M.Sc. CHEMISTRY

CHOICE BASED CREDIT SYSTEM (CBCS)

Curriculum & Syllabus

2023-2024

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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

Phone: 0422 – 2980011–14
Email: info@kahedu.edu.in Web: www. kahedu.edu.in

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)
Coimbatore - 641 021, Tamil Nadu, India

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

REGULAR MODE
CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS - 2023

The following regulations are effective from the academic year 2023 -2024 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.	Programme 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	MA English

1.2 MODE OF STUDY

Full-Time

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 ADMSSION 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.	Name of the Programme Offered	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 / Molecular Biology / Genetic Engineering / Biochemistry / Agriculture / Forestry / Medical Lab Technology / Life Sciences

3	M.Sc. Biotechnology	B.Sc. Degree with 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 science
5	M.Sc. Chemistry	B. Sc. Chemistry, Industrial Chemistry, Polymer Chemistry
6	M.Sc. Mathematics	B.Sc. Mathematics / B.Sc. Mathematics with Computer Applications
7	M.Sc. Computer Science	B.Sc. Computer Science / Computer Technology / Information Technology / Electronics / Software Systems / BCA/ B.Sc. Applied Sciences
8	M.Com	B.Com./BCom.(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 semester.

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. Examination shall be conducted at the end of every semester for the respective courses.

3. CHOICE BASED CREDIT SYSTEM

3.1 All programmes are offered under Choice Based Credit System with a total credit ranges from 87 to 93 for the PG programmes.

3.2 Credits

Credits means the weightage given to each course of study by the experts of the Board of Studies concerned.

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. Core course

Core course consists of theory and practical and the examinations shall be conducted at the end of each semester.

b. Elective course

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.

In case the candidate undertakes the project work outside the Department, the teacher concerned within the Department shall be the Main guide and the teacher/scientist under whom the work is carried out will be the Co-guide. The candidate shall bring the attendance certificate from the place where the project work carried out.

d. Value Added Courses

Courses of varying durations but not less than 30 hours which are optional and offered outside the curriculum that add value and help the students in getting placement. Students of all programmes are eligible to enroll for the Value Added Courses. The student shall choose one Value Added Course per semester from the list of Value Added Courses available in KAHE. The examinations shall be conducted at the end of the Value Added Course at the Department level and the student has to secure a minimum of 50% of marks to get a pass. The certificate for the Value Added Course for the passed out students shall be issued duly signed by the HOD and Dean of the Faculty concerned.

e. Internship

The student shall undergo 15 days internship in 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.100 marks is awarded for Internship through Continuous Internal Assessment.

f. 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 02 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	23EGPOE301	English for Competitive Examinations
2	Commerce	23CMPOE301	Personal Finance and Planning
3	Management	23MBAPOE301	Organizational Behavior
4	Computer Applications	23CAPOE301	Robotics Process Automation
5	Computer Science	23CSPOE301	Cyber Forensics
6	Mathematics	23MMPOE301	Coding theory
7	Physics	23PHPOE301	Material Characterization
		23PHPOE302	Numerical Methods and Programming
8	Chemistry	23CHPOE301	Chemistry in Everyday Life
9	Microbiology	23MBPOE301	Fermentation Technology
10	Biochemistry	23BCPOE301	Nutrition and Dietetics
11	Biotechnology	23BTPOE301	Sericulture

Online Course

Student shall study at least one online course from SWAYAM / NPTEL / MOOC in any one of the first three semesters for which examination shall be conducted at the end of the course by the respective external agencies if any. The student can register to the courses which are approved by the Department. The student shall produce a Pass Certificate from the respective agencies before the end of the third semester. The credit(s) earned by the students will be considered as additional credit(s) over and above the credits minimum required to earn a particular Degree.

5. MEDIUM OF INSTRUCTION

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

6. 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 for End Semester Examinations (ESE).

(ii) Maximum Marks for Project work

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

7. 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 ward students' periodically (once in 2 weeks) on the Notice Board to enable the students to know their attendance status and satisfy the **clause 7** of this regulation.

b. **ONLINE COURSE COORDINATOR**

To help students in planning their online courses and for general advice on online courses, the HOD shall nominate a coordinator for the online

courses. The Online course coordinator shall identify the courses which the students can select for their programme from the available online courses offered by different agencies periodically and inform the same to the students. Further, the coordinators shall advice the students regarding the online courses and monitor their course.

8. 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 concerned HoD / senior faculty as a Chairperson. The objective of the class committee Meeting is all about the teaching – learning process. Class Committee shall be convened at least once in a month. The 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 of the class committee.
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.

9. COURSE COMMITTEE FOR COMMON COURSES

Each common theory course offered to more than one discipline or group shall have a “Course Committee” comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Dean depending upon whether all the teachers handling the common course belong to a single department or to various other departments. The ‘Course Committee’ shall meet in order to arrive at a common scheme of

evaluation for the tests to ensure a uniform evaluation of the tests. If feasible, the course committee shall prepare a common question paper for the Internal Assessment test(s).

10. REQUIREMENTS TO APPEAR FOR THE END SEMESTER EXAMINATION

a. Ideally 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. However, the candidate has to pay the prescribed condonation fee to KAHE.

c. However, a candidate who has secured attendance less than 65% in the current semester due to any reason shall not be permitted to appear for the current semester examinations. But he/she will be permitted to appear for his/her supplementary examinations, if any and he/she has to re-do the same semester with the approval of the Dean, Students Affairs and 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 class, the test marks and the record of class work (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 to respective Dean once in a fortnight. 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. The 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 (first 2 ½ units)	10
3	Test – II (last 2 ½ units)	10
4	Journal Paper Analysis & Presentation*	15
Continuous Internal Assessment : Total		40

*****Evaluated by two faculty members of the department concerned. Distribution up 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
Continuous Internal Assessment: 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 **Pattern of Test Question Paper**

Instruction	**Remarks**
Maximum Marks	50 marks
Duration	2 Hours
Part – A	Objective type (20x1=20)
Part - B	Short Answer Type (3 x 2 = 6)
Part - C	3 Eight marks questions 'either – or' choice (3 x 8 = 24 Marks)

11.4 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 60 marks.

Pattern of ESE Question Paper

Instruction	**Remarks**
Maximum Marks	60 marks for ESE
Duration	3 hours (½ Hr for Part – A Online & 2 ½ Hours for Part – B and C)
Part – A	20 Questions of 1 mark each (20 x 1 = 20 Marks) Question No. 1 to 20 Online Multiple Choice Questions
Part- B	5 Questions of six marks each (5 x 6 = 30 Marks.) Question No. 21 to 25 will be 'either-or' type, covering all five units of the syllabus; i.e.,

Instruction	Remarks
	Question No. 21: Unit - I, either 21 (a) or 21 (b), Question No. 22: Unit - II, either 22 (a) or 22 (b), Question No. 23: Unit - III, either 23 (a) or 23 (b), Question No. 24: Unit - IV, either 24 (a) or 24 (b), Question No. 25: Unit - V, either 25 (a) or 25 (b)
Part - C	Question No.26. One Ten marks Question (1 x 10 = 10 Marks)

12.2 **Practical:** There shall be combined valuation. The pattern of distribution of marks shall be as given below.

Experiments	: 40 Marks
Record	: 10 Marks
Viva-voce	: 10 Marks
Total	**: 60 Marks**

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 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: There is a passing minimum 20 marks out of 40 marks for CIA and the passing minimum is 30 marks out of 60 marks in ESE. The overall passing in each course is 50 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 secures a 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 CIA marks (if it is pass) obtained by the candidate in the first appearance 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

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 scored.

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.

$$\textbf{GPA} \text{ of a Semester} = \frac{\text{Sum of the product of the GP by the corresponding credits of the courses offered in that Semester}}{\text{Sum of the credits of the courses of that Semester}}$$

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 retotalling 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 is 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.
- Not any disciplinary action pending 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 13) 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 13) 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 19) shall be declared to have passed the examination in **Second Class**.

21. PROVISION FOR WITHDRAWAL FROM END-SEMESTER EXAMINATION

21.1 A candidate due to valid reason on prior application may be granted permission to withdraw from appearing for the examination of any one course or consecutive examinations of more than one course in a semester examination.

21.2 Such withdrawal shall be permitted only once during the entire period of study of the degree programme.

21.3 Withdrawal of application is valid only if it is made within 10 days prior to the commencement of the examination in that course or courses and

recommended by the HoD / Dean concerned and approved by the Registrar.

21.3.1 Notwithstanding the requirement of mandatory TEN days notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

21.4 Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction. This provision is not applicable to those who seek withdrawal during IV semester.

21.5 Withdrawal from the End semester examination is **NOT** applicable to arrears courses of previous semesters.

21.6 The candidate shall reappear for the withdrawn courses during the examination conducted in the subsequent semester.

22. PROVISION FOR AUTHORISED BREAK OF STUDY

22.1 **Break of Study shall be granted only once for valid reasons for a maximum of one year during the entire period of study of the degree programme.** However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for break of study. If a candidate intends to temporarily discontinue the programme in the middle of the semester for valid reasons, and to rejoin the programme in a subsequent year, permission may be granted based on the merits of the case provided he / she applies to the Registrar, but not later than the last date for registering for the end semester examination of the semester in question, through the HoD stating the reasons therefore and the probable date of rejoining the programme.

22.2 The candidate thus permitted to rejoin the Programme after the break shall be governed by the Curriculum and Regulations in force at the time of rejoining. Such candidates may have to do additional courses as per the Regulations in force at that period of time.

22.3 The authorized break of study (for a maximum of one year) will not be counted for the duration specified for passing all the courses for the purpose of classification. (Vide Clause 20). However, additional break of study granted will be counted for the purpose of classification.

22.4 The total period for completion of the Programme reckoned from, the commencement of the first semester to which the candidate was admitted shall not exceed the maximum period specified in clause 2.1 irrespective of the period of break of study (vide clause 22.3) in order that he/she may be eligible for the award of the degree.

22.5 If any student is detained for want of requisite attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted 'Break of Study' or 'Withdrawal' (Clause 21 and 22) is not applicable for this case.

23. 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.

24. 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.

25. DISCIPLINE

25.1. 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.

25.2. 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.

26. 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.

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,**	

DEPARTMENT OF CHEMISTRY

FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

PG PROGRAM (CBCS)

M.Sc., Chemistry (2023-2024 Batch and onwards)

Course Code	Name of the Course	Objectives & Outcomes		Instruction hours per week			Credits	Maximum Marks			Page No.
		PEO's	PO's	L	T	P		CIA	ESE	Total	
								40	60	100	
Semester-I											
23CHP101	Organic Chemistry-I (Reaction Mechanisms)	1,2,3	a,c,e	4	0	0	4	40	60	100	25
23CHP102	Inorganic Chemistry-I (Nuclear Chemistry and Metallic Clusters)	1,2,3	a,c,e	4	0	0	4	40	60	100	28
23CHP103	Physical Chemistry- I (Quantum Chemistry and Surface Chemistry)	1,2,3	a,c,e	4	0	0	4	40	60	100	31
23CHP104	Molecular Spectroscopy	1,2,3,4	a,b,c,h,j	4	0	0	4	40	60	100	34
23CHP105A	Green Chemistry	1,2,3	a,c,e	4	0	0	4	40	60	100	37
23CHP105B	Medicinal Chemistry and Drug Design										40
23CHP105C	Frontiers in Material Chemistry										43
23CHP111	Organic Chemistry Practical-I (Qualitative Analysis and Single Stage Preparations)	3,4	b,h,j	0	0	4	2	40	60	100	45
23CHP112	Organic Chemistry Practical-II (Quantitative Analysis and Double Stage Preparations)	3,4	b,h,j	0	0	4	2	40	60	100	47
	Journal Paper Analysis and Presentation	1,2,3	a,b,c,d,e,h,j	2	-	-	-	-	-	-	
	Semester Total			**22**	**0**	**8**	**24**	**280**	**420**	**700**	
Semester-II											
23CHP201	Organic Chemistry-II (Rearrangements, Reactions, Photochemistry and Pericyclic Reactions)	1,2,3	a,c,e	4	0	0	4	40	60	100	49

23CHP202	Inorganic Chemistry-II (Co-ordination Chemistry)	1,2, 3	a,c, e	4	0	0	4	40	60	100	52
23CHP203	Physical Chemistry II (Group Theory and Chemical Kinetics)	1,2, 3	a,c, e	4	0	0	4	40	60	100	55
23CHP204	Analytical Chemistry	3,4	f,h	4	0	0	4	40	60	100	58
23CHP205A	Research Methodology and IPR	1,2, 3	a,c, e	4	0	0	4	40	60	100	61
23CHP205B	Advanced Energy Devices										63
23CHP205C	Sensors										66
23CHP211	Inorganic Chemistry Practical-I (Qualitative Analysis and Preparations)	3,4	b,h,j	0	0	4	2	40	60	100	68
23CHP212	Inorganic Chemistry Practical-II (Quantitative Analysis and Complex Preparations)	3,4	b,h,j	0	0	4	2	40	60	100	70
	Journal Paper Analysis & Presentation	1,2, 3	a,b, c,d, e,h,j	2	-	-	-	-	-	-	
	Semester Total			**22**	**0**	**8**	**24**	**280**	**420**	**700**	
Semester-III											
23CHP301	Organic Chemistry- III (Natural Products)	1,2, 3	a,c, e	4	0	0	4	40	60	100	72
23CHP302	Physical Chemistry-III (Thermodynamics)	1,2, 3	a,c, e	4	0	0	4	40	60	100	74
23CHP303	Physical Methods in Chemistry (Instrumentation**)**	1,2, 3	a,c, e	4	0	0	4	40	60	100	77
21CHP304	Polymer Chemistry	3,4	f,h	4	0	0	4	40	60	100	79
23CHP305A	Industrial Organic Synthesis	1,2, 3	a,c, e	4	0	0	3	40	60	100	81
23CHP305B	Electrochemical Devices for Electric Vehicles										83
23CHP305C	Nanochemistry										85
23CHP311	Physical Chemistry Practical-I (Molecular Weight Determination and Conductometric Titrations)	3,4	b, h,i	0	0	3	2	40	60	100	87
23CHP312	Physical Chemistry Practical-II (Chemical Kinetics and Potentiometric Titrations)	3,4	b, h,i	0	0	3	2	40	60	100	89
	Journal Paper Analysis and Presentation	1,2, 3	a,b, c,d, e,h,j	1	-	-	-	-	-	-	
23XXPOE 301	Open Elective	-	-	3	-	-	2	40	60	100	91-117

23CHP391	Internship*	1,2, 3	a,b, c,d, e,h,j	-	-	-	2	100	-	100	118
	Semester Total			**24**	**0**	**6**	**27**	**420**	**480**	**900**	
Semester-IV											
23CHP491	Project and Viva-Voce	1,2, 3	ab,c ,d,e, h,j	-	-	30	15	80	120	200	119
	*End of II Semester Internship for 15 days										
Semester Total				**0**	**0**	30	**15**	**80**	**120**	**200**	
Grand Total				**68**	**0**	**52**	**90**	**1060**	**1440**	**2500**	

List of Core Course Elective					
Elective-I		**Elective-II**		**Elective-III**	
Code	**Course**	**Code**	**Course**	**Code**	**Course**
23CHP105A	Green Chemistry	23CHP205A	Research Methodology and IPR	23CHP305A	Industrial Organic Synthesis
23CHP105B	Medicinal Chemistry and Drug Design	23CHP205B	Advanced Energy Devices	23CHP305B	Electro chemical Devices for Electric Vechicles
23CHP105C	Frontiers in Material Chemistry	23CHP205C	Sensors	23CHP305C	Nanochemistry

List of Open Elective Courses

S. No.	**Name of the Offering Department**	**Course Code**	**Course Name**
1	Management	23MBAPOE301	Organizational Behaviour
2	Physics	23PHPOE301	Materials Characterization
3	Physics	23PHPOE302	Numerical Methods and Programming
4	Computer Applications	23CAPOE301	Robotic Process Automation
5	Biochemistry	23BCPOE301	Nutrition and Dietetics
6	Computer Science	23CSPOE301	Cyber Forensics
7	Commerce	23CMPOE301	Personal Finance and Planning
8	Chemistry	23CHPOE301	Chemistry in Everyday Life
9	Microbiology	23MBPOE301	Fermentation Technology
10	English	23EGPOE301	English for Competitive Examinations
11	Biotechnology	23BTPOE301	Sericulture
12	Mathematics	23MMPOE301	Coding Theory

Programme Outcomes (PO's)

a. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.

b. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

c. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

d. Students will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

e. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

f. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.

g. Students will be able to function as a member of an interdisciplinary problem solving team.

h. The graduate has specific skills in planning and conducting advanced chemical experiments and applying structural-chemical characterisation techniques.

i. Are able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.

j. Are able to use modern library searching and retrieval methods to obtain information about a topic, chemical, chemical technique, or an issue relating to chemistry.

Programme Specific Outcomes (PSO's)

k. A graduate with a Master's degree in Chemistry will have in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.

l. Students will have an advanced level understanding of the following areas of chemistry - Analytical, Inorganic, Organic, and Physical Chemistry. They should master graduate level understanding of their major area(s) of research.

m. Students will be able to communicate scientific results in writing and in oral presentation.

n. Students will become proficient in their specialized area of chemistry and acquire the basic tools needed to carry out independent chemical research.

Programme Educational Objectives

PEO-1

The Masters in Chemistry extends the depth and breadth of knowledge in all branches of chemistry, suitable for a professional chemist capable of conducting research.

PEO-2

To carryout research in the trust areas of chemistry. Will be able to communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.

PEO-3

To motivate critical thinking and analytical skills to solve complex chemical problems and the Ability to handle problems of practical relevance to society while complying with economical, environmental, ethical, and safety factors.

PEO-4

To practice chemistry by performance of experiments in the laboratory classes. To perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.

Mapping

PO	a	b	c	d	e	f	g	h	i	j	k	l	m	n
PEO 1	x	x			x			x	x		x	x	x	
PEO 2		x	x	x	x			x	x		x		x	x
PEO 3			x	x		x	x			x			x	x
PEO 4	x	x	x			x		x		x	x	x		x

M.Sc. Chemistry **2023-2024**
23CHP101

SEMESTER-I
ORGANIC CHEMISTRY-I (REACTION MECHANISMS)

4H-4C

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

Course Objectives

This course enables the students

- To understand the aromaticity, its types and techniques in the determination of reaction mechanism.
- To know about various types of addition reactions and the concepts in organic synthesis.
- To learn the concepts of electrophilic substitution involved in organic compounds.
- To understand the knowledge about the nucleophilic substitution reaction.
- To analyze the various types of elimination reactions and synthetically important reagents.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Learn the concept of aromaticity and various types of aromaticity.	Apply
CO2	Determine the various types of addition reactions and the concepts in organic synthesis.	Apply
CO3	Apply the concepts of electrophilic substitution involved in organic compounds.	Apply
CO4	Discuss about the nucleophilic substitution reaction.	Understand
CO5	Correlate the various types of elimination reactions and synthetically important reagents.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	L	S	L	M	M	S
CO2	S	S	L	M	M	S	M	M	L	M
CO3	M	S	S	S	M	S	M	S	M	S
CO4	S	S	M	M	S	S	M	S	M	S
CO5	S	S	S	M	S	S	M	S	M	S

S-Strong; M-Medium; L-Low

UNIT - I Aromaticity and chemical methods in mechanisms (9)

Aromaticity-introduction–Modern definitions of aromaticity, Huckel's rule & Craig's rule- aromaticity of benzenoid and heterocyclic compounds. Non-benzenoid aromatics-annulenes, azulenes, ferrocenes and fulvenes.

Kinetic and non-kinetic methods of study of reaction mechanisms-kinetic methods-Primary and secondary kinetic isotopic effects. Non-kinetic methods-study of intermediates, isotopic labeling, stereochemical studies, energy profile diagrams 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)

Addition reactions: Electrophilic, nucleophilic and free radical 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)

Aromatic electrophilic substitution reactions-formylations-Gattermann, Gattermann Koch, Riemer Tiemann and Vilsmeier-Haack reactions. Kolbes, Bischler-Napieralski and Hofmann-Martius reactions. Friedel crafts alkylation and acylations.

Aliphatic electrophilic substitution reactions-mechanisms-SE1, SE2 and SEi-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)

Aliphatic nucleophilic substitution reactions-mechanisms-S_N1, S_N2, ion pair and S_Ni-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 participation.

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)

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: Oxidizing reagents: Preparations and synthetic applications of DDQ, DBU, Dimethyl sulfoxide, Osmium tetroxide, Selenium dioxide and Mercuric acetate.

Reducing reagents: Preparations and synthetic applications of trimethyl silyl iodide, Dicyclohexylcarbodiimide (DCC), LDA and DIBAL-H.

SUGGESTED 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. Sanyal, S. N. (2014). *Reactions, Rearrangements and Reagents* (IV Edition). New Delhi: Bharathi Bhawan (Publishers and Distributors).
4. Tewari, N. (2011). *Advanced Organic Reaction Mechanism* (III Edition). Kolkata: Books and Allied (P) Ltd.
5. Warren, S., & Wyatt, P. (2008). *Organic Synthesis: The Disconnection Approach* (II Edition). John Wiley & Sons Ltd., Chichester.
6. Clayden, J., Greeves, N. & Warren, S. (2012). *Organic Chemistry* (II Edition). Oxford University Press, Oxford.

SEMESTER-I
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**
External Semester Exam: 3 Hrs

Course Objectives

This course enables the students

- To learn about the fundamentals of metallic clusters, boranes and related compounds.
- To know the various defects and its application on inorganic crystals.
- To understand the basics of organometallic chemistry and its catalytic application.
- To understand the nuclear structure, stable and unstable atomic nuclei, nuclear reactions and different modes of radioactive decay and also methods for measurements of radioactivity.
- Know the detection of radioactive rays and to measure the radiation in samples.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Describe about the fundamentals of metallic clusters, boranes and related compounds.	Understand
CO2	Classify the various defects and its application on inorganic crystals.	Apply
CO3	Explain the basics of organometallic chemistry and its catalytic application.	Apply
CO4	Discuss about the nuclear structure, stable and unstable atomic nuclei, nuclear reactions and different modes of radioactive decay and also methods for measurements of radioactivity.	Analyze
CO5	Illustrate the detection of radioactive rays and to measure the radiation in samples.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**M**	**M**	**L**	**S**	**L**	**M**	**L**	**S**
CO2	**S**	**S**	**L**	**M**	**M**	**M**	**M**	**M**	**L**	**M**
CO3	**M**	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**M**	**S**
CO4	**S**	**M**	**M**	**M**	**S**	**M**	**M**	**S**	**M**	**M**
CO5	**S**	**M**	**M**	**M**	**S**	**S**	**M**	**L**	**L**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Inorganic rings, cages and clusters (10)

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)

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)

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)

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)

Nuclear reactions - Bethes'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, aagnetic confinement. Atomic power projects in India, stellar energy, synthetic elements - application of radio isotopes - Hot atom chemistry**.**

SUGGESTED 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. Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). *Advanced Inorganic Chemistry* (VI Edition). New York: John Wiley & Sons.
6. Glasstone, S. (2014). *Sourcebook on Atomic Energy* (III Edition). New Delhi: East West Press.
7. Gurdeep Raj, (2014). *Advanced Inorganic Chemistry* Vol. I (24^{th} Revised Edition). Meerut: Goel Publishing House.
8. Madan, R. D. (2019). *Modern Inorganic Chemistry*. New Delhi: S. Chand & Co.
9. Puri, B. R., Sharma, L. R. & Kalia, K. C. (2017). *Principles of Inorganic Chemistry* (33^{rd} Edition). New Delhi: Shoban Lal & Co.
10. Malik, W. C., Tuli, G.D. &Madan. R.D. (2010). *Selected topics in Inorganic Chemistry*. New Delhi. S. Chand & Co.

SEMESTER-I
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**
External Semester Exam: 3 Hrs

Course Objectives

This course enables the students

- To understand the fundamentals and applications of classical mechanics and quantum chemistry.
- To apply the Schrodinger equation for mono and diatomic molecular models.
- To learn the structure of an atom and different approximation methods.
- To understand the various types of adsorption theories and its isotherm model.
- Know about the different types of catalysis in surface reactions.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the fundamentals and applications of classical mechanics and quantum chemistry.	Understand
CO2	Apply the Schrodinger equation for mono and diatomic molecular models.	Apply
CO3	Illustrate the structure of an atom and different approximation methods.	Analyze
CO4	Describe the various types of adsorption theories and its isotherm model.	Understand
CO5	Classify about the different types of catalysis in surface reactions.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**L**	**L**	**M**	**L**	**M**	**L**	**M**	**M**	**S**
CO2	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**S**	**L**	**M**
CO3	**M**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**M**	**M**
CO4	**S**	**L**	**L**	**M**	**S**	**M**	**L**	**M**	**M**	**S**
CO5	**S**	**S**	**S**	**M**	**S**	**M**	**M**	**S**	**M**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Failure of classical mechanics and operators (11)

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)

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)

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)

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)

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.

SUGGESTED 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. Levine, I. N. (2016). *Quantum Chemistry* (VII Edition). New Delhi: Pearson Education Pvt. Ltd.
5. Puri, B. R., Sharma, L. R., Pathania, M. S. (2020). *Principles of Physical Chemistry* (47^{th} Edition). Jalandar: Vishal Publishing Co.
6. Atkins, P., & De Paula, J. (2014). *Atkins Physical Chemistry* (X Edition). Oxford: Oxford University Press.

SEMESTER-I
MOLECULAR SPECTROSCOPY

4H-4C

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

Course Objective

This course enables the students

- To learn the knowledge about Electronic spectroscopy.
- To understand about IR spectroscopy and its application.
- To apply the different aspects of NMR spectroscopy to predict the structure of compounds.
- 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 synthetic chemistry for the confirmation of known molecules and the precise elucidation of the shape and structure of unknown compounds of high complexity.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Explain the knowledge about Electronic spectroscopy.	Understand
CO2	Discuss about IR spectroscopy and its application.	Apply
CO3	Predict the structure of compounds from different aspects of NMR spectroscopy.	Apply
CO4	Compare the various types of fragmentation process in Mass Spectroscopy.	Analyze
CO5	Evaluate the invaluable tools in synthetic chemistry for the confirmation of known molecules and the precise elucidation of the shape and structure of unknown compounds of high complexity. Illustrate the basic principles of Mossbauer spectroscopy	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**L**	**M**	**M**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**S**	**M**	**M**	**S**	**M**
CO3	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**M**	**S**
CO5	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Ultraviolet and Visible spectroscopy (9)

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)

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)

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)

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 - McLaffertty 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)

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

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

carbon atoms).

SUGGESTED 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. Silverstein, R. M., Webster, F. X., & Kiemle, D. (2014). *Spectroscopy of Organic Compounds* (VIII Edition). New York: John Wiley & Sons.
5. Drago, R. S. (2012). *Physical Methods in Inorganic Chemistry*. New York: East- West Press Pvt. Ltd.
6. Banwell. (2017). *Fundamentals of Molecular & Spectroscopy* (IV Edition), McGraw-Hill Education (India) Pvt. Limited.
7. Sharma., B. K. (2012). *Instrumental Methods of Chemical Analysis* (28^{th} Edition) Meerut: Krishna Prakashan Media (p) Ltd.
8. Kalsi, P. S. (2002). *Spectroscopy of Organic compounds* (5^{th} Edition), New Age International (P) Limited, Publishers.

SEMESTER-I
GREEN CHEMISTRY

4H-4C

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

Course Objectives

This course enables the students

- To understand about the concept of Green chemistry and its principles.
- To design and develop the Green chemical synthesis.
- To Know about the alternative source of energy for the chemical reactions.
- To understand about the hazard assessment and mitigation in chemical industry.
- Build the application of Greener routes to improve industrial processes to produce important products and pharmacological compounds.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss about the concept of Green chemistry and its principles.	Understand
CO2	Propose the Green chemical synthesis.	Create
CO3	Identify the alternative source of energy for the chemical reactions.	Apply
CO4	Explain about the Hazard assessment and mitigation in chemical industry	Understand
CO5	Analyze the application of Greener routes to improve industrial processes to produce important products and pharmacological compounds.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	M	S	M	M	M	S
CO2	M	S	S	S	S	S	S	S	S	M
CO3	M	S	S	S	S	S	S	S	M	S
CO4	S	M	M	M	S	S	M	M	M	S
CO5	M	S	S	S	M	S	S	S	S	M

S-Strong; M-Medium; L-Low

UNIT - I Introduction to Green chemistry and principles of Green chemistry (9)

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.

UNIT - II Designing a Green chemical synthesis (10)

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)

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)

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)

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.

SUGGESTED 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. Anastas, P. T., & Warner, J. C. (1998). *Green Chemistry: Theory and Practice*. Oxford: Oxford University Press.
6. Matlack, A. S. (2001). *Introduction to Green Chemistry*. New York: Marcel Dekker.
7. Cann, M. C., & Connely, M. E. (2000). *Real-World Cases in Green Chemistry*. Washington: American Chemical Society.
8. Ryan, M. A., & Tinnesand, M. (2002). *Introduction to Green Chemistry*. Washington: American Chemical Society.
9. Lancaster, M. (2010). *Green Chemistry: An Introductory Text* (II Edition). Cambridge: RSC Publishing.
10. Clark, J. H, & Macquarrie, D. J. (2002). *Handbook of Green Chemistry & Technology*. Abingdon: Blackwell Publishing.

SEMESTER-I

MEDICINAL CHEMISTRY AND DRUG DESIGN **4H-4C**

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

Course Objectives

This course enables the students

- To learn the principles of medicinal chemistry in drug design process.
- To understand about the various chemical reactions in drug metabolism and its current importance.
- To know about the drug design with their classification and their recent developments.
- To elucidate the enzyme structure and comprehend DNA-drug interactions.
- To understand the importance of antibiotics and cardiovascular drugs.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Comprehend the basic principles of medicinal chemistry in drug design process.	Understand
CO2	Explain the biochemical and physiological effects of drugs through pharmacodynamics, drug metabolism and pharmacokinetics	Understand
CO3	Build knowledge on the drug design with their classification and their recent developments.	Apply
CO4	Acquire the importance of various enzyme structure elucidation & DNA-drug interactions.	Analyze
CO5	Describe the classification of various antibiotics and their mode of action. Discuss various cardiovascular diseases, mode of action of cardiovascular drugs and their side effects.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**S**	**L**	**L**	**M**	**S**
CO2	**M**	**M**	**L**	**M**	**M**	**M**	**M**	**M**	**S**	**M**
CO3	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**M**	**M**	**S**
CO4	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**	**L**	**S**
CO5	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**L**	**S**

S-Strong; M-Medium; L-Low

UNIT- I Introduction to Medicinal chemistry (9)

History of medicinal chemistry, general mechanism of drug action on lipids, carbohydrates, proteins and nuleic acids, drug metabolism and inactivation, receptor structure and sites, drug discovery development, design and delivery systems, gene therapy and drug resistance.

UNIT- II Drug Metabolism (9)

Introduction, oxidation, reduction, hydrolysis, conjugation, Pharmacokinetics: Drug absorption, drug distribution, drug elimination, drug disposition, pharmacokinetic parameters, uses of pharmacokinetics in drug development process, Pharmacodynamics: Enzyme stimulation, inhibition, sulphonamides, membrane active drug, biotransformation, xenobiotics.

UNIT- III Drug Design (10)

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of pro-drugs and soft-drugs, factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Clinical testing and synthesis of drugs – various phases in preclinical testing and clinical trials –theories of drug activity: Occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship (QSAR) - testing drugs in vivo –therapeutic index and therapeutic ratio.

UNIT- IV Elucidation of enzyme structure& Interactions (10)

Mechanism, kinetic, spectroscopic, isotopic and stereochemical studies. Chemical models and mimics for enzymes, design, synthesis and evaluation of enzyme inhibitors. DNA-protein interaction and DNA drug interaction. Concepts of drug receptors. Elementary treatment of drug Receptor interactions. Physicochemical parameters: Lipophilicity, Partition coefficient, electronic ionization constants. LD-50 and ED-50.

UNIT- V Antibiotics and Cardiovascular drugs (10)

Introduction and classification, synthesis uses and side effects of antibiotics (a) penicillin-V (b) penicilline–G (c) cephalosporin - mode of action of penicillin and cephalosporin. Cardiovascular diseases, arteriolar dilators, diuretics, adrenergic receptor blockers, synthesis mode of action, uses and side effects of cardiovascular drugs.

SUGGESTED BOOKS

1. Ghosh, J. (2012). *A Text book of Pharmaceutical Chemistry*. New Delhi: S. Chand Pub Ltd.
2. Abraham, D. J. (2003). *Burgers Medicinal Chemistry and Drug Discovery* (VI Edition)., Hoboken: Wiley-Interscience.
3. Silverman, R. B., & Holladay, M. W. (2014). *The Organic Chemistry Drug Design and Drug Action*, (III Edition). Oxford: Academic Press.
4. Lemke, T. L., William, D. A., Roche, V. F., & Zito, S. W. (2012). *Foye's Principles of Medicinal Chemistry* (VII Edition). New York: Wolters Kluwer.
5. Patrick, G. L. (2017). *An Introduction to Medicinal Chemistry* (VI Edition). Oxford: University Press.
6. Pandeya, S. N., & Dimmock, J. R. (2008). *An Introduction to Drug Design*. New Delhi:

New Age International (P) Limited.
7. Ilango, K., & Valentina, P. (2017). *Text Book of Medicinal Chemistry*. Vol II. Chennai: Keerthi Publishers.
8. Ashutosh Kar, (2018). *Medicinal Chemistry* (III Edition). New Delhi: New Age International Publishers.
9. Gupta, S. P. (2008). *QSAR and Molecular Modeling* (I Edition). Springer- Netherlands: Anamaya Publishers.

SEMESTER-I

FRONTIERS IN MATERIAL CHEMISTRY **4H-4C**

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

External Semester Exam: 3 Hours

Course Objectives

This course enables the students

- To understand the various forms of materials.
- To know about the supramolecular assemblies and various preparation methods of materials.
- To apply the various instrumental techniques to characterize the materials.
- Know about the different types of properties of metal and nano materials.
- To gain the knowledge about the application of advanced materials on various bio-systems.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Classify the various forms of materials.	Understand
CO2	Explain the supramolecular assemblies and various preparation methods of materials.	Understand
CO3	Utilize the various instrumental techniques to characterize the materials.	Apply
CO4	Illustrate about the different types of properties of metal and nano materials.	Analyze
CO5	Utilize the knowledge about the application of advanced materials on various bio-systems.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**L**	**M**	**L**	**M**	**L**	**S**
CO2	**S**	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**M**	**M**
CO3	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**
CO4	**M**	**S**	**M**	**M**	**S**	**S**	**M**	**M**	**M**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong; M-Medium; L-Low

UNIT-I Introduction to materials **(10)**

Advanced materials: Meso & microporous materials, supramolecular assemblies, polymers

composites, nanomaterials (metals, metal oxide, and core-shell structured nanocomposites). Structural features, physical & chemical properties.

UNIT-II Supramolecular assemblies and preparation of Materials (10)

Supramolecular assemblies: Organic and metal-organic assemblies with voids and channels, thin-films of monolayers and self-assembled layers, structural transformations. Metal nanoparticles: Wet chemistry, mechanical, form in place, gas phase. Size control synthesis: metal precursor, solvent, reducing agent, stabilizer, etc.

UNIT-III Characterization Techniques (9)

Characterization Techniques such as, UV-Vis, XRD, TEM, SEM, XPS, AFM, electrochemical, etc.

UNIT-IV Material Properties (10)

Electrical, optical, mechanical, magnetic; catalytic, chemical and electrochemical. Selective examples of synthesis: Metal nanoparticles, metal oxide nanoparticles, carbon nano-tubes and graphenes. Functionalization of metals nanoparticles: With organic ligands, polymers and biomolecules for selective applications.

UNIT-V Application of advanced materials (9)

Applications of advanced materials: catalysis, fuel cells, display devices, hybrid materials for nano-bio systems, bio-electronic devices, bio-recognition events and sensors, super capacitors.

SUGGESTED BOOKS

1. Anthony, R West, (2014). *Solid State Chemistry and Its Applications*. Wiley.
2. Smart, L. E., & Moore, E. A. (2012). *Solid State Chemistry–An Introduction.* Taylor and Francis.
3. Raghavan, V. (2015). *Material Science and Engineering: A First Course* (VI Edition). New Delhi: PHI Learning.
4. Koch C. C., (2006). *Nanostructured Materials: Processing, Properties and Potential Applications* (II Edition). Norwich: William Andrew Publishing.
5. Singh Nalwa, H., (2001). *Nanostructured Materials and Nanotechnology: Concise Edition.* Cambridge: Academic Press.
6. Murr, L. (1984). *Industrial Materials Science and Engineering.* New York: Marcel Dekker Inc.
7. Moffatt, W. G., Pearsall, G. W. & Wulff, J. (1964). *Structure and Properties of Materials: Structure.* Wiley.

SEMESTER-I
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**
External Semester Exam: 4 Hrs

Course Objectives

This course enables the students

- To understand the principles behind the qualitative analysis by semi micro-qualitative analysis method.
- To apply the techniques to prepare the organic compounds.
- To understand the basic concept and advantages of semi- micro qualitative analysis.
- To analyze the systematic separations of the organic mixtures.
- To evaluate the functional groups with their special tests.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Describe the qualitative analysis by semi micro-qualitative analysis method.	Understand
CO2	Utilize the techniques to prepare the organic compounds.	Apply
CO3	Explain the basic concept and advantages of semi- micro qualitative analysis.	Remember
CO4	Examine the systematic separations of the organic mixtures.	Analyze
CO5	Determine the functional groups with their special tests.	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	L	S	L	M	M	M
CO2	S	S	M	S	M	S	M	S	M	S
CO3	M	L	L	M	M	S	M	M	L	S
CO4	S	S	M	S	S	S	M	S	S	M
CO5	S	S	S	S	S	S	M	S	S	S

S-Strong; M-Medium; L-Low

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.

SUGGESTED 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.
4. 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.

SEMESTER-I
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**
External Semester Exam: 4 Hrs

Course Objectives

This course enables the students

- To understand the basic principles and systematic procedure in quantitative analyses.
- To apply the systematic procedure for estimation of organic compounds.
- To know the Iodine, saponification and acetyl value of oil.
- To analyze the different methods of extraction of natural products.
- To gain the knowledge about the estimation of active constituents in natural products.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the basic principles and systematic procedure in quantitative analyses.	Understand
CO2	Experiment with systematic procedure for estimation of organic compounds.	Apply
CO3	Identify Iodine, saponification and acetyl value of oil.	Apply
CO4	Categorize the different methods of extraction of natural products.	Analyze
CO5	Demonstrate the estimation of active constituents in natural products.	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	M	M	L	M	M	S
CO2	S	S	M	M	M	S	M	M	L	M
CO3	M	S	S	S	M	S	M	S	M	S
CO4	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S-Strong; M-Medium; L-Low

Contents

I. Organic Estimations

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.

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

SEMESTER-II
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**
External Semester Exam: 3 Hrs

Course Objectives

This course enables the students

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

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss about the various types of molecular rearrangements	Understand
CO2	Illustrate the principles of conformational analysis and stereochemistry of organic compounds.	Apply
CO3	Classify the various forms of radical reactions and the rearrangements.	Apply
CO4	Explain the concepts in organic photochemistry.	Understand
CO5	Categorize the various theories in pericyclic reactions, cycloaddition and sigmatropic reactions.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	M	M	L	M	L	M	M	S
CO2	S	S	L	S	S	S	S	M	S	M
CO3	S	S	S	S	M	S	M	S	M	S
CO4	M	M	M	M	S	M	S	M	M	S
CO5	S	S	S	S	S	S	M	S	S	M

S-Strong; M-Medium; L-Low

UNIT- I Molecular rearrangements (8)

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 (8)

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 (8)

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 (6)

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-photoreduction of ketones.

UNIT - V Pericyclic reactions (12)

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.

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

SEMESTER-II
INORGANIC CHEMISTRY- II (CO-ORDINATION CHEMISTRY)

4H-4C

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

Course Objectives

This course enables the students

- To understand the theories of bonding in coordination compounds.
- To study about the electronic spectra of the complexes.
- Gain the knowledge on metal carbonyls and organometallic chemistry.
- To analyze the types of organometallic compounds such as alkyl, alkene and cyclopentadienyl compounds.
- To study the types of co-ordination chemistry reactions and their application in biological system.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Describe the theories of bonding in coordination compounds.	Understand
CO2	Apply the electronic spectra to examine the coordination compounds.	Apply
CO3	Explain about the metal carbonyls and organometallic chemistry.	Understand
CO4	Categorize the types of organometallic compounds such as alkyl, alkene and cyclopentadienyl compounds.	Analyze
CO5	Classify the types of co-ordination chemistry reactions and its existence in our biological system.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**L**	**M**	**M**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**S**	**S**	**M**
CO3	**M**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**	**S**	**M**	**M**	**M**	**S**
CO5	**S**	**S**	**M**	**M**	**S**	**S**	**M**	**M**	**S**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Coordination Chemistry and bonding (8)

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 (8)

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 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 (8)

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 (8)

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 (8)

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.

SUGGESTED 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. Aktins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F., & Hagerman, M. (2010). *Shriver & Atkins' Inorganic Chemistry* (V Edition). Britain: Oxford University Press.
3. Malik. Wahid. U, Tuli. G. D and Madan, R.D. (2009). *Selected Topics in Inorganic Chemistry*. New Delhi: S. Chand and Co.
4. Sarn, K. (2005). *Co-ordination Chemistry* (I Edition). New Delhi: Rajat Publications.
5. Catherine, E. H., & Alan G. S. (2012). *Inorganic Chemistry* (IV Edition). England: Pearson Education Limited, Harlow.
6. Cotton, F. A., Wilkinson, G., & Paul. L. (2007). *Basic Inorganic Chemistry* (III Edition). New York: John Wiley & Sons.
7. Chakraburty, D. K. (2012). *Inorganic Chemistry*. (II Revised Edition) New Delhi: New Age International Publishing Pvt. Ltd.
8. Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). *Advanced Inorganic Chemistry* (VI Edition). New York: John Wiley & Sons.
9. Drago, R. S. (2012). *Physical Methods in Inorganic Chemistry*. New York: Rein Gold Publishing Corporation.
10. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, (2013). *Inorganic Chemistry*, Pearson

SEMESTER-II
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**
External Semester Exam: 3 Hrs

Course Objectives

This course enables the students

- To knowledge about the symmetry of elements and matrices.
- To apply the concept of group theory to predict the physical property of the compounds.
- To understand the fundamental knowledge of chemical kinetics and to establish a relationship between the rate of reaction and the concentration of the reactants (the rate law, or rate equation).
- To analyze the various types of reactions in solution and its effects.
- Study about the different methods of fast reaction and kinetic theory of gases.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Explain about the symmetry of elements and matrices	Understand
CO2	Predict the physical property of the compounds by using the concepts of group theory.	Apply
CO3	Explain the fundamental knowledge of chemical kinetics and to establish a relationship between the rate of reaction and the concentration of the reactants (the rate law, or rate equation).	Understand
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

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**L**	**L**	**L**	**L**	**L**	**S**
CO2	**S**	**S**	**M**	**S**	**M**	**M**	**S**	**M**	**M**	**M**
CO3	**M**	**L**	**M**	**M**	**M**	**M**	**M**	**L**	**L**	**M**
CO4	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**M**	**S**
CO5	**S**	**S**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**

S-Strong; M-Medium; L-Low

UNIT- I Symmetry elements and matrices (10)

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 (8)

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 (8)

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 (8)

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 (8)

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.

SUGGESTED BOOKS

1. Raman, K.V. (2002). *Group Theory and Its Applications to Chemistry*. New Delhi: Tata McGraw Publishing Company.
2. Cotton, F. A. (2003). *Chemical Applications of Group Theory* (III Edition). Texas: A Wiley Inter Science Publication.
3. Veera Reddy, K. (2009). *Symmetry and Spectroscopy of Molecules*. New Delhi: New Age International Pvt. Ltd.
4. Bahl, A., Bahl, B. S., & Tuli, G. D, (2014). *Essentials of Physical Chemistry* (V Edition). New Delhi: S. Chand & Company.
5. Puri, B.R., Sharma, L.R., & Pathania, M.S. (2015). *Elements of Physical Chemistry*. Jalandhar: Vishal Publishing House.
6. Laidler, K. J. (2004). *Chemical Kinetics* (III Edition). New Delhi: Pearson Education Publishing. Indian Branch.
7. Gurdeep Raj, (2019). *Chemical Kinetics*. Meerut: Goel Publishing House.
8. Frost, A. A., & Pearson, R. G. (1953). *Kinetics and Mechanism*. New York: Wiley Eastern, Pvt. Ltd.

SEMESTER-II
ANALYTICAL CHEMISTRY

4H-4C

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

Course Objectives

This course enables the students

- To understand the fundamentals of instrumentation techniques.
- To calibrate the instruments and validate the analytical methods.
- To gain knowledge on the solvent extraction and separation techniques.
- To analyze the electro analytical techniques and its applications.
- To understand the theories, concept and calculation of volumetric analysis.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the fundamentals of instrumentation techniques.	Understand
CO2	Operate the UV and HPLC instruments and illustrate the validate the analytical methods.	Apply
CO3	Classify the types of separation techniques.	Understand
CO4	Categorize the electro analytical techniques and its applications.	Analyze
CO5	Explain the theories, concept and calculation of volumetric analysis.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**S**
CO2	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**M**
CO3	**M**	**M**	**M**	**M**	**S**	**M**	**M**	**M**	**M**	**S**
CO4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong; M-Medium; L-Low

UNIT-I Errors in chemical analyses (6)

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 (7)

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 (7)

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)

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)

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

SUGGESTED BOOKS

1. Geeffery, G. H., (1989). *Vogel's Text Book of Quantitative Chemical Analysis*. ELBS Edn.
2. Skoog, A.K., West, D.M., Holler, F.J., & Crouch, S.R. (2004). *Fundamentals of Analytical Chemistry* (VIII Edition). Thomson Brooks Cole.
3. Rouessac, F., & Rouessac, A. (2013). *Chemical Analysis: Modern Instrumentation Methods and Techniques* (II Edition). John Wiley and Sons.
4. Skoog, A., Holler, E.J., & Crouch, S.R. (2007). *Principles of Instrumental Analysis*

(VI Edition). Thomson Brooks Cole.
5. Fifield, F.W., & Kealey, D. (1983). *Principles and Practice of Analytical Chemistry* (II Edition). London: International Book Company.
6. Willard, H.H., Merrit, L.L., Dean, J.A., & Settle, F.A. (1986). *Instrumental Methods of Analysis*. New Delhi: CBS Publishers.

SEMESTER-II
RESEARCH METHODOLOGY AND IPR

4H-4C

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

Course Objectives

This course enables the students

- To know the student conversant with Chemical Databases for their Literature collections
- To encourage students to develop curiosity towards commercial Chemistry softwares for their research
- To acquire knowledge about chemical reaction set-up and its scientific relevance.
- To apply the concept of research ethics on technical writing
- To know about process and procedures in IPR.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Describe a research problem using the available chemistry literature.	Understand
CO2	Develop curiosity towards commercial Chemistry softwares for their research	Apply
CO3	Classify various chemical reaction set-up and its scientific relevance.	Understand
CO4	Apply the research ethics to technical writing	Apply
CO5	Analyze the stepwise process and procedures to apply the patent rights.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**S**	**M**	**M**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**M**
CO3	**S**	**M**	**S**	**M**	**M**	**M**	**M**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**M**	**M**	**S**
CO5	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**

S-Strong; M-Medium; L-Low

UNIT- I Chemical Literature Databases (6)

Chemical/Beilstein abstracts, CAS Number, DOI, Citation Index, Impact Factors, h-index, Scifinder/Reaxys design, Keyword Text Search, Identification of Research Problems, Scopus and Web of Sciences.

UNIT- II Chemistry Softwares (8)

tructure Tools, Chemical drawings and Chiral representations, Chemsketch, BioRad, Chemoffice, Chemdraw, 3D representation, Energy Minimization process, Substructure identifications, Chemical Structures for manuscript (ACS, RSC, Elsevier), Chemical compounds and Suppliers identification.

UNIT- III Chemical Reaction Design (9)

Dean Stork Reaction set-up, Soxhlet extraction set-up, Barr hydrogenation Apparatus, Karl-Fisher Titrations for moisture content Concept of Rotary evaporator, Distillations, Auto Titrator, Reaction monitoring- dry/wet reaction set-up, Handling hygroscopic compounds. Low Temperature bath (freezing mixture), Anhydrous conditions.

UNIT- IV Research Ethics and Technical writing (8)

Research ethics – Plagiarism, Effective literature studies approaches and analysis, Effective technical writing, how to write report, Paper - Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-V Intellectual Property Rights (9)

Nature of Intellectual Property: Patents, Designs, Trade and Copyright - Process of Patenting and Development: technological research, innovation - patenting, development. International Scenario: International cooperation WIPO, on Intellectual Property. Procedure for grants of patents, Patenting under PCT- Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

SUGGESTED BOOKS

1. Burns, R. (1997). *Introduction to Research Methods* (III Edition). London:Addison Wesley Longman.
2. Kothari, C. R. (2008). *Research Methodology: Methods and Techniques*. New Delhi: New- Age International.
3. Usharani, S. (2000). Analytical Chemistry (I Edition). Noida: Mcmillan, India Ltd.
4. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (2011). *Vogel's Textbook of Practical Organic Chemistry* (V Edition). Pearson India.

SEMESTER-II
ADVANCED ENERGY DEVICES

4H-4C

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

Course Objectives

This course enables the students

- To understand the basic theories and concepts in electrochemistry.
- Know about mathematical equations to determine the properties of batteries
- 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.
- To study about the additional energy storage devices and renewable energy.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the basic theories and concepts in electrochemistry.	Understand
CO2	Apply the mathematical equations to determine the properties of batteries.	Apply
CO3	Identify the different types of energy storage devices.	Understand
CO4	Examine the technology terms behind the battery and its application on electric and hybrid vehicles.	Analyze
CO5	Illustrate about the additional energy storage devices and renewable energy.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	M	S	M	L	M	M	S
CO2	S	S	S	S	M	S	S	S	L	M
CO3	S	M	M	M	M	S	M	M	M	S
CO4	M	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S

S-Strong; M-Medium; L-Low

UNIT - I Electrochemistry-I **(8)**

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)**

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)**

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 **(8)**

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 safty issues, Peukert equation-Coulombic efficiency of batteries and battery lifetime - Battery pack control module.

UNIT - V Additional energy storage devices and Renewable energy **(10)**

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.

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

SEMESTER-II
SENSORS

4H- 4C

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

Course Objectives

This course enables the student

- Learn the basics definition and concepts of sensors.
- To study about the various types of sensors based on transducer.
- To know about the different types of sensors based on recognizing system.
- To understand about the various forms of nano sensors.
- To study about the application of sensors in number of technical control process.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the basic theories and concepts in electro chemistry.	Understand
CO2	Classify the various types of sensors based on transducer.	Understand
CO3	Categorize the types of sensors based on recognizing system.	Analyze
CO4	Explain about the various forms of nano sensors.	Understand
CO5	Appraise the application of sensors in number of technical control process.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**L**	**M**	**M**	**S**
CO2	**S**	**M**	**M**	**S**	**M**	**S**	**M**	**M**	**M**	**M**
CO3	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**M**	**M**	**S**	**M**	**M**	**M**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**

S-Strong; M-Medium; L-Low

UNIT I- Introduction to sensors **(8)**

Definitions and concepts: Brief historical background, definitions for sensors and biosensors, terminology and working vocabulary; main technical definitions: calibration, selectivity,

sensitivity, reproducibility, detection limits, response time; introduction to transducers; primary and secondary types, active and passive; analog and digital transducers, nanosensors and micro electro mechanical systems (MEMS).

UNIT- II Types of sensors based on transducer (7)

Sensors based on mode of transduction; mass sensors, piezoelectric and acoustic wave transducers), optical sensors (absorption, fluorescence, bio/chemiluminescence, SPR), electrochemical sensors (amperometric, potentiometric, conductometric), semiconductor transducers (ISFET, ENFET) and thermal sensors. Basic principles, limitations & problems to be addressed.

UNIT- III Types of sensors based on recognizing system (9)

Sensors based on sensing layer; chemical sensor-semi-conductor gas sensors, solid electrolyte gas sensors, ion-selective electrode sensors, and humidity sensors, field effect transistor sensors, bio-sensors; enzymes based, affinity-based biosensors, inhibition-based biosensors; cell-based biosensors (Membrane receptors and transporters); biochips and biosensor arrays, immobilization of bio-recognition elements: adsorption, encapsulation -(hydro-gel, sol-gel glass, etc.), covalent attachment and diffusion issues. An overview of performance.

UNIT- IV Nanosensors (8)

Definition: nano optical sensors, nano mechanical sensors, plasmon resonance sensors with nano particles and nanowire based sensors, bio receptors; bio detectors, nano array based detector, nano particle based detector, ultra-sensitive detection of pathogenic biomarkers and ultra-sensitive detection of single bacteria.

UNIT- V Applications of sensors (8)

One dimensional gas sensors; gas sensing with nanostructured thin films, absorption onsurfaces and metal oxide modifications by additives. Environmental monitoring; technological process control; food quality control; clinical chemistry; test-strips for glucose monitoring; implantable sensors for long-term monitoring; forensic science benefits; problems & limitations.

SUGGESTED BOOKS

1. Janata, J. (2009). *Principles of Chemical Sensors* (II Edition). London: Springer.
2. Diamond, D. (2000). *Principles of Chemical and Biological Sensors*. New York: Wiley.
3. Eggins, B. R. (2004). *Chemical Sensors and Biosensors. Hoboken*: John Wiley & Sons Ltd.
4. Dorf, R. C. (2018). *Sensors, Nanoscience, Biomedical Engineering, and Instruments* (I Edition). Boca Raton: CRC Press.
5. Ligler, F. S., & Taitt, C. R. (2008). *Optical Biosensors: Present & Future* (II Edition). Elsevier.
6. Cunningham, A. J. (1998). *Introduction to Bioanalytical Sensors*. John Wiley& Sons.
7. Spichiger-Keller, U. E. (2008). *Chemical Sensors and Biosensors for Medical and Biological Applications*. Wiley-VCH.

SEMESTER-II
INORGANIC CHEMISTRY PRACTICAL–I
(QUALITATIVE ANALYSIS AND PREPARATIONS)

4H-2C

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

Course Objectives

This course enables the students

- To understand the qualitative analysis by semi micro-qualitative analysis method.
- To study about the procedures for the preparation of inorganic complexes.
- Know the systematic procedure for the separation of d-block elements.
- To apply the step wise procedure to predict the anions along with metals.
- To analyze the d-block elements with their special tests.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Explain the qualitative analysis by semi micro-qualitative analysis method.	Understand
CO2	Illustrate the procedures for the preparation of inorganic complexes.	Apply
CO3	Identify the correct systematic procedure for the separation of d-block elements.	Apply
CO4	Experiment with the step wise procedure to predict the anions along with metals.	Apply
CO5	Examine the d-block elements with their special tests.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	L	M	M	S
CO2	S	S	M	S	M	M	M	M	S	S
CO3	S	S	S	S	S	M	M	S	S	S
CO4	S	S	M	S	S	S	M	S	M	S
CO5	M	S	S	S	S	S	L	S	M	S

S-Strong; M-Medium; L-Low

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.

SUGGESTED BOOKS

1. Ramanujam, V. V. (2004). *Inorganic Semi-micro Qualitative Analysis* (III Edition). Chennai: The National Publishing Company.
2. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications.
3. Siddhiqui, Z. N. (2002). *Practical Industrial Chemistry* (I Edition). New Delhi: Anmol Publications Pvt. Ltd.
4. Mendham, J. R., Denney, C., Barnes, J. D., & Thomas, M. (2002). *Vogel's Textbook of Quantitative Chemical Analysis* (VI Edition). Singapore: Pearson Education Ltd.
5. Lepse, P. A., & Peter, L. B. (1986). *Lab Manual for Lingren's Essentials of Chemistry*. New Delhi: Prentice Hall.
6. Srivastava,T.N., & Kamboj, P. C. (2013). *University Practical Chemistry*. New Delhi. Milestone Publishers and Distributors.

SEMESTER-II

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**
External Semester Exam: 4 Hrs

Course Objectives

This course enables the students to

- To know the concepts and systematic procedure in gravimetric analysis.
- To apply the systematic procedure for estimation of metals.
- To study the synthetic method to prepare in-organic co-ordination complexes.
- To analyze the molecules and identify its nature through chromatography technique.
- To apply this ideas and concepts to water treatment process, food science and forensic fields.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the concepts and systematic procedure in gravimetric analysis.	Understand
CO2	Choose the systematic procedure for estimation of metals.	Apply
CO3	Identify the correct the synthetic method to prepare in-organic co-ordination complexes.	Apply
CO4	Predict the molecules and identify its nature through chromatography technique.	Analyze
CO5	Practice this ideas and concepts to water treatment process, food science and forensic fields.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	L	S	L	M	M	S
CO2	S	S	S	M	S	S	M	M	S	S
CO3	S	S	S	S	M	S	M	M	M	S
CO4	M	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S	S	S	M

S-Strong; M-Medium; L-Low

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 nickel and zinc.

II. Titrimetry

1. Oxidation using ceric salts.
2. Oxidation using vanadium 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. Analysis of cement

VI. Titrations in non aqueous solvents.

VII. Preparation, analysis and study of co-ordination complexes (any 5).

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

SEMESTER-III
ORGANIC CHEMISTRY- III (NATURAL PRODUCTS)

4H-4C

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

Course Objectives

This course enables the students to

- To know about properties of terpenoids and structural elucidation of important terpenoids.
- To study about the structure of steroids and do its synthesis.
- To understand the importance of alkaloids in medicinal field and its synthesis.
- To gain the knowledge about various forms of proteins and enzymes.
- To acquire the knowledge about types and structure of nucleic acids.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Explain the properties of terpenoids and structural elucidation of important terpenoids.	Understand
CO2	Illustrate the structure of steroids and do its synthesis	Apply
CO3	Describe the importance of alkaloids in medicinal field and its synthesis.	Understand
CO4	Classify the various forms of proteins and enzymes.	Apply
CO5	Discuss the types and structure of nucleic acids.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**M**	**M**	**L**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**S**
CO3	**S**	**M**	**L**	**M**	**M**	**M**	**S**	**S**	**L**	**S**
CO4	**S**	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**M**	**S**
CO5	**S**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**L**	**S**

S-Strong; M-Medium; L-Low

UNIT–I Terpenoids **(9)**

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)**

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

UNIT-III Alkaloids **(9)**

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)**

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)**

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.

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

M.Sc. Chemistry **2023-2024**
23CHP302

SEMESTER-III
PHYSICAL CHEMISTRY-III (THERMODYNAMICS)

4H-4C

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

Course Objectives

This course enables the students

- To understand the thermodynamics and non-ideal systems.
- To study about the 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
- To understand the various theories and importance of heat capacity of solids.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the thermodynamics and non-ideal systems.	Understand
CO2	Illustrate the need of third law of thermodynamics.	Apply
CO3	Differentiate the classical Maxwell-Boltzman statistics and quantum statistics of gases.	Analyze
CO4	Determine the thermodynamic properties of different types of atomic gases based on partition functions.	Apply
CO5	Explain the various theories and importance of heat capacity of solids.	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**M**	**S**	**M**	**S**
CO2	**S**	**S**	**M**	**M**	**S**	**S**	**M**	**S**	**M**	**M**
CO3	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**	**S**
CO4	**S**	**S**	**S**	**M**	**S**	**M**	**M**	**S**	**M**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Themodynamics and Non-ideal systems (9)

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)

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)

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. Legrangian 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)

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)**

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.

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

SEMESTER-III
PHYSICAL METHODS IN CHEMISTRY (INSTRUMENTATION)

4H-4C

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

Course Objectives

This course enables the students

- To understand the principle and working of an electron microscope.
- To analyze samples through electron spectroscopy and various methods in thermal analysis.
- To study about the diffraction methods and Raman spectroscopy.
- Gain a knowledge on the electron spin resonance spectroscopy.
- Know about the concepts and instrumentation of atomic spectrometry.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Explain the principle and working of an electron microscope.	Understand
CO2	Examine the samples through electron spectroscopy and classify the various methods in thermal analysis.	Analyze
CO3	Discuss about the diffraction methods and Raman spectroscopy.	Apply
CO4	Illustrate the electron spin resonance spectroscopy.	Apply
CO5	Describe the concepts and instrumentation of atomic spectrometry.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	M	S	M	M	M	S
CO2	M	S	M	S	S	S	M	S	S	M
CO3	S	S	M	S	M	S	M	S	M	S
CO4	S	M	M	M	S	S	M	S	M	S
CO5	S	S	S	M	S	S	M	S	M	S

S-Strong; M-Medium; L-Low

UNIT – I Microscopic techniques (7)

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)

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)

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)

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.

UNIT – V Atomic spectrometry (11)

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.

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

M.Sc. Chemistry **2023-2024**
23CHP304

SEMESTER–III
POLYMER CHEMISTRY

4H-4C

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

Course Objectives

This course enables the students

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

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Describe the basic concepts and types of polymerizations.	Understand
CO2	Classify the types of co-ordination polymerization and utilize the Ziegler-Natta catalyst in polymer synthesis.	Analyze
CO3	Categorize the various methods of molecular weight determination.	Analyze
CO4	Apply the polymer processing technique to prepare the polymer products.	Apply
CO5	Classify the types of commercial polymers and its application.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	M	S	L	M	M	S
CO2	S	S	M	M	M	S	M	M	L	M
CO3	M	S	S	S	M	S	S	S	S	S
CO4	S	S	M	S	S	S	M	M	S	S
CO5	S	S	S	M	S	S	M	S	M	S

S-Strong; M-Medium; L-Low

UNIT - I Polymer basic concepts (7)

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 (10)

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)

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)

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 (10)

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.

SUGGESTED 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. Stevens, M. P. (2012). *Polymer Chemistry An Introdcution* (III Edition, Indian Edition). New York: Oxford University Press.
4. Alcock, H. R., Lampe, F. W., & Mark, J. E. (2003). *Contemporary Polymer Chemistry* (III Edition). NJ: Prentice Hall Englewood Cliffs.
5. Flory, P. J. (1953). *Principles of Polymer Chemistry.* New York: Cornell University Press.
6. Odian, G. (2004). *Principles of Polymerization* (IV Edition). New York: John Wiley & Sons.

SEMESTER-III
INDUSTRIAL ORGANIC SYNTHESIS

4H-3C

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

Course Objectives

This course enables the students

- To know about the design and synthesis of organic molecules.
- To study about the types of laboratory synthesis and separation techniques.
- To understand the various forms of protecting group.
- To analyze the organic reagents and its application in organic synthesis.
- To acquire the knowledge of naming reactions in organic synthesis.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Categorize the various synthetic methods for organic molecules.	Analyze
CO2	Classify the types of laboratory synthesis and separation techniques.	Understand
CO3	Summarize the various forms of protecting group.	Analyze
CO4	Discover the suitable organic reagents for the synthesis process.	Analyze
CO5	Illustrate the naming reactions in organic synthesis.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**
CO2	**S**	**S**	**L**	**M**	**M**	**M**	**L**	**S**	**L**	**S**
CO3	**M**	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**
CO4	**M**	**S**	**S**	**M**	**S**	**S**	**M**	**S**	**S**	**M**
CO5	**S**	**S**	**S**	**M**	**S**	**S**	**L**	**S**	**M**	**M**

S-Strong; M-Medium; L-Low

UNIT- I Design and synthesis of organic molecules (9)

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)

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)

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)

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)

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.

SUGGESTED BOOKS

1. Warren, S. (2010). *Organic Synthesis the Disconnection Approach*. Wiley and Sons.
2. Renuga, S. (2016). *Name Reactions and Reagents in Organic Synthesis*. Jalandhar-Delhi: Vishal Publishing Co.
3. Nasir Hussain & Saba Khan, (2016). *Reactions and Reagents*. New Delhi: Himanshu Publications.
4. Clayden, J., Greeves, N. & Warren, S. (2012). *Organic Chemistry* (II Edition). Oxford: Oxford University Press.
5. Sanyal, S. N. (2014). *Reactions, Rearrangements and Reagents* (IV Edition). New Delhi: Bharathi Bhawan (Publishers and Distributors).
6. Smith, M. B. (2015). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure* (VII Edition). New Jersey: John Wiley & Sons, Inc., Hoboken.

SEMESTER-III

ELECTROCHEMICAL DEVICES FOR ELECTRIC VEHICLES

4H-3C

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

Course Objectives

This course enables the students

- To learn the basics of electrochemical devices.
- To understand the fundamentals of energy storage and storage batteries.
- To evaluate and test the electrochemical devices in various methods.
- To apply the fuel cell and supercapacitors in the development of technology.
- Gain a knowledge about the importance of electric vehicles in future.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Discuss the basics of electrochemical devices.	Understand
CO2	Classify the types of storage batteries and its performance characteristics.	Apply
CO3	Examine and test the electrochemical devices in various methods.	Analyze
CO4	Identify the fuel cell and super capacitors in the development of technology.	Apply
CO5	Illustrate the importance of electric vehicles in future.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	L	S	M	M	M	S
CO2	S	M	M	S	M	S	S	M	S	M
CO3	M	S	S	S	S	S	S	S	S	S
CO4	S	S	M	M	S	S	M	S	S	M
CO5	M	S	M	M	S	S	S	S	S	M

S-Strong; M-Medium; L-Low

UNIT- I Basics of electrochemical devices **(9)**

EMF, reversible and irreversible cells, free energy, effect of cell temperature, thermodynamic

calculation of the capacity of a battery, calculations of energy density of cells - factors affecting battery capacity, voltage level, current drain of discharge, types of discharge: continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, charging methods, battery age & storage condition.

UNIT- II Storage batteries (10)

Principle, design, construction, performance characteristics, advantage and disadvantages - Primary batteries-Zn-MnO_2 carbon-zinc, carbon-zinc chlorides, and zinc-silver oxide-Secondary batteries–lead-acid, nickel-cadmium, nickel-metal hydride, silver oxide-zinc system, lithium-ion, lithium- polymer battery systems - battery maintenance and safety precautions - application of phase-change materials for energy conservation - batteries for electric vehicle applications.

UNIT- III Testing & evaluation of electrochemical devices (9)

Evaluation of active mass, surface area measurement - BET method - internal resistance of cells - A.C. impedance method - testing of capacity, retention of charge, vibration, life, efficiency, leakage for sealed cells, high rate discharge, and testing of separators.

UNIT- IV Fuel cells & super capacitors (10)

Introduction to super capacitors, types of super capacitors-introduction to fuel cells, types of fuel cells and technology development -polymer electrolyte, direct methanol, phosphoric acid, molten carbonate and solid oxide fuel cells–material related challenges-stack engineering - microbial fuel cells.

UNIT- V Future of Electric vehicles (10)

Introduction to energy storage requirements in hybrid and electric vehicles - laboratory test of electric vehicle batteries, vehicle tests with electric vehicle batteries, safety of electric vehicle, charging station and fast charging of Li-ion battery-future of electric vehicles.

SUGGESTED R BOOKS

1. Linden, D., & Reddy, T. B. (2002). *Hand Book of Batteries and Fuels* (III Edition). McGraw Hill Book Company.
2. McNiol, B. D., & Rand, D. A. J. (1998). *Power Sources for Electric Vehicles*. Elsevier Publications.
3. Nazri, G. A. (2009). *Lithium Batteries– Science and Technology*. New York: Springer.
4. Emadi, A. (Ed.), Miller, J., & Ehsani, M. (2003). *Vehicular Electric Power Systems*. Boca Raton: CRC Press.
5. Husain, I. (2010). *Electric and Hybrid Vehicles*. Boca Raton: CRC Press.
6. Pavlov, D. (2011). *Lead–Acid Batteries: Science and Technology*. Amsterdam: Elsevier.
7. Conway, B. E. (1999). *Electrochemical Supercapacitors: Scientific Fundamentals and Technological Application*s. New York: Kluwer Academic / Plenum publishers.
8. Mench, M. (2008). *Fuel Cell Engines*. New York: John Wiley.
9. Viswanathan, B., & Aulice Scibioh M. (2006). *Fuel Cells: Principles and Applications*. Universities Press.
10. Williamson, S. S. (2013). *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*. Springer.

SEMESTER–III
NANOCHEMISTRY

4H-3C

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

Course Objectives

This course enables the students

- 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 analyze the various types of 1D, 2D and 3D nanoparticles of carbon and its application.
- To study about the various types of properties of nanomaterials.
- Gain a knowledge about the nano technology occurred in nature and application of nanomaterials.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Explain the fundamentals-size and scale units of nanomaterials	Understand
CO2	Classify the various types of synthesis method of nanoparticles and its stabilization.	Apply
CO3	Differentiate the various form carbon nanoparticles and its application	Analyze
CO4	Illustrate the various types of properties of nanomaterials.	Apply
CO5	Relate the existence of nano technology in nature and the application of nanomaterials	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**M**	**S**	**M**	**M**	**L**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**M**	**M**
CO3	**M**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**M**	**M**	**M**	**S**	**S**	**M**	**M**	**M**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Fundamentals- Size & scale units **(9)**

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)

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, fullerenes, nanowires, porous silicon, bio-inspired synthesis nanocomposite fabrication, nanolithography, cryochemical synthesis, stabilization of nanoparticles.

UNIT - III Carbon nanotubes and Nanosensors (10)

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)

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

UNIT – V Applications of nanomaterials and Nanotechnology in nature (10)

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.

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

SEMESTER-III
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
External Semester Exam: 4 Hrs

Course Objectives

This course enables the students

- To analyze the heat of solution, determination of molecular weight and distribution coefficient.
- To apply the basic concepts of conductometric titrations to determine the ionic strength.
- To understand the various laws in electrochemistry.
- 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 (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Examine the heat of solution, determination of molecular weight and distribution coefficient.	Analyze
CO2	Utilize the basic concepts of conductometric titrations to determine the ionic strength.	Apply
CO3	Illustrate the various laws in electrochemistry.	Apply
CO4	Make use of conductometric method for the solutions and measure its conductivity.	Apply
CO5	Determine the distribution co-efficient influence the solubility of various systems.	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	M	S	M
CO2	S	S	M	M	S	S	M	M	M	S
CO3	M	S	S	S	M	S	M	S	M	S
CO4	S	S	M	S	S	S	M	S	M	S
CO5	S	S	S	S	S	S	S	S	S	M

S-Strong; M-Medium; L-Low

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 $ZnSO_4$/
8. 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.
9. 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).
10. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
11. Determination of equivalent conductance, degree of dissociation and dissociation constant of a strong electrolyte.
12. Verification of Debye-Huckel Onsager equation.
13. Verification of Ostwald dilution law.
14. Verification of Kohlraush law for weak electrolytes.
15. Conductometric titration of a mixture of a weak acid and strong acid against a strong base.
16. Determination of the solubility of a sparingly soluble salt.
17. Conductometric titration: Acid-base and precipitation titrations including mixture of halides.

SUGGESTED 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. Thomas, A. O. (2003). *Practical Chemistry*. Cannanore: Scientific Book Center.
6. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications.
7. Srivastava.T. N., & Kamboj. P. C. (2013). *University Practical Chemistry*. New Delhi: Milestone Publishers and Distributors.

SEMESTER-III
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**
External Semester Exam: 4 Hrs

Course Objectives

This course enables the students

- 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.
- To study about the chemical kinetics in various organic/inorganic compounds.
- To evaluate the metal concentration in water samples using adsorption technique.

Course Outcomes (CO's)

At the end of this course, students will be able to

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

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	M	S	M	M	M	S
CO2	M	S	S	S	M	S	M	M	L	M
CO3	M	S	S	S	M	S	S	S	M	S
CO4	S	S	M	S	S	S	S	S	M	S
CO5	M	S	S	S	S	S	M	S	M	S

S-Strong; M-Medium; L-Low

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.

SUGGESTED 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. Thomas, A.O, (2003). *Practical Chemistry*. Cannanore: Scientific Book Center.
6. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles of Practical Chemistry* (II Edition). New Delhi: S. Chand Publications

M.Sc. Chemistry **2023-2024**
23MBAPOE301

SEMESTER-III
ORGANIZATIONAL BEHAVIOUR

3H-2C

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

Course Objectives

This course enables the students

- 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 understand 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.
- To realize the importance of groups and teamwork and managing of conflict between the members of the organization.

Course Outcomes (CO's)

At the end of this course, students will be able to

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

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							**S**			
CO2							**S**			
CO3							**M**			
CO4							**M**			
CO5							**M**			

S-Strong; M-Medium; L-Low

UNIT-I Organization Behavior Introduction **(8)**

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

UNIT-II Behavior and Personality **(7)**

Attitudes – Sources - Types - Functions of Attitudes. Values – Importance - Types of Values. Personality – Determinants of personality- Theories of Personality - psycho-analytical, social learning, job-fit, and trait theories.

UNIT-III Perception **(7)**

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)**

Foundation of Group Behavior - 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 **(7)**

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

SUGGESTED BOOKS

1. Fred Luthans. (2017). *Organizational Behavior: An Evidence - Based Approach*, 12thedition, Mcgraw Hill Education, New Delhi.
2. Steven Mcshane and Mary Ann VonGlinow (2017), *Organizational Behavior*, 6th edition, McGraw Hill Education, New Delhi
3. Robbins, S. P., and Judge, T.A. (2016). *Organizational Behaviour* (16thedition). New Delhi: Prentice Hall of India.
4. Laurie J. Mullins (2016), *Management and Organisational behaviour*, 10thedition, Pearson Education, New Delhi
5. Robbins, S. P., and Judge, T.A. (2016). *Essentials of Organizational Behavior*.13thEdition, Pearson Education.

E- Resources:

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

SEMESTER-III
MATERIALS CHARACTERIZTION

3H-2C

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

Course Objectives

This course enables the students

- To study materials is always important, for any application, including fabrication of satellites.
- To introduce various methods available for characterizing the materials. The characterization of materials specifically addresses that portfolio with which researchers and educators must have working familiarity.
- To provide an introduction to materials characterization and its importance
- To discuss different types of characterization techniques and their uses.
- To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques introduction.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Handle with X-ray, thermal, microscopic, and electrical methods of characterization.	Analyze
CO2	Understand and describe the fundamental principles behind the methods of characterization which are included in the curriculum	Create
CO3	Analyze, interpret and present observations from the different methods.	Understand
CO4	Evaluate the uncertainty of observations and results from the different methods.	Create
CO5	Understand the history of materials science with basic understanding of metals, binary alloys, magnetic materials, dielectric materials and polymers	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		**S**	**M**	**S**	**S**		**M**		**S**	
CO2		**S**	**S**	**M**	**S**		**M**		**M**	
CO3		**M**	**M**	**S**	**S**		**M**		**M**	
CO4		**S**	**S**	**M**	**M**		**M**		**S**	
CO5		**M**	**M**	**S**	**M**		**M**		**M**	

S-Strong; M-Medium; L-Low

UNIT-I **(8)**

X-ray techniques for materials characterization X-ray diffraction: Principle, measuring system and applications for characterization of powdered materials. X-ray diffraction profile and analysis: FWHM and line broadening, Crystallite size effect and Scherrer formula, Effect of strain (tensile vs compressive, uniform vs. non-uniform) Introduction to Extended X-ray absorption fine structure (EXAFS), Surface extended X-ray absorption (SEXAFS).

UNIT-II **(7)**

Microscopic techniques Principles, instrumentations and applications of Optical microscope, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM) for characterization of different samples. Energy dispersive X-ray microanalysis (EDS) - Basic aspects of atomic force microscopy (AFM).

UNIT-III **(7)**

Spectroscopic methods Principle, instrumentation and applications of UV-Visible Diffuse Reflectance (UV-Vis DRS) spectroscopy, FT-IR, Raman and Fluorescence spectroscopy. Hand of experience on operation of UV-Vis-DRS, FT-IR, Raman and data analysis.

UNIT-IV **(7)**

Thermoanalytical Methods Principle, instrumentation and applications of Thermogravimetric Analysis (TGA), Differential Temperature Analysis (DTA) and Differential Scanning Calorimetry (DSC). Factors affecting the TGA/DTA/DSC results and their interpretations. Hand on experience of operation of TG/DSC and data analysis.

UNIT-V **(7)**

Electroanalytical Techniques Voltammetric principles, hydrodynamic voltammetry, stripping voltammetry, cyclic voltammetry, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes, qualitative and quantitative analysis current-potential relation applicable for Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV), interpretation of cyclic voltammograms and parameters obtainable from voltammograms. Hand on experience on operation of CV and data analysis.

SUGGESTED BOOKS

1. Theory and Applications of UV Spectroscopy, H.H.Jaffe and M.Orchin, IBH-Oxford.
2. Inorganic spectroscopic methods, A.K. Brisdon, Oxford Chem. Primers, 1997, New York.
3. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L.Ho, Wiley

Inter science.

4. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.
5. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley.
6. Fundamental of Molecular Spectroscopy, C. N. Banwell and E. McCash, Tata McGraw Hill, 4th edition, 1994, New Delhi.

SEMESTER-III
NUMERICAL METHODS AND PROGRAMMING

3H-2C

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

Course Objectives

This course enables the students

- Computational physics may be broadly defined as 'the science of using computers to assist in the solution of physical problems, and to further physics research.
- To equip the students of M.Sc. Physics with knowledge of programming in C, roots of equation, interpolation, curve fitting, numerical differentiation, numerical integration, solution of ordinary differential equations
- To introduce students to computational methods for simulating physical systems and solving problems arising in physics and astronomy, as well as in other related fields
- Computers now play a role in almost every branch of physics like large scale quantum mechanical calculations in nuclear, atomic, molecular and condensed matter physics, large scale calculations in such fields as hydrodynamics, astrophysics, plasma physics, meteorology and geophysics etc.
- The huge increase in the power of computers in recent years has made an impact on the role of computational physics.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Programme numerical methods and their implementation like applying to problem in physics, including modeling of classical physics to quantum system as well as data analysis (Linear and non linear).	Understand
CO2	Analysis techniques for propagating error, representing data graphically. Create, solve and interpret basic mathematical tool.	Analyze
CO3	Program independently computers using leading-edge tools	Understand
CO4	Formulate and computationally solve a selection of problems in physics	Create
CO5	Use the tools, methodologies, language and conventions of physics to test and Communicate ideas and explanations.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		**M**	**L**	**M**	**L**		**L**		**M**	
CO2		**S**	**L**	**M**	**M**		**M**		**L**	

CO3		**S**	**S**	**S**	**M**		**M**		**M**	
CO4		**S**	**M**	**M**	**S**		**M**		**M**	
CO5		**S**	**S**	**M**	**S**		**M**		**M**	

S-Strong; M-Medium; L-Low

UNIT- I **(8)**

Errors, different type of errors. Representation of numbers in computer, computer arithmetic, zero in floating point number.

UNIT– II **(7)**

Operators –finite differences, average, differential, etc., their inter-relations. Difference of polynomials. Difference equation. Interpolation. Lagrange's methods, error terms. Uniqueness of interpolating polynomial.

UNIT- III **(7)**

Newton's fundamental interpolation. Forward, backward and central difference interpolations. Interpolation by iteration. Spline interpolation, comparison with Newton's interpolation. Hermite's interpolation. Bivariate interpolation, Lagrange and Newton's methods. Inverse interpolation.

UNIT- IV **(7)**

Approximation of function. Least square method. Use of orthogonal polynomials. Approximation by Chebyshev polynomials, Max-min principle. Economization of power series.

UNIT- V **(7)**

Python Programming–Loops-Conditional statements- Functions- Object-oriented programming- Array computing- 2 and 3d visualizations

SUGGESTED BOOKS

1. E. Balagurusamy, "Numerical Methods", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999
2. W.H. Press, B.P. Flannery et al., "Numerical Recipes: Art of Scientific Computing", 3rd Edition, Cambridge Press, 2007.
3. J. M. Mathews and K. Fink, "Numerical Methods using MATLAB ", 4rd Edition, Prentice Hall Publication, 2004
4. Dr. B.S. Grewal, "Numerical Methods in Engineering and Science ", Khanna Publication.
5. Robert J schilling, Sandra l harries, " Applied Numerical Methods for Engineers using MATLAB and C.", Thomson Brooks/cole.
6. Richard L. Burden, J. Douglas Faires, "Numerical Analysis", Thomson / Brooks/cole
7. John. H. Mathews, Kurtis Fink, "Numerical Methods Using MATLAB", Prentice Hall publication
8. JAAN KIUSALAAS, "Numerical Methods in Engineering with MATLAB", Cambridge Publication

WEB LINKS:

1. https://archive.nptel.ac.in/content/

SEMESTER-III
ROBOTIC PROCESS AUTOMATION

3H-2C

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

Course Objectives

This course enables the students

- Understand the RPA and the ability to differentiate it from other types of automation.
- Model the sequences and the nesting of activities
- Model the workflow of different scrapping methodologies
- Understand to handle the exceptions and will troubleshoot towards the solution
- Experiment with workflow in a manner to get the optimized output from a Bot.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Describe RPA, where it can be applied and how it's implemented.	Analyze
CO2	Describe the different types of variables, Control Flow and data manipulation techniques.	Analyze
CO3	Identify and understand Image, Text and Data Tables Automation.	Apply
CO4	Describe how to handle the User Events and various types of Exceptions and strategies.	Apply
CO5	Understand the Deployment of the Robot and to maintain the connection	Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1					**L**		**L**			
CO2					**M**		**M**			
CO3					**M**		**M**			
CO4					**S**		**M**			
CO5					**S**		**M**			

S-Strong; M-Medium; L-Low

UNIT-I Introduction To Robotic Process Automation (8)

Scope and techniques of automation, Robotic process automation - What can RPA do?, Benefits of RPA, Componentsof 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 controlflow architecture - RPA business case - RPA Team - Process Design Document/Solution Design Document - Industriesbest suited for RPA - Risks & Challenges with RPA - RPA and emerging ecosystem.

UNIT-II RPA Tool Introduction and Basics (7)

Introduction to RPA Tool - 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)

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 Data Tables & 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)

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)

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

SUGGESTED BOOKS

1. Alok Mani Tripathi, "Learning Robotic Process Automation", Packt Publishing, 2018.
2. Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, "Introduction to Robotic Process Automation:a Primer", Institute of Robotic Process Automation,1st Edition 2015.
3. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant", Independently Published, 1st Edition 2018.
4. Srikanth Merinda," Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018.
5. Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots andautomate business processes", Packt Publishing, 1st Edition 2018.

WEB LINKS:

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

SEMESTER-III
NUTRITION AND DIETETICS

3H-2C

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

Course Objectives

This course enables the students

- Fundamentals of food, nutrients and their relationship to health
- Respect to deriving maximum benefit from available food resources
- Understanding of the consequences of vitamin and mineral deficiency/excess of vitamin
- Respect to the nutrition in adult age
- Nutrition deficiency diseases and their consequences
- Food adulteration and prevention of food adulteration

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	The fundamentals of nutrition and their relationship to health	Understand
CO2	To derive maximum benefits from available food resources	Understand
CO3	The consequences of vitamin and mineral deficiency/excess of vitamin	Understand
CO4	The nutrition in adult age	Remember
CO5	Nutrition deficiency diseases and their consequences	Remember

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1					**L**	**S**	**L**		**M**	**S**
CO2					**M**	**S**	**M**		**L**	**M**
CO3					**M**	**M**	**M**		**M**	**S**
CO4					**M**	**S**	**M**		**M**	**S**
CO5					**M**	**S**	**M**		**M**	**S**

S-Strong; M-Medium; L-Low

UNIT 1 **(7)**

Basic concepts in food and nutrition- Understanding relationship between food, nutrition and health, Functions of food- Physiological, psychological and social. Dietary guidelines for Indians food pyramid. Junk foods and its causes.

UNIT II **(7)**

Nutrients - 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 **(8)**

Adult nutrition

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, Breastfeeding biology, Breastfeeding support and Counselling, Infant and young child feeding and care - Current feeding practices andnutritional concerns, guidelines for infant and young child feeding, Breast feeding, weaning and complementary feeding. Assessment and management of moderate and severe malnutrition among children, Micronutrient malnutrition among preschool children. Child health and morbidity, neonatal, infant and child mortality.

UNIT IV **(7)**

Introduction to Nutritional deficiency diseases -Causes, symptoms, treatment, prevention of the following: Protein Energy Malnutrition (PEM), Vitamin A Deficiency (VAD), Iron Deficiency Anaemia (IDA), Iodine Deficiency Disorders (IDD), Zinc Deficiency, Flurosis Nutritional needs during pregnancy, common disorders of pregnancy (Anaemia, 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 **(7)**

Dietetics: Diet for diabetes mellitus-Nutrition recommendations for patient with diabetes, Meal planning, Exchange list of different food groups, Glycemic index based formulation of diet for diabetic individual, Diabetic diets menu wise. Diet for Cardiovascular Diseases -Dietary management and general guidelines for coronary heart disease, Dietary recommendations of WHO. Diet for Acute cardiac diseases. Influence of diet on carcinogenesis, Dietary risk factors and cancers at various sites in the human body, diet therapy, diet for cancer patients, managing eating problems during treatment. Hormonal imbalance-Poly cystic ovarian syndrome, hypogonadism, cushing syndrome. Causes of hormonal imbalance. Treatment- Dietary and stress management protocols to be followed.

SUGGESTED BOOKS

1. Gordon M, Wardlaw and Paul M. (2012). Perspectives in Nutrition: U.S.A. McGraw Hill Publishers. 9rd Edition. New Delhi
2. Srilakshmi. B.(2014) Nutrition Science: New Age International (P) Ltd. Publishers.4th Edition. New Delhi.
3. Srilakshmi.B. (2015) Food Science. New Age International (P) Ltd. Publishers. 6nd Edition., New Delhi
4. Darshan Sohi (2012). A Comprehensive Textbook of Nutrition & Therapeutic Diets. Jaypee Brothers Medical Publishers Pvt. Ltd.

SEMESTER-III
CYBER FORENSICS

3H-2C

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

Course Objectives

This course enables the students

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

Course Outcomes (COs)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Define, understand and explain various investigation procedures and summarize duplication of digital evidence.	Remember
CO2	Apply the knowledge of digital evidences.	Understand
CO3	Design and develop various forensics tools and analyse the network forensics.	Create
CO4	Demonstrate the systematic study of high-tech forensics	Understand
CO5	Understand the importance of reports.	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			**L**	**M**	**L**		**L**			**S**
CO2			**L**	**M**	**M**		**M**			**M**
CO3			**S**	**S**	**M**		**M**			**S**
CO4			**M**	**M**	**S**		**M**			**S**
CO5			**S**	**M**	**S**		**M**			**S**

S-Strong; M-Medium; L-Low

Unit-I Computer forensics and investigations **(8)**

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)**

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)**

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)**

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 **(7)**

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.

SUGGESTED 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", Academic Press, 1st Edition,
3. John R Vacca,.(2016)."Computer Forensics", Cengage Learning, 2nd Edition.

WEB LINKS:

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

SEMESTER-III
PERSONAL FINANCE AND PLANNING

3H-2C

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

Course Objectives

This course enables the students

- To familiarize with regard to the concept of Investment Planning and its methods.
- To examine the scope and ways of Personal Tax Planning.
- To analyze Insurance Planning and its relevance.
- To develop an insight in to retirement planning and its relevance.
- To construct an optimal portfolio in real life situations.

Course Outcomes (COs)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Familiarize with regard to the concept of Investmen 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

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							**L**			
CO2							**M**			
CO3							**M**			
CO4							**M**			
CO5							**M**			

S-Strong; M-Medium; L-Low

UNIT-I **(8)**

Introduction to Financial Planning - 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 **(7)**

Investment Planning - 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 **(7)**

Personal Tax Planning - 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 **(7)**

Insurance Planning - 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 **(7)**

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

SUGGESTED BOOKS

1. Indian Institute of Banking & Finance. (2017). Introduction to Financial Planning. New Delhi: Taxmann Publication.
2. Pandit, A. (2014). The Only Financial Planning Book that You Will Ever Need. Mumbai: Network Publications Ltd.
3. Sinha, M. (2008). Financial Planning: A Ready Reckoner. New York: McGraw Hill Education.
4. Halan, M. (2018). Let’s Talk Money: You've Worked Hard for It, Now Make It Work for You. New York: HarperCollins Publishers.
5. Tripathi, V. (2017). Fundamentals of Investment. New Delhi: Taxmann Publication.

SEMESTER-III
CHEMISTRY IN EVERYDAY LIFE

3H-2C

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

Course Objectives

This course enables the students

- Gain knowledge in the importance of chemistry in food industry.
- To understand the chemistry of medicines and cosmetics.
- To study about chemistry in energy utilization and storage process.
- Know about the chemistry of soaps, detergents and textiles.
- To learn about the chemistry behind the polymers, fuel and agriculture.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Illustrate the importance of chemistry in food industry.	Apply
CO2	Explain the chemistry of medicines and cosmetics.	Understand
CO3	Utilization of chemistry concepts in energy storage devices.	Apply
CO4	Discuss about the chemistry of soaps, detergents and textiles.	Understand
CO5	Apply the concept of chemistry in polymers, fuel and agriculture industry.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**S**	**M**	**L**	**M**	**L**	**S**	**L**	**M**	**M**	**S**
CO2	**S**	**S**	**L**	**M**	**M**	**S**	**M**	**M**	**L**	**M**
CO3	**M**	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**M**	**S**
CO4	**S**	**S**	**M**	**M**	**S**	**S**	**M**	**S**	**M**	**S**
CO5	**S**	**S**	**S**	**M**	**S**	**S**	**M**	**S**	**M**	**S**

S-Strong; M-Medium; L-Low

UNIT - I Importance of Chemistry in food (8)

Chemicals in food, colouring agents, artificial preservatives, flow stabilizers, binding substance, flavours and sweeteners, antioxidants, minerals, vitamins. Chemistry at the breakfast table, raising agents- gluten, the taste maker- glutamic acid, stimulants-Caffeine, chemistry of

onion, garlic and curcumin.

UNIT - II Chemistry in medicines and cosmetics (8)

Elements in the human body, drugs and their classification, drug-target interaction, action of different classes of drugs, antiseptics and disinfectants.
Cosmetics: Chemistry behind the lotions, fragrances, talcum powder, sunblock and sunscreen, toothpaste, lipsticks, nail polishes.

UNIT - III Chemistry in energy (8)

Solar energy - fuel from sun light - splitting of water - hydrogen from sunlight - hydrogen economy - fuel cells - batteries - photovoltaics - stealing the sun - nuclear energy - nuclear fission and fusion - production of electricity by a nuclear reactor - radioactivity and the hazards of radioactivity - living with nuclear power.

UNIT - IV Importance of chemistry in soaps, detergents and textiles (6)

Detergents and soaps, types of soaps and detergents, saponification, cleansing action of soaps and detergents, perfumes used in soaps.

Textiles: Chemistry behind wool, silk, jute, cotton, glass fibre, polyester, acrylic, nylon, and other raw materials.

UNIT - V Chemistry of polymers, fuel and agriculture (6)

Polymers, types, polyethylene, plastics, disposal of plastics, degradation of polymers and plastics using nano materials. Petrochemistry, petrol, diesel, LPG, CNG, kerosene, oils, and other fuels. Agriculture: fertilizers, herbicides, insecticides, and fungicides.

SUGGESTED BOOKS

1. Tripathy, S. N., & Sunakar Panda (2004). *Fundamentals of Environmental Studies* (II Edition). New Delhi: Vrianda Publications Private Ltd.
2. Arvind Kumar (2004). *A Textbook of Environmental Science*. New Delhi: APH Publishing Corporation.
3. Anubha Kaushik, C. P., & Kaushik (2004). *Perspectives in Environmental Studies*. New Delhi: New Age International Pvt. Ltd. Publications.
4. Seymour R. B., & Charles, E. (2003). *Seymour's Polymer Chemistry: An Introduction.* Marcel Dekker, Inc.
5. Stocchi. E, (1990). *Industrial Chemistry* (Vol–I). UK: Ellis Horwood Ltd.
6. Jain, P. C., & Jain, M. (2004). *Engineering Chemistry*. Delhi: Dhanpat Rai & Sons.
7. Sharma, B. K., & Gaur, H. (1996). *Industrial Chemistry.* Meerut: Goel Publishing House.

M.Sc. Chemistry **2023-2024**
23MBPOE301

SEMESTER-III
FERMENTATION TECHNOLOGY

3H-2C

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

Course Objectives

This course enables the students

- To encompass the use of microorganisms in the manufacture of food or industrial products on the basis of employment.
- Get equipped with a theoretical and practical understanding of industrial microbiology
- Appreciate how microbiology is applied in the manufacture of industrial products
- Know how to source microorganisms of industrial importance from the environment
- Know about the design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer
- Understand the rationale in medium formulation & design for microbial fermentation, and sterilization of medium and air.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Provides knowledge in the large-scale production of industrial product, and teaches the modern employment trends to cater the needs of industry.	Understand
CO2	Students will differentiate the types of fermentation processes	Apply
CO3	Understand the biochemistry of various fermentations	Understand
CO4	Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms	Analyze
CO5	Comprehend the techniques and the underlying principles in downstream processing	Apply
CO6	Students can able to explore the practical skills in research activities.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		M	L		L	S	L			
CO2		S	L		M	S	M			
CO3		L	S		M	S	M			
CO4		S	M		M	S	M			
CO5		S	S		S	S	M			

S-Strong; M-Medium; L-Low

UNIT-I Basics of fermentation processes **(8)**

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; scaleup 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)**

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

UNIT-III Screening and Inoculum development **(7)**

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)**

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

UNIT-V Alcohols and Beverages **(7)**

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

SUGGESTED BOOKS

1. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W.H.Freemn and company, USA.
4. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3rd edition, ASM Press, USA.
5. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
6. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi.
7. Tanuja.S and Purohit, S.S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.

SEMESTER-III
ENGLISH FOR COMPETITIVE EXAMINATIONS

3H-2C

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

Course Objectives

This course enables the students

- •To train learners to crack competitive exams
- •To know of various tools that is essential for 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.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	The student may settle in life with a government job.	Apply
CO2	The student may develop various skills	Understand
CO3	The successful student may guide other students to success.	Understand
CO4	Analyse logical reasoning questions, error analysis, and correct usage of words.	Analyze
CO5	Develop the knowledge of grammatical system of English language.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							**L**			
CO2							**M**			
CO3							**M**			
CO4							**M**			
CO5							**M**			

S-Strong; M-Medium; L-Low

UNIT-I Grammar **(8)**

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

UNIT-II Word Power **(7)**
Idioms and Phrases-One word substitution-Synonyms-Antonyms-Words often confused

UNIT-III Paragraph **(7)**
Expansion of an idea

UNIT-IV Writing **(7)**
Essay- Letters-Memos-Agenda-Resume writing

UNIT-V Speaking **(7)**
Public Speaking-Group Discussion-Interview-Spoken English

SUGGESTED BOOK

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

SEMESTER-III
SERICULTURE

3H-2C

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

Course Objectives

This course enables the students

- To apply knowledge and skills of Seri biotechnology for development new mulberry variety and silkworm breeds suitable for varied agro-climatic zones.
- To apply tools and techniques of biostatics for critical analysis and interpretation of data accrued.
- To use bioinformatics tools and techniques for the analysis and interpretation of bimolecular data for better understating mulberry and silkworm.
- To demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of Seri biotechnology.
- Thorough knowledge and application of good laboratory and good manufacturing practices in sericulture and biotech industries.
- To demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up small-scale enterprises.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Know the different components and chain link of sericulture industry.	Understand
CO2	Understand concepts of sericulture industry and demonstrate interdisciplinary skills acquired in mulberry plant cultivation and silkworm rearing.	Understand
CO3	Demonstrating the Laboratory and field skills in mulberry cultivation and Silkworm rearing with an emphasis on technological aspects.	Create
CO4	To transfer the knowledge and technical skills to the Seri-farmers.	Understand
CO5	To analyze the environmental issues and apply in management of mulberry garden and silkworm rearing at field.	Analyze
CO6	Demonstrate comprehensive innovations and skills in improvement of mulberry and silkworm varieties for betterment of sericulture industry and human welfare.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							L			
CO2							M			
CO3							M			
CO4							M			
CO5							M			

S-Strong; M-Medium; L-Low

UNIT-I **(8)**

Introduction to Sericulture - History of Sericulture – Sericulture organization in India, By products of silk industry. Mulberry and Non – mulberry silkworm types–Morphology and Life cycle of Bombyxmori,

UNIT-II **(7)**

Mulberry Cultivation: Mulberry Varieties – Methods of Irrigation –Nutrient Management and Weed control. Pruning and Harvesting – Crop improvement – Mechanism in Moriculture – Pest and Disease, deficiencies and symptoms in Mulberry.

UNIT-III **(7)**

Rearing of silkworm – Rearing Appliances – rearing operation. Harvesting and marketing of cocoons. Cocoon processing and reeling - Appliances used for reeling. Pre reeling process – Cocoon boiling. Reeling technology – re-reeling technology.

UNIT-IV **(7)**

Non – Mulberry Sericulture Scope of Non-mulberry Sericulture - Non-mulberry silk varieties and fauna, tasar, muga, eri–Silk Production and Marketing – Tropical tasar/muga– Morphology, anatomy grainage.

UNIT-V **(7)**

Diseases of silkworm-Pebrine Protozoan, Flacherie bacterial, Nuclear Polyhedrosisviral and Muscardine fungal diseases. Pests of Silkworm.

SUGGESTED BOOKS

1. Krisnamoorthy S., Improved Method of Rearing Young Age Silk Worms: Reprinted by CSB, Bangalore, 1986.
2. Tanaka Y., Sericology, CSB, Pub., Bangalore, 1964.
3. Ullal S.R., and Narasimhan M.N., Hand Book of Practical Sericulture, CSB, Bangalore, 1987.
4. HisaoAruga, Principles of sericulture, Oxford and IBH Publishing Company, 1994.
5. Hrccrama Reddy, G. 1998. Silkworm Breeding, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
6. Otsuki el.al. 1987. Silkworm Egg Production (Translated from Japanese Language), Oxford wild IBH Publishing Co. Pvt. Ltd., New Delhi.

7. Yasuji Hamamura, 2001 Silkworm Rearing on Artificial Diet (Translated from Japanese Language), Oxford wild IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Mahadevappa, D. Halliyal, V.G., Sankar, D.G and Bhandiwad, R. 2000. Mulberry Silk Reeling Technology, Oxford wild IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Dandin, S.B et.al. 2003. Advances in Tropical Sericulture, National Academy of Sericulture Sciences India, Central Silk Board, Bangalore, India.
10. Ganga G., Sulochanachetty. J. An Introduction of Sericulture. Oxford, New Delhi – 1977.
11. Johnson M., and Kesary M., Sericulture, CSI Press, Marthandam, 2008.
12. Text Book of Tropical Sericulture, Pub., Japan Overseas Volunteers, 1975

SEMESTER-III
CODING THEORY

3H-2C

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

Course Objectives

This course enables the students

- Elements of coding theory and its applications.
- Understand the concept of bounds in coding theory.
- About the encoding and decoding.
- Analyze the concept of cyclic coding
- Acquiring the knowledge special cyclic codes.

Course Outcomes (CO's)

At the end of this course, students will be able to

COs	Course Outcomes	Blooms Level
CO1	Recognize the basic concepts of coding theory.	Apply
CO2	Understand the importance of finite fields in the design of codes.	Understand
CO3	Detect and correct the errors occur in communication channels with the help of methods of coding theory.	Apply
CO4	Apply the tools of linear algebra to construct special type o codes.	Apply
CO5	Use algebraic techniques in designing efficient and reliable data transmission methods.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							**L**			
CO2							**M**			
CO3							**M**			
CO4							**M**			
CO5							**M**			

S-Strong; M-Medium; L-Low

UNIT-I Error Detection, Correction and Decoding (8)

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

UNIT-II Linear Codes **(7)**

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

UNIT-III Bounds in Coding Theory **(7)**

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)**

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

UNIT-V Special Cyclic Codes **(7)**

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

SUGGESTED BOOKS

1. San Ling and Chaoping Xing (2004). Coding Theory: A first course, Cambridge University Press.
2. Lin. S & Costello. D. J. (1983). Jr., 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.
4. Berlekamp E.R. (1968). Algebriac Coding Theory, Mc Graw-Hill.
5. H. Hill (1986). A First Course in Coding Theory, OUP.

WEB LINKS:

1. https://www.youtube.com/watch?v=XepXtl9YKwc
2. https://www.youtube.com/watch?v=oeQWxhlnCHM
3. https://www.youtube.com/watch?v=Z-QGtxlQWak

23CHP391

SEMESTER-III

INTERNSHIP

0H-2C

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

23CHP491

SEMESTER-IV
PROJECT AND VIVA-VOCE

30H-15C

Instruction Hours/week:L: 0 T: 0 P: 30 **Marks: Internal: 80 External: 120 Total:200**