-	-	-	-	-	1	-	2	-	2	-	-	2	-
CO2	-	-	3	-	1	-	-	-	1	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	2	-	-	-	-	-	2	-	-	-	2
CO5	3	-	3	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Average	**3**	-	**3**	-	**1**	**1**	**2**	-	**1**	-	**2**	-	**2**	-	-	**2**	**2**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

SEMESTER III

24CHPOE301 **INDUSTRIAL CHEMISTRY** **3H-2C**

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Elementary level understanding of sugar, paints, glass, cement and rubber at the B.Sc level.

COURSE OBJECTIVES (CO):

- To understand the comprehensive process of cane sugar, cement and rubber production.
- To gain the understanding of paint classification, constituents and diverse applications
- To understand the physical and chemical properties of glass, its characteristics and the manufacturing processes.

Course Outcomes (CO's):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Explain the process of cane sugar production.	Evaluate
CO2	Classify paints, constituents and diverse applications.	Analyze
CO3	Examine the physical and chemical properties of glass.	Analyze
CO4	Analyze the manufacturing processes of cement, including the wet and dry processes,	Analyze
CO5	Discuss the rubber fabrication, including refining processes, fabrication methods, and vulcanization techniques.	Create

UNIT I SUGAR **8 HOURS**

Introduction, Manufacture of Cane Sugar - Extraction of juice, Purification of Juice, Defecation, Sulphitation, Carbonation, Concentration or Evaporation. Crystallization - Separation of crystals, drying, refining, recovery of sugar from Molasses, Bagasse. Manufacture of sucrose from beet root. Estimation of sugar, double sulphitation process, double carbonation.

UNIT II PAINTS **8 HOURS**

Classification, constituents, setting of paints, requirements of a good paint. Emulsion, Latex, Luminescent, Fire retardant and Heat resistant paints. Methods of applying paints. Special applications and failures of paint. Varnishes - Introduction – Raw materials – Manufacture of varnishes.

UNIT III GLASS **8 HOURS**

Introduction, Physical/Chemical properties, Characteristics of glass. Raw materials, methods of manufacture - formation of batch material, melting, shaping, annealing and finishing of glass.

UNIT IV CEMENT **6 HOURS**

Introduction, raw materials, manufacture – Wet process, Dry process, reactions in kiln, setting of cement, properties and uses of cement. Plaster of Paris, Gypsum, Lime

UNIT V RUBBER **6 HOURS**

Introduction, Importance, types and properties of rubber. Refining of crude rubber, drawbacks of raw rubber. Rubber fabrication, vulcanization techniques**.**

TOTAL:36 HOURS

TEXT BOOKS:

1. Sharma, B.K. (2014). *Industrial Chemistry* (14th Edition). Meerut: Goel Publishing House.
2. Jain, P.C. & Monika Jain. (2016). *Engineering Chemistry* (16th Edition). New Delhi: Dhanpat Rai Publishing Co. (Pvt) Ltd.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PS O1	PS O2
CO1	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	2	-	-	-	-	-	-	-	-	-	-		-	-
CO4	3	-	-	2	-	2	-	-	2	-	2	-	-	-	-	-	-
CO5	3	-	-	2	-	2	-	-	2	-	2	-	-	-	-	-	-
Average	**3**	**-**	**-**	**2**	**-**	**2**	**-**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**

1-Low, 2-Medium, 3-High, '-' No Correlation

24MBPOE301 FERMENTATION TECHNOLOGY 3H–2C

Instruction Hours/week: L:3 T:0 P:0 **Marks:** Internal**: 40** External**: 60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Not required

COURSE OBJECTIVES (CO):

- To study the use of microorganisms in the manufacture of food or industrial products on the basis of employment.
- To gain knowledge on design of bioreactors, factors affecting growth and production, heat transfer and oxygen transfer
- To understand the rationale in medium formulation; design for microbial fermentation, and sterilization of medium and air.

COURSE OUTCOMES (COs):

Upon completion of this course students will be able to:

COs	Course Outcomes	Blooms Level
CO1	Acquire knowledge in the production of industrial product, and gain knowledge in fermentation components and types	Understand
CO2	Isolate, preserve the microbes for fermentation upstream processes	Apply
CO3	Apply techniques for microbial production of various enzymes	Apply
CO4	Experiment with production of organic acids and beverages	Apply
CO5	Practice the techniques for the production of amino acids, vitamins and single cell proteins	Apply

UNIT I BASICS OF FERMENTATION PROCESSES 7 HOURS

Definition, scope, history, and chronological development of the fermentation industry. Component parts of the fermentation process. Component parts of fermentation process. Microbial growth kinetics, batch and continuous, direct, dual or multiple fermentations; scale up of fermentation, comparison of batch and continuous culture as investigative tools, examples of the use of fed batch culture.

UNIT II ISOLATION AND PRESERVATION 7 HOURS

Isolation, preservation, and strain improvement of industrially important microorganisms. Use ofrecombination system (Parasexual cycle, protoplast fusion techniques), application of recombinant strains, and the development of new fermentation products.

UNIT III SCREENING AND INOCULUM DEVELOPMENT 7 HOURS

Screening (primary and secondary screening); detection and assay of fermentation products (Physico-chemical assay, biological assays). Inoculum development, criteria for transfer of inoculum, development of inoculum: Bacteria, Fungi and Yeast.

UNIT IV MICROBIAL PRODUCTION 7 HOURS

Fermentation type reactions (Alcoholic, bacterial, mixed acid, propionic acid, butanediol and acetone-butanol). Microbial production of enzymes (amylases, Proteases, cellulases) primary screening for producers, large scale production. Immobilization methods.

UNIT V ALCOHOLS AND BEVERAGES 8 HOURS

Fermentative production of industrial alcohol, production of beverages. Production of organic acids: citric acid, amino acids: glutamic acid, production of vitamins. fungal enzymes and Single cell protein.

TOTAL: 36 HOURS

TEXT BOOKS:

1.Sridhar, S. (2010). *Industrial Microbiology*. New Delhi: Dominant Publishers.
2.Tanuja. S and Purohit, S.S. (2008). *Fermentation Technology*. Jodhpur: Agrobios Publication.
3.Harider, S.I. and Ashok, A. (2009). *Biotechnology, A Comprehensive Training Guide for theBiotechnology Industry*. New York: CRC Press.

REFERENCE BOOKS:

1.Casida, L.E. (2007). *Industrial Microbiology*. New Delhi: New age international (P) Ltd.
2.Clark, D.P and Pazdernik, N.J. (2009). *Biotechnology Applying the Genetic Revolution*. UK: Elsevier Academic Press.
3.Glazer, A and Nikaido. (1995). *Microbial Biotechnology Fundamentals of Applied Microbiology*. USA: W. H. Freeman and company.
4.Glick, B.R and Pasternak, J.J. (2003). *Molecular Biotechnology Principles and Applications of Recombinant DNA* (III Edition). USA ASM Press.

CO, PO, PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PSO 1	POS 2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	2	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3
CO4	-	-	-	2	-	2	-	3	-	-	2	-	-	-	-	-	3
CO5	-	-	-	2	-	2	-	3	-	-	2	-	-	-	2	-	3
Average	**2.7**	**-**	**-**	**2**	**-**	**2**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**3**

1 - Low, 2 - Medium, 3 - High, '-' - No Correlation

Semester III

24BTPOE301 **NUTRITION AND DIETETICS** **3H–2C**

Instruction Hours/week:L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total**:100**

End Semester Exam: 3 Hours

PREREQUISITE:

Student should know about basics of food, its nutrients and their relationship to health.

COURSE OBJECTIVES (CO):

- To understand the fundamentals of food, nutrients and their relationship to health.
- To develop knowledge on nutrition deficiency diseases and their consequences.
- To know about food adulteration and prevention of food adulteration.

COURSE OUTCOMES (COs):

Upon completion of this course, the student will be able to:

COs	Course Outcomes	Blooms Level
CO1	Name the fundamentals of nutrition and their relationship to health.	Remember
CO2	Learn to derive maximum benefits from available food resources.	Understand
CO3	Identify the consequences of vitamin and mineral deficiency/excess of vitamin.	Apply
CO4	Analyze the importance of nutrition in adult age.	Analyze
CO5	Assess about nutrition deficiency diseases and their consequences.	Evaluate

UNIT I BASIC CONCEPTS IN FOOD AND NUTRITION **5 HOURS**

Understanding relationship between food, nutrition and health, Functions of food-Physiological, psychological and social. Dietary guidelines for Indians and food pyramid.

UNIT II NUTRIENTS **5 HOURS**

Functions, dietary sources and clinical manifestations of deficiency/ excess of the following nutrients: Carbohydrates, lipids and proteins, Fat soluble vitamins-A, D, E and K, Water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C, Minerals – calcium, iron and iodine.

UNIT III NUTRITION DURING THE ADULT YEARS **10 HOURS**

Physiological changes, RDA, nutritional guidelines, nutritional concerns and healthy food choices – Adult, Pregnant woman, Lactating mother, Elderly. Nutrition during childhood - Growth and development, nutritional guidelines, nutritional concerns and healthy food choices - Infants, Preschool children, School children, Adolescents. Nutritional needs of nursing mothers and infants, determinants of birth weight and consequences of low birth weight, Breast feeding, Assessment and management of moderate and severe malnutrition among children, Child health and morbidity, neonatal, infant and child mortality.

UNIT IV INTRODUCTION TO NUTRITIONAL DEFICIENCY DISEASES

6 HOURS

Causes, symptoms, treatment, prevention of the following: Protein Energy Malnutrition (PEM), Vitamin A Deficiency (VAD), Iron Deficiency Anemia (IDA), Iodine Deficiency Disorders (IDD), Zinc Deficiency, Flurosis Nutritional needs during pregnancy, common disorders of pregnancy (Anemia, HIV infection, Pregnancy induced hypertension), relationship between maternal diet and birth. Maternal health and nutritional status, maternal mortality and issues relating to maternal health.

UNIT V DIETETICS **10 HOURS**

Dietary and stress management. Dietary recommendations of WHO. Diet for diabetes mellitus-Nutrition recommendations for patient with diabetes, Meal planning, Diet for Cardiovascular Diseases -Dietary management and general guidelines for coronary heart disease, Diet for cancers at various sites in the human body, diet therapy, managing eating problems during treatment. Hormonal imbalance – Poly cystic ovarian syndrome, causes of hormonal imbalance. Diet management.

TOTAL: 36 HOURS

TEXT BOOKS:

1. Srilakshmi. B. (2015). *Food Science* (VI Edition). New Delhi: New Age International (P) Ltd. Publishers.
2. Swaminathan. M. (2008). *Essential of Food and Nutrition* (Vol II). Bangalore: The Bangalore Printing and Publishing Co. Ltd.

REFERENCE BOOKS:

1. Garrow, J.S., and James, W.P.T. (2000). *Human Nutrition & Dietetics*. UK: Longman Group.
2. Gordon M, Wardlaw and Paul M. (2012). *Perspectives in Nutrition* (IX Edition). New Delhi: McGraw Hill Publishers.
3. Sharma, R (2004). *Diet Management* (III Edition). Chennai: Reed Elsevier India Private Limited.
4. Srilakshmi, B. (2014). *Nutrition Science* (IV Edition). New Delhi: New Age International (P) Ltd. Publishers.

CO, PO, PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PSO1	PSO2
CO1	3	-	-	-	-	-	-	2	2	-	2	2	2	-	2	2	2
CO2	3	-	-	-	-	-	-	2	2	-	2	2	2	-	2	2	2
CO3	3	-	-	-	-	-	-	2	2	-	2	2	2	-	2	2	2
CO4	3	-	-	-	-	-	-	2	2	-	2	2	2	-	2	2	2
CO5	3	-	-	-	-	-	-	2	2	-	2	2	2	-	2	2	2
Average	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**2**	**2**	**2**	**-**	**2**	**2**	**2**

1-Low; 2-Medium; 3-Strong; '-' No correlation

Semester III

24CHP391 **INTERNSHIP**

0H-2C

Instruction Hours/week: L: 0 T: 0 P: 0 **Marks:** Internal**: 100** External**: 0** Total**:100**

M.Sc. Chemistry		**2024-2025**
		Semester IV
24CHP491	**PROJECT AND VIVA-VOCE**	**30H-15C**
Instruction Hours/week: L:0 T:0 P:30	**Marks:** Internal**: 80** External**: 120** Total**:200**	