**SHRIMATHI DEVKUNVAR NANALAL BHATT VAISHNAV COLLEGE**

**FOR WOMEN (AUTONOMOUS)**

**CHENNAI - 600044**

**Re accredited with "$A^+$" Grade by NAAC**

# MASTER OF SCIENCE-CHEMISTRY

## (Shift – I- SFS)

**Under the faculty of Science**

**(M.Sc. CHEMISTRY)**

**CHOICE BASED CREDIT SYSTEM (CBCS)**

**OUTCOME BASED EDUCATION (OBE)**

(Effective from the Academic Year 2020-21)

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# RULES AND REGULATIONS
# PG DEPARTMENT OF CHEMISTRY
# Revised Syllabus of 2020 - 2021
# (M.Sc., CHEMISTRY)

**OBJECIVES OF THE COURSE**

- To make the students to understand the importance of chemistry in their day-to-day life.
- To explore the interpretation skills/ability of the students in their field.
- To enhance the innovating ideas of Research in the field of chemical science.
- To encourage the students for competitive examinations and decision making by enhancing their knowledge.
- To enable the students to pursue Master of Philosophy and Doctoral Research degree to work in colleges and Universities.

## PG REGULATIONS

## 1. ELIGIBILITY FOR ADMISSION:

All candidates must have cleared their graduation in Chemistry from a recognized educational institution in India.

## 2. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the Degree only if she has undergone the prescribed course of study in a College affiliated to the University for a period of not less than two academic years, passed the examinations all the four-Semesters prescribed earning a minimum of 91 Credits (in Parts-I & II)

## 3. DURATION:

a. Each academic year shall be divided into two semesters. The first academic year shall comprise the first and second semesters and the second academic year the third and fourth semesters.

b. The odd semesters shall consist of the period from June to November of each year and the

even semesters from December to April of each year. There shall be not less than 90 working days for each semester.

## 4. COURSE OF STUDY:

The main Subject of Study for Master Degree Courses shall consist of the following

PART – I CORE SUBJECTS, PROJECT/ELECTIVES

PART – II SOFT SKILLS & INTERNSHIP

1. Skill based subjects (Four) -

   a) Teaching Skills

   b) Research Skills

   c) Soft Skill – SWAYAM COURSE (MOOC)

   d) Soft Skill – SWAYAM COURSE (MOOC)

Recommended Credits Distribution: (Total should not be less than 91 Credits)

| **Course Type** | **No. of Papers** | **Credits / Paper** | **Credits** |
|---|---|---|---|
| Core (Theory) | 15 | 4 | 60 |
| Core (Practical) | | | |
| Core (Project ) | | | |
| Elective | 5 | 3 | 15 |
| Internship | | 2 | 2 |
| Skill based courses | 2 | 3 | 6 |
| SWAYAM Courses | 2 | 4 | 8 |
| **Total** | | | **91** |

## 5. ATTENDANCE

CATEGORY-A: ATTENDANCE REQUIREMENT

All candidates must put in 75% and above of attendance for Arts, Science, Commerce courses both UG/PG including MBA/MCA Degree courses for appearing the University Examination. (Theory/Practical)

CATEGORY –B: CONDONATION OF SHORTAGE OF ATTENDANCE

If a candidate fails to put in the minimum attendance (Percentage stipulated), the Principals shall condone the shortage of attendance up to a maximum limit of 10% (i.e. between 65% and above and less than 75%) for all UG/PG courses. (i.e. Arts Science, Commerce, MBA and MCA) after collecting the prescribed fee of RS.250/-each for Theory/Practical examination separately, (Theory Rs.250/- Per semester/Per Candidate: Practical Rs.250/- Per semester/ Per Candidate) towards the condonation of shortage of attendance.

CATEGORY-C: NOT ELIGIBLE FOR CONDONATION OF SHORTAGE OF ATTENDANCE

Candidates who have secured less than 65% but more than 50% of attendance are NOT ELIGIBLE for condonation of shortage of attendance and such candidates will not be permitted to appear for the regular examination, but will be allowed to proceed to the next year/next semester of the course and they may be permitted to take next University examination by paying the prescribed condonation fee of Rs.250/- each for Theory/Practical separately. Names of such candidates should be forwarded along with their attendance details in the prescribed format mentioning the category(3copies). Degree Wise/Year wise/Branch wise/semester wise/together with the fees collected from them. So as to enable them to get permission from the University and to attend the Theory/Practical examination subsequently without any difficulty.

CATEGORY-D: DETAINED STUDENTS FOR WANT OF ATTENDANCE

Candidate who have put in less than 50% of attendance have to repeat the course (by re-joining ) for which they lack attendance without proceeding for II/III year as the case may be.

Until they re-join the course and earn the required attendance for that particular semester/year, no candidates shall be permitted to proceed to the next year/next semester of the course under any circumstances. They have to obtain prior permission from the University to re-join the course.

Provided in case of candidates who are admitted form the academic year 2003 -2004 earning less than 50% of attendance in any one of the semesters due to any extraordinary circumstances such as medical ground, such candidates shall produce Medical Certificate issued by the authorized, Medical Attendant (AMA), duly certified by the Principal of the college shall be permitted to proceed to the next semester and to complete the course of study. Such candidates shall have to repeat the semester, which they have missed by re-joining after completion of final semester of the course, by paying the fee for the break of study ad prescribed by the University from time to time.

CATEGORY-E: CONDONATION OF SHORTAGE OF ATTENDANCE FOR MARRIED WOMEN STUDENTS

In respect of married women students undergoing UG/PG course, the minimum attendance for condonation (Theory/Practical) shall be relaxed and prescribed ad 55% instead of 65% if they conceive during their academic career. Medical certificate form the Doctor attached to the Government Hospital (D.G.O) and the prescribed fee of Rs.250%- therefor together with the attendance details shall be forwarded to this off ice to consider the condonation of attendance mentioning the category.

0% Attendance

The candidates who have earned 0% of attendance, have to repeat the course (by re-joining) without proceeding to succeeding semester and they have to obtain prior permission form the University to re-join the course immediately for which applications issued for the academic year.

## 6. BREAK IN STUDY

After enrolling into any of the courses offered by the college a student is allowed to be absent continuously for period of FIVE years (Max. Condonable period- from the day of enrolment) after which she forfeits her admission.

A student who wants to continue her study within the condonable break period can

rejoin in the same semester in the EXISTING VACANCY after getting the permission from the Principal and subsequently from University of Madras. Such students should also get a letter from the respective Head of the Department stating that she is not repeating any paper which she has already completed in other semesters.

## 7. TRANSFER OF STUDENTS AND CREDITS:

Transfer from other Autonomous or Non-Autonomous college or from other University is allowed for the same program with same nomenclature provided there is a vacancy in the respective program of study and the student has passed all the examinations under the previous system. **Students with standing arrears are NOT eligible for transfer.**

The marks obtained in the previous system will be converted and grades will be assigned as per the University norms.

Such students **are eligible** for classification.

Such student is NOT eligible for ranking, prizing and medals on qualifying the PG degree.

## 8. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS

1) Candidate shall register their names for the First Semester Examination after the admission in the M.Sc. PBPBT Course.

2) Candidates shall be permitted to proceed from the first semester up to the final Semester irrespective of their failure in any of the Semester Examinations subject to the condition that the candidate should register for all arrear subjects of earlier semesters along with current (subject) semester subjects.

3) Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed by the University/College.

## 9. PASSING REQUIREMENTS

1) There shall be no passing minimum for Internal. But 0 also should not be awarded. In case a student absents herself for all the CIA exams and ends in getting 0 in internal in a particular subject, she will be awarded 1 or 2 marks for attendance.

2) For all subjects (Theory/Practical/Project) the passing requirement is as follows: i) candidate should secure not less than 50% of marks in End Semester Examination (ESE) and not less than 50% in aggregate of the total internal and external marks.

3) A candidate who passes in all subjects earning 91 credits within the maximum period of four years reckoned from the date of admission to the course shall be declared to have qualified for the degree.

4) A student who fails in either Project work or Viva-voce shall be permitted to redo the project work for evaluation and re-appear for the Viva-voce on a subsequent occasion, if so recommended by the examiners.

5) Grading shall be based on overall marks obtained (Internal + External)

## 10. MEDIUM OF INSTRUCTION AND EXAMINATIONS

The medium of instruction and examinations for the papers of Part I & II shall be the language concerned. For part I subjects other than modern languages, the medium of instruction shall be either Tamil or English and the medium of examinations is in English/Tamil irrespective of the medium of instruction. For modern languages, the medium of instruction and examination will be in the languages concerned.

## 11. SUBMISSION OF RECORD NOTE BOOKS FOR PRACTICAL EXAMINATIONS

Candidates appearing for practical examinations should submit bonafide Record Note Books prescribed for practical examinations, otherwise the candidates will not be permitted to appear for the practical examinations.

## 12. CLASSIFICATION OF SUCCESSFUL CANDIDATES

1) A Candidate who qualifies for the Degree and secures CGPA between 9.0 – 10.0 shall be declared to have passed the examination in FIRST CLASS - EXEMPLARY provided she has passed the examination in every subject she has registered as well as in the project work in the first appearance.

2) A Candidate who qualifies for the Degree and secures CGPA between 7.5 – 8.9 shall be declared to have passed the examination in FIRST CLASS WITH DISTINCTION provided she has passed the examination in every subject he/she has registered as well as in the project work in the first appearance.

3) A candidate who qualifies for the degree as per the regulations for passing requirements and secures CGPA between 6.0 – 7.4 shall be declared to have passed the examination in FIRST CLASS

4) A candidate who qualifies for the degree as per the regulations for passing requirements and secures CGPA between 5.0 –5.9 shall be declared to have passed the examination in SECOND CLASS

5) Only those candidates who have passed all the papers including practical and project work in the first appearance shall be considered for the purpose of RANKING.

## 13. RANKING

1) Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction.

2) Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the First Appearance due to lack of attendance are only eligible for classification.

## 14. GRADING SYSTEM

The term grading system indicates a SEVEN (7) point scale of evaluation of the performance of students in terms of marks obtained in the Internal and External

Examination, Grade points and letter grade.

Minimum Credits to be earned:

For TWO year PG Programme: Best 91 Credits (Part I: Major/Elective, Part –II: Soft skills)

Conversion of Marks to Grade Points and Letter Grade

(Performance in a Course / Paper)

| RANGE OF MARKS | GRADE POINTS | LETTER GRADE | DESCRIPTION |
|---|---|---|---|
| 90-100 | 9.0-10.0 | O | Outstanding |
| 80-89 | 8.0-8.9 | D+ | Excellent |
| 75-79 | 7.5-7.9 | D | Distinction |
| 70-74 | 7.0-7.4 | A+ | Very Good |
| 60-69 | 6.0-6.9 | A | Good |
| 50-59 | 5.0-5.9 | B | Average |
| 40-49 | 4.0-4.9 | U | Re-appear |
| ABSENT | 0.0 | AAA | ABSENT |

## 15. CLASSIFICATION & CALCULATION OF GPA AND CGPA

For a Semester:

**GRADE POINT AVERAGE [GPA]**

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the courses}}{\text{Sum of the credits of the courses in a semester}}$$

For the entire programme:

**CUMULATIVE GRADE POINT AVERAGE [CGPA]**

$$CGPA = \frac{\text{Sum of the multiplication of grade points by the credits of the courses For entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

| CGPA | GRADE | CLASSIFICATION OF FINAL RESULT |
|---|---|---|
| 9.5-10.0 | O+ | First Class - Exemplary * |
| 9.0 and above but below 9.5 | O | |
| 8.5 and above but below 9.0 | D++ | First Class with Distinction * |
| 8.0 and above but below 8.5 | D+ | |
| 7.5 and above but below 8.0 | D | |
| 7.0 and above but below 7.5 | A++ | First Class |
| 6.5 and above but below 7.0 | A+ | |
| 6.0 and above but below 6.5 | A | |
| 5.5 and above but below 6.0 | B+ | Second Class |
| 5.0 and above but below 5.5 | B | |
| 0.0 and above but below 5.0 | U | Re-appear |

**The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme (Major, Elective/Project and Non-Major Elective courses alone) / M.Phil. are eligible.

## 16. ESE REVALUATION

A student is eligible to appeal for revaluation of the paper only **if she secures a minimum of 10 in the internal tests (CAT) of that paper** if the internal maximum marks is 25 and **a minimum of 6 in the internal tests (CAT) of that paper** if the internal marks is 15. This has to be done within 10 days from the publication of results. She also has to pay the prescribed fee. The revaluation will be done by an external examiner appointed by the Principal.

## 17. ARREAR / REPEAT EXAMINATIONS

1) A candidate having arrear paper(s) shall have the option to appear along with the regular semester papers.

2) Candidates who fail in any of the papers in Part I & II of PG degree examinations shall complete the paper concerned within **four** years from the date of admission to the said course.

## 18. SUPPLEMENTARY / INSTANT EXAMINATION

1) Final year students (PG – II year 4th semester) are **only** eligible to apply for Supplementary / Instant Examination.

2) Students who have only one paper as arrear in the final semester are allowed to take up supplementary / instant examination.

3) Supplementary / Instant Examination will not be conducted for practical papers and projects.

## 19. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

1. Students who are mentally disabled, learning disability and mental retardation, who are slow learners, who are mentally impaired having learning disorder and seizure disorder and students who are spastic and cerebral palsy the following concessions shall be granted obtaining prior permission from the University
    a. One-third of the time of paper may be given as extra time in the examination.
    b. Leniency in overlooking spelling mistakes
2. Students who are visually challenged
    a. Exempted from paying examination fees.
    b. A scribe shall be arranged by the college and the scribe be paid as per the college decision.

## 20. MALPRACTICE

The College views malpractice of any kind very seriously. The college has a Malpractice committee consisting of four senior staff members. Students found to be directly or indirectly involved in malpractice of any kind during examinations will be subject to penalty of very high proportions.

## 21. MAXIMUM PERIOD FOR COMPLETION OF THE PROGRAMME TO QUALIFY FOR A DEGREE:

1. A student who for whatever reasons is not able to complete the programme within the normal period (N) or minimum duration prescribed for the programme, may be allowed **TWO** year period beyond the normal period to clear the backlog to be qualified for the degree. (Time span is N + 2 years for completion of the programme)
2. In exceptional cases like major accidents and child birth, an extension of **ONE** year be considered beyond maximum span of time that is **N+2+1**. Students qualifying during the extension period are **NOT** eligible for ranking.

## 23. REGULATORY BODIES

Under autonomy, the college is free to frame its curriculum and conduct examinations. These functions are monitored by the **Board of Studies, Board of Examiners and the Academic Council.**

**Board of Studies**

Separate Board of studies are constituted for each programme offered by a department. Each Board of Studies will meet at least once a year to design courses, modify syllabi / examination pattern and recommend the same to the Academic Council.

The Board of Studies is composed of:

- Head of the Department (Chair Person)
- A nominee of the University of Madras
- Two subject experts from other teaching institutions
- One representative from the Industry / Corporate sector / allied area relating to placement
- One meritorious alumnus
- The faculty of the department

The tenure of the external experts is for TWO years.

**Board of Examiners**

A list of board of examiners is obtained by circulating the details of courses offered by the college to other colleges and through the list provided by the departments. Single valuation is done for UG courses and double valuation, one Internal and one External, for PG courses.

**Academic Council**

The Academic Council is composed of:

- The Principal (Chairman)
- All heads of the department in the college
- Four senior teachers of the college representing different categories of teaching
- Four representatives from the Industry / Corporate sector / allied area relating to placement / Commerce / Law / Education / Medicine / Engineering nominated by the Governing Body
- Three nominees of the University of Madras
- A faculty member nominated by the principal (Member Secretary)

The term of the nominated members shall be TWO years.

## 24. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

**The Post graduate students of various disciplines would be fully equipped:**

- **PEO 1:** To hone their critical intelligence, professional behaviour and strive towards creative endeavour.
- **PEO 2:** To augment research and entrepreneurial skills supplemented with rich kills of communication, teamwork and leadership to excel in their profession.
- **PEO 3**: To imbibe a deep sense of rationality and in depth knowledge of the various contemporary issues that would elevate their comprehension in the global context.
- **PEO 4**: To pursue research and development in Life science.

- **PEO 5:** Secure jobs in the field of Education and in Institutes and Industries that require scientific thinking and critical problem solving skills.

## 25. PROGRAMME OUTCOMES (POs)

**The Postgraduate students of all disciplines will be able to:**

- **PO 1:** Identify and analyze the complex problems reaching substantiated conclusions using domain knowledge.
- **PO 2:** Apply investigative research, specialize in problem identification, formulate research design, utilize analytical tools, draw valid inferences and provide suggestions leading to nation building initiatives.
- **PO 3:** Strengthen professional ethics and career planning with systematic building of intrapersonal and interpersonal skills to participate in the intellectual diasporas.
- **PO 4:** Establish oneself as a self-reliant, empowered individual to have an inclusive, healthy and compassionate understanding towards life and society.
- **PO 5:** Equipped with technical/managerial expertise to innovate and critically analyze various attributes which constitute pivotal issues in a multidisciplinary scenario.
- **PO 6:** Emerge as innovators and pioneers to create new avenues of employment catering to the global trends as well as demands.

## 26. PROGRAMME SPECIFIC OUTCOMES (PSOs)

- **PSO1:** Acquire in depth knowledge at an advanced level enabling confidence to face competitive examinations of national and global standards.
- **PSO2:** Apply skills in problem solving, critical thinking, analytical reasoning in chemistry domain and use modern techniques, chemistry software to interpret and design scientific processes.
- **PSO3:** Enhance Skill in planning and conducting advanced level chemical experiments, elucidating the structure of compounds and complexes using chemical characterization techniques.

- **PSO4:** Develop a creative scientific mind to communicate effectively in public forum scientific ideas and their impact on socio-economic issues and also provide value based ethical leadership and sensitize the need for a green environment.
- **PSO5:** Exhibit the ability to work in teams. Demonstrate sensitivity and readiness to share their knowledge and capabilities with the marginalized and oppressed in their communities.

## 27. QUESTION PAPER PATTERN:

QUESTION PAPER PATTERN FOR OBE (2020-21 onwards) Theory

UG/PG –Question paper Pattern- conventional on- paper mode

| **Bloom's Category Level** | **Sections** | **Marks** | **Word limit** | **Total** | **Meaning of K's** |
|---|---|---|---|---|---|
| K1, K2 | Multiple Choice Questions<br>15 questions * 2 | 30 | Correct choice | 75 | K 1 & K2 - Understanding Level K 3 - Apply Level K 4 - Analyze Level K 5 – Evaluate Level K 6 – Create Level |
| K3, K4 | Section B<br>5 Questions out of 7 questions<br>*5 Marks | 25 | Short answers {approx. 500 Words) | | |
| K4, K5,k6 | Section C<br>1 out of 3 Questions<br>*10 Marks<br>+<br>Compulsory Question<br>10 Marks | 20 | Elaborate answers (approx. 1000 Words) | | |

*** 75 marks to be converted as 60 marks.**

# PG QUESTION PAPER PATTERN
# FOR OBE ONLINE ASSESSEMENT
# (2020 - 2021)

| Bloom's Category Level | Sections | Marks | Description of answer | Total | Meaning of K's |
|---|---|---|---|---|---|
| **INTERNAL SETTING** | | | | | |
| K1,K2,K3 | **Section A**<br>Multiple Choice Questions<br>25 Questions<br>*1 Marks<br>(No Choice) | 25X1=25 | Choose the right option. | 50 | K 1 & K2 - Understanding Level<br>K 3 - Apply Level<br>K 4 - Analyze Level<br>K 5 – Evaluate Level<br>K 6 – Create Level |
| **EXTERNAL SETTING** | | | | | |
| K2,k3,K4, K5,K6 | **Section B**<br>5 out of 7 Questions<br>*5 Marks | 25 | Short answers/500 Words | | |

*** 50 marks to be converted as 60 marks.**

**BLOOM'S CATEGORY LEVEL (ANNEXURE chart)**

| S.no | K component scale | Verbs for question |
|---|---|---|
| **1.** | **K 1& K2 Verbs** | Verbs to be used for questioning are "choose, find, identify, indicate, match, name, state, what, when, where, which, who, cite, label, reproduce. define, list, quote, revise, explain, show, sketch, illustrate, interpret, describe, substitute, convert, give example, rephrase |
| **2.** | **K2 &k3** | The questions may contain the verbs such as explain, show, sketch, illustrate, interpret, describe, substitute, convert, examFle, rephrase, apply, relate, solve, classify, predict, compute, prepare |
| **3.** | **K4** | The questions may contain verbs - Apply, relate, solve, classify, predict, compute, prepare. |
| **4.** | **K5** | The questions may contain any of the following verbs : Ascertain, diagnose, distinguish, infer, associate, examine, differentiate, reduce, discriminate, dissect, determine, justify, organize, recommend, solve. |
| **5.** | **K6** | The questions may contain any of the following verbs: Appraise, conclude, critique, judge, assess, contrast, deduce, weigh. Compare, criticize, evaluate. |

## Question paper pattern for Continuous Assessment Test (CAT)

## (The online assessment pattern)

P.G PROGRAMME

## SHRIMATHI DEVKUNVAR NANALAL BHATT VAISHNAV COLLEGE FOR WOMEN

**M.SC. DEGREE EXAMINATION,**

**PG DEPARTMENT OF CHEMISTRY**

**2020-21 YEAR,**

**I/II/III/IV SEMESTER**

CAT – I/II/III

Sub Title: Max. Marks: 50
Sub Code: Date:

**Time: 2hrs.**

**Question paper Pattern-Two Components: (Max marks=50) - 3hrs**

I. **Multiple Choice Questions (MCQ) - 20 marks (10x2=20)**
II. **Google Class Room (GCR) - 30 marks (**Structured)

A. **Section A: 5 out of 6 – each carries 2 marks (5x2=10)**
B. **Section B: 4 out of 5 – each carries 5 marks (4x5=20)**

- The answers for the questions for QP uploaded in GCR will be as uploads (images of hand written answer sheets converted to pdf) in Google Class Room.
- The duration for each GCR session (answering and uploading) would be 3 hours (maximum).
- The structured component (30 marks) SHOULD be conducted in GCR as per the CAT schedule. MCQ (10X2=20) CAN be conducted out of schedule also, but should be completed during the CAT examination scheduled.

Note: The GCR question paper and MCQ assessment links to be shared with the COE office for approval and validity on or before the respective allotted dates.

# COURSE PROGRAMME PROFILE

## M.SC. CHEMISTRY

**TOTAL CREDITS: 91** **TOTAL TEACHING HRS: 450**

| PART | COURSE | TITLE OF THE PAPER | CODE | L | T | H | C |
|---|---|---|---|---|---|---|---|
| | | **I SEMESTER** | | | | | |
| **I** | Core Theory I | Organic Chemistry-I | 20PCHCT1001 | 4 | 2 | 6 | 4 |
| **I** | Core Theory II | Inorganic Chemistry -I | 20PCHCT1002 | 4 | 2 | 6 | 4 |
| **I** | Core Theory III | Physical Chemistry-I | 20PCHCT1003 | 4 | 2 | 6 | 4 |
| **I** | Elective-I | Polymer Chemistry | 20PCHET1001 | 4 | 1 | 5 | 3 |
| **I** | Core Practical-I | *Organic Chemistry Practical | 20PCHCP2001 | 4 | 2 | 6 | 4 |
| **II** | Skill based elective | Teaching Skills | 18PSSTS1001 | 2 | | 2 | 3 |
| | | **Total** | | | | **31** | **22** |
| | | **II SEMESTER** | | | | | |
| **II** | Core Theory IV | Organic Chemistry-II | 20PCHCT2004 | 4 | 2 | 6 | 4 |
| **II** | Core Theory V | Inorganic Chemistry-II | 20PCHCT2005 | 4 | 2 | 6 | 4 |
| **II** | Core Theory VI | Physical Chemistry-II | 20PCHCT2006 | 4 | 2 | 6 | 4 |
| **II** | Elective II | Nano Chemistry | 20PCHET2002 | 4 | 1 | 5 | 3 |
| **II** | Core Practical II | *Inorganic Chemistry Practical-I | 20PCHCP2002 | 5 | 1 | 6 | 4 |
| **II** | Soft Skills | SWAYAM (MOOC) NPTEL | 18MOOC2002 | 2 | | 2 | 4 |
| | | **Total** | | | | **31** | **23** |

| PART | COURSE | TITLE OF THE PAPER | CODE | L | T | H | C |
|---|---|---|---|---|---|---|---|
| **III SEMESTER** | | | | | | | |
| III | Core Theory VII | Organic Chemistry-III | 16PCHCT3007 | 4 | 2 | 6 | 4 |
| III | Core Theory VIII | Inorganic Chemistry-III | 16PCHCT3008 | 4 | 2 | 6 | 4 |
| III | Core Theory IX | Physical Chemistry-II | 16PCHCT3009 | 4 | 2 | 6 | 4 |
| III | Elective III | Electrochemistry | 16PCHCE3009 | 4 | 1 | 5 | 3 |
| III | Major Practical III | *Inorganic Chemistry Practical-II | 16PCHCP4003 | 4 | 2 | 6 | 4 |
| III | | Research Skills | 18PSSRS3003 | 2 | | 2 | 3 |
| III | | Internship | 17PPBIP3001 | - | | | 2 |
| | | Total | | | | 31 | 24 |
| **IV SEMESTER** | | | | | | | |
| IV | Core Theory X | Organic Chemistry-IV | 16PCHCT4010 | 4 | 2 | 6 | 4 |
| IV | Elective IV | Research Methodology | 16PCHCE4004 | 4 | 1 | 5 | 3 |
| IV | Elective V | Analytical Techniques in Chemistry | 16PCHCE4005 | 4 | 1 | 5 | 3 |
| IV | Major Practical IV | *Physical Chemistry Practical | 16PCHCP4004 | 2 | 2 | 4 | 4 |
| IV | | PROJECT | 16PCHPR4001 | | 6 | 6 | 4 |
| IV | Extra Disciplinary | SWAYAM (MOOC) | 18MOOC4004 | 2 | 2 | 4 | 4 |
| | | Total | | | | 30 | 22 |

**L = Lecture Hrs; T = Tutorial Hrs; H = Hrs/week; C = Credits**

*** Practicals will be conducted at the end of even semester**

## RUBRICS FOR CONTINUOUS ASSESSMENT

| | |
|---|---|
| **Assignment** | 5 Marks |
| **Seminar** | 5 Marks |
| **Field visit** | Yes |
| **Participatory Learning** | Yes |
| **Group Discussion** | Yes |
| **Flipped/Blended Learning** | Yes |

## Assessment Model (from 2020 – 21 onwards)
## Post graduation programme
## 40% Internal 60% External

| S.No | Assessment Component | Marks | Weighted % |
|---|---|---|---|
| **A.** | **Theory** | | |
| 1 | **INTERNAL ASSESSMENTS** | 2 x 50 = 100 | 15 |
| | Continuous Assessment Test(best two out of three) | | |
| 2 | Quiz/Group Discussion/Seminar/Assignment/Role Play/ Case Study/ Open Book/ snap Test/ Video Presentation/ Review (any three to be considered) | 3 x 10 = 30 | 15 |
| 3 | MCQ (one test to be conducted online during the semester) | 20 | 10 |
| 4 | **EXTERNAL ASSESSMENT** | 75 | 60 |
| | End semester examinations | | |
| | Grand Total | | **100** |

| B | Practical | | |
|---|---|---|---|
| 1 | INTERNAL ASSESSMENTS | | |
| | Continuous Assessment Test(best two out of three) | 2 x 50 = 100 | 15 |
| 2 | Record + Observation | 10 +10 = 20 | 15 |
| 3 | MCQ (one test to be conducted online during the semester) | 20 | 10 |
| 4 | **EXTERNAL ASSESSMENT** | | |
| | End semester Examinations | 60 | 60 |
| | Grand Total | | **100** |

## COURSE FRAMEWORK
## SEMESTER I

| SEM | COURSE CODE | COURSE TITLE | TITLE OF THE PAPER | HRS | CR | CA | SE | T |
|---|---|---|---|---|---|---|---|---|
| **I** | 20PCHCT1001 | Core Theory-I | Organic Chemistry-I | **6** | **4** | **40** | **60** | **100** |
| **I** | 20PCHCT1002 | Core Theory-II | Inorganic Chemistry -I | **6** | **4** | **40** | **60** | **100** |
| **I** | 20PCHCT1003 | Core Theory-III | Physical Chemistry-I | **6** | **4** | **40** | **60** | **100** |
| **I** | 20PCHET1001 | Core Elective-I | Polymer Chemistry | **5** | **3** | **40** | **60** | **100** |
| **I** | 20PCHCP2001 | Core Practical-II | *Organic Chemistry Practical-I | **6** | **4** | **40** | **60** | **100** |
| **I** | 18PSSTS1001 | Skill based elective | Teaching skills | **2** | **3** | **50** | | **50** |
| | | | **Total** | **31** | **22** | | | |

## SEMESTER I

## CORE THEORY I

## ORGANIC CHEMISTRY

**TOTAL HOURS: 90** **SUB CODE: 20PCHCT1001**

**CREDIT: 4** **L-T-P: 4-1-1**

## COURSE OBJECTIVES:

- Understand the importance of stereo chemical aspects.
- Feature the various aspects of nucleophilic and electrophilic substitution reactions
- Acquire the knowledge of Vitamins, cholesterol and hormones

**COURSE OUTCOMES:** on completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | **U**nderstand the details of various aspects of Stereo Chemistry and identify stereo chemical notations |
| CO2 | Acquire knowledge on conformations and reactivity |
| CO3 | To understand various types of aliphatic and aromatic nucleophilc substitution reactions and mechanisms. |
| CO4 | To explain the mechanistic aspects in electrophilic substitution and Reaction conditions, products formation and mechanisms of some named reactions |
| CO5 | To study the synthesis of Terpenoids and Steroids and Conversion of cholesterol to progesterone, estrogen and testosterone and structural elucidation of cholesterol |

# SYLLABUS

**UNIT– I** **(18 Hrs)**

**Stereochemistry**

Introduction to optical activity and chirality, prochiral carbons. Configuration and conformational isomers. Absolute configuration-enatiomers- R, S nomenclature.

Steroisomerism due to molecular dissymmetry-allenes, biphenyls, spiro compounds, trans cyclooctene and cyclononene and molecules with helical structures enantiotopic, homotopic and diastereotopic hydrogens in compounds up to ten carbons only. Stereo specific and stereo selective reactions. Inter conversion of Sawhorse, Newman and Fischer projections. Molecules with more than one asymmetric center -definition of diasteroisomer-constitutionally symmetrical, unsymmetrical chiral compounds E.g.erythro and threo compounds.

Geometrical isomerism. E, Z nomenclature of olefins, geometrical and optical isomerism (if shown) of disubstituted cyclopropane, cyclobutane and cyclopentanes.

**UNIT– II** **(18 Hrs)**

**Conformational analysis:**

Conformation of some simple, 1, 2-disubstituted ethane derivatives. Conformational analysis of disubstituted cyclohexanes and their stereo chemical features [cis, trans and optical isomerism (if shown) by these derivatives]. Conformation and reactivity of substituted cyclohexanols (oxidation and acylation), cyclohexanones (reduction involving selectrides) and cyclohexane carboxylic acid derivatives (esterification and hydrolysis).Conformational analysis of cyclohexenes. Conformation and stereochemistry of cis and trans decalin and 9-methyl decalin.

**UNIT– III** **(18Hrs)**

**Nucleophilic Substitution reactions:**

Aliphatic Nucleophilic substitution-SN1, SN2 and SNi mechanism - Nucleophile and leaving groups Stero chemistry and Ion pairs. Neighbouring group participation – by Aryl group, O, N, S halogens, single, double and triple bonds. Reactivity, structural, solvent and steric effects. Substituent effect on carbocations – cyclopropyl and carbonyl cations. Substitution in norbornyl system and at bridgehead carbon. Substitutions by ambident nucleophiles such as CN, NO2, phenoxide and allkylation using dianion (EAA), acylation and alkylation of active

methylene compounds.Nucleophilic substitution at carbon which is doubly bonded to oxygen and nitrogen - alkylation and acylation of amines, halogen exchange, Von-Braun reaction. Claisen and Dieckmann condensations.

Aromatic nucleophilic substitution - methods of generation of benzyne intermediate and reactions of aryne intermediates. Nucleophilic substitution involving diazonium ions. Aromatic nucleophilic substitution of activated halides. Ziegler alkylation. Chichibabin reaction. Hammet equation. Derivation and free energy relationship, simple problems. Taft equation

**UNIT– IV** **(18 Hrs)**

**Electrophilic substitution reactions:**

Arenium ion mechanism. Orientation and reactivity (ortho, meta and para directing groups) of nitration, halogenation, alkylation, acylation and diazonium coupling. Formylation reactions - Gatterman, Gatterman-Koch, Vilsmeyer-Hack & Reimer-Tieman Reaction. Synthesis of di & tri substituted benzenes (symmetrical tribromobenzene, 2-amino-5-methylphenol, 3-nitro-4-bromobenzoicacid, 3, 4-dibromonitrobenzene, 1, 2, 3 - trimethylbenzene) starting from benzene or any mono substituted benzene

**UNIT– V** **(18Hrs)**

**Terpenoids and Steroids**

Flavones, isoflavones, anthocyanins ( Synthesis of parent and simple alkyl or aryl substituted derivatives are expected). Synthesis of carotenoids, licopenesand Vitamin A1 (Reformatsky and Wittig reaction methods only).

Structural elucidation of cholesterol (by chemical degradation). Conversion of cholesterol to progestrone, esterone and testosterone.

## TEXT BOOKS:


1. E. Eliel, S.H.Wilen and L.N.Mander, 1994, Stereochemistry of Carbon Compounds, 2nd Edition, John Wiley & Sons, New York
2. D.Nasipuri, 1994, Stereochemistry of Organic Compounds, 2nd Edition, Wiley Eastern Ltd, New Delhi
3. PS. Kalsi, 1993, Stereochemistry, Conformation Analysis and Mechanism, 2nd Edition, Wiley Eastern Limited, Chennai

4. P.S. Kalsi, 1994, Stereochemistry and Mechanism Through Solved Problems Wiley Eastern Ltd.
5. Niel Isaacs, 1987, Physical Organic Chemistry, ELBS Publications
6. R.Bruckner, 2002, Advanced Organic Chemistry, Reaction Mechanism, Elsevier, New Delhi

**BOOKS FOR REFERENCE:**

1. F.A. Carey and R.J. Sundberg, 2001, Advanced Organic Chemistry, Part A and Part-B, 4th Edition, Plenum Press, New York
2. J. March, 1992, Advanced Organic Chemistry, 4th Edition, John Wiley & Sons, Singapore.
3. T.L. Gilchrist and C.W. Rees, Carbenes, Nitrenes and Arynes, Thomas Nelson and Sons Ltd., London.
4. T.L. Gilchrist, 1992, Heterocyclic Chemistry, 2nd Edition, Longman, Essex, England
5. J.A.Joule and K.Mills, 2000, Heterocyclic Chemistry, 4th Edn, Backwell Science Publishers, England.
6. John Mc. Murray,Organic Chemistry, Cengage Learning, 8th edition,2011.

## E-LEARNING RESOURCES:

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Book%3A_Organic_Chemistry_with_a_Biological_Emphasis_v2.0_(Soderberg)/03%3A_Conformations_and_Stereochemistry
2. https://personal.utdallas.edu/~biewerm/8-conformational.pdf
3. https://www.organic-chemistry.org/namedreactions/nucleophilic-substitution-sn1-sn2.shtm
4. https://www.masterorganicchemistry.com/2017/11/09/electrophilic-aromatic-substitution-the-mechanism/
5. http://www.columbia.edu/itc/chemistry/c3045/client_edit/ppt/PDF/26_11_16.pdf

## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 2 | 3 |
| **CO 2** | 2 | 2 | 2 | 2 | 2 |
| **CO 3** | 2 | 2 | 2 | 2 | 2 |
| **CO 4** | 3 | 2 | 2 | 2 | 3 |
| **CO 5** | 2 | 2 | 3 | 2 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| **Average** | **2.4** | **2.2** | **2.2** | **2.0** | **2.4** |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):** Lecture, Power point presentation/Seminar, Exercises and discussions (group and individual), Rapid fire question session, brain storming.

## SEMESTER I

## CORE THEORY II

## INORGANIC CHEMISTRY-I

**TOTALHOURS: 90** **SUB CODE: 20PCHCT1002**
**CREDIT: 4** **L-T-P: 4 – 1- 1**

## COURSE OBJECTIVES

1. Identifying the structural orientation of the metallic compounds.
2. Underline the various aspects of theories in coordination complexes.
3. Describe the stability and reaction mechanism of various complexes.

**COURSE OUTCOMES:** On completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Correlate the structure and bonding nature of the complexes. |
| CO2 | Illustrate the crystal field stabilization and splitting patterns of complexes. |
| CO3 | Examine the reaction rate and the mechanism operates on the complex. |
| CO4 | Identify the spectral diagram of the complexes in different term states |
| CO5 | Differentiate the structural aspects of the different metal clusters |

# SYLLABUS

**Unit I: Bonding in Inorganic compounds (18Hrs)**

Poly acids: Isopolyacids and heteropolyacids of vanadium, chromium, molybdenum and tungsten.

Inorganic Polymers: Silicates, structure - properties - correlation and applications - molecular sieves, polysulphur - nitrogen compounds and poly - organophosphazenes.

**Unit II: Boron compounds and clusters (18Hrs)**

Boron hydrides: Polyhedral boranes, hydroborate ions, carboranes and metallo carboranes. Wade's rules, preparation and reactions of Boron hydrides.

Metal Clusters: Chemistry of low molecularity metal clusters upto trinuclear metal clusters; multiple metal-metal bonds.

**Unit III: Theories of coordination (18Hrs)**

Inadequacies of VB Theory- Crystal field theory- d-orbital splitting; octahedral, tetrahedral and square planar-LFSE, concept of weak and strong acids, Spectro chemical series-evidences for metal ligand orbital overlap,Nephlelauxetic effect,MO theory and energy level diagrams, Jahn-Teller distortion, charge transfer spectra

**Unit IV**

**Stability and stereo isomerism of coordination complexes (18Hrs)**

Stability of complexes: thermodynamic stability – stepwise and overall stability constants, their relationships, factors affecting the stability, HSAB approach , chelate effect, importance of chelates. Chelating agents; types of EDTA titrations; direct and back titrations; replacement titrations; masking and demasking reagents.

Macrocyclic ligands; types; schiff bases; crown ethers; cryptands; Stereochemical aspects; Stereoisomerism in inorganic complexes; isomerism arising out of ligand and ligand conformation; chirality and nomenclature of chiral complexes; optical rotatory dispersion and circular dichroism.

**Unit-V**

**Reaction mechanisms and substitution reactions in coordination compounds (18Hrs)**

Electron transfer reactions; outer and inner sphere processes; atoms transfer reaction, complementary and non-complementary reactions. Formation and rearrangement of precursor complexes, binding ligand, successor complexes, Marcus theory.

Substitution Reactions : Substitution in square planar complexes, reactivity of platinum complexes, influence of entering, leaving and other groups, trans-effect, substitution of octahedral complexes of cobalt and chromium, replacement of coordinated water, solvolytic (acids and bases) reactions applications in synthesis (platinum and cobalt complexes only).Rearrangement in 4 and 6 coordinate complexes: reaction at coordinated ligands-template effect.

**Text Books:**


1. J.E.Huheey, E.A. Keiter and R.L.Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Edition, Pearson Education India, 2006.
2. J.D.Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, 2008.
3. G.L.Miessler and D.A.Tarr, *Inorganic Chemistry,* 3rd Edition, Pearson Prentice Hall, 2005.
4. F.A.Cotton, Geoffrey Wilkinson, C.A. Murillo and Manfred Bochmann, *Advanced Inorganic Chemistry,* 6th Edition, Wiley, 2007.
5. R.Gopalan and V.Ramalingam, *Concise Coordination Chemistry,* Vikas Publication House Pvt Ltd, 2000.


**Reference Books:**


1. Puri, Sharma and Kalia, *Principles of Inorganic Chemistry,* 33rd Edition, Milestone Publishers, 2017.
2. Ajai Kumar, *Coordination Chemistry,* 4th Edition, Aaryush Education, 2016.
3. Weller, Overton, Rourke and Armstrong, 6th Edition, Oxford University Press India, 2015.
4. Catherine E. HouseCroft and G. Sharpe, *Inorganic Chemistry*, 5th Edition, Pearson Publication, 2005.
5. Ajai Kumar, *Coordination Chemistry,* 4th Edition, Aaryush Education, 2018.

**Web Resources:**

1. https://www.nrcresearchpress.com/doi/pdfplus/10.1139/v92-089
2. http://webcache.googleusercontent.com/search?q=cache:http://chem.yonsei.ac.kr/chem/upload/CHE3103-01/119265830654522.pdf
3. https://opentextbc.ca/chemistry/chapter/19-3-spectroscopic-and-magnetic-properties-of-coordination-compounds/
4. https://nptel.ac.in/courses/104105033/
5. https://www.adichemistry.com/inorganic/cochem/reactionmechanism/transeffect/trans-effect-1.html

## Mappingof CO with PSO:

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 1 | 1 | 3 |
| **CO 2** | 2 | 1 | 3 | 2 | 2 |
| **CO 3** | 1 | 2 | 2 | 2 | 2 |
| **CO 4** | 2 | 2 | 1 | 2 | 3 |
| **CO 5** | 3 | 2 | 2 | 3 | 1 |
| | 2.2 | 1.8 | 1.8 | 2.0 | 2.2 |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):** Lecture, Power point presentation/Seminar, Exercises and discussions (group and individual), Rapid fire question session, brain storming

## SEMESTER I

## CORE THEORY III

## PHYSICAL CHEMISTRY-I

**TOTALHOURS: 90** **SUB CODE: 20PCHCT1003**
**CREDIT: 4** **L-T-P: 4 – 1- 1**

## COURSE OBJECTIVES

To make the students to be conversant with

1. Examine the behavior of ideal and real gases in solutions.
2. Understanding the molecular symmetry operations of different molecules.
3. Describe the reaction rates in the solution as well as in the catalytic surface

**COURSE OUTCOMES:** on completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Get an overview about the thermodynamic properties in different chemical properties |
| CO2 | Measure the factor that influence the changes in rate of the reaction |
| CO3 | Analyze the activity of catalyst on the reaction sites |
| CO4 | Recognize the symmetry operation, point group and its construction of tables |
| CO5 | Interpret the hybridization of different molecules using character table. |

# SYLLABUS

**Unit I**

**Thermodynamics – I** **(18Hrs)**

Partial molar properties - Partial molar free energy (Chemical potential) - Partial molar volume and partial molar heat content - their significance and determination of these quantities. Variation of chemical potential with temperature and pressure.

Thermodynamics of real gases - gas mixture - fugacity definition - determination of fugacity variation of fugacity with temperature and pressure -thermodynamics of ideal and non-ideal binary solutions-dilute solutions-excess functions for non-ideal solutions and their determination-the concepts of activity and activity coefficients-determination of standard free energies.

**Unit II**

**Chemical Kinetics – I** **(18Hrs)**

Effect of temperature on reaction rates - collision theory - molecular beams - collision cross sections - effectiveness of collisions - probability factors - potential energy surfaces – transition state theory - partition functions and activated complex. Eyring equation - estimation of free energy, enthalpy and entropy of activation and their significance.

**Unit III**

**Chemical Kinetics – II** **(18Hrs)**

Reactions in solutions - effect of pressure, dielectric constant, ionic strength and salt effect - kinetic isotopic effects - linear free energy relationships-Hammett and Taft equations - Homogeneous catalysis - Acid base catalysis - mechanisms and Bronsted catalysis law.

**Unit IV**

**Group theory – I** **(18Hrs)**

Symmetry elements and operations. Concepts of groups, Sub groups, class, order, Abelian and Non-Abelian point groups. Products of symmetry operations and group multiplication table, point groups-identification and determination-reducible and irreducible representations-Direct product representation-orthogonality theorem and its consequences-character table – construction ($NH_3$, $H_2O$).

**Unit V**

**Group theory – II** **(18Hrs)**

Hybrid orbital in non-linear molecules ($CH_4$, $XeF_4$, $BF_3$, $SF_6$ and $NH_3$). Determination of representations of vibrational modes in non-linear molecules ($H_2O$, $CH_4$, $XeF_4$, $BF_3$, $SF_6$ and $NH_3$)

Symmetry selection rules for infrared, Raman and electronic Spectra - mutual exclusion principle. Electronic Spectra of Ethylene and formaldehyde-Applications of group theory.

**Text Books:**


1. K.L.Kapoor, A Textbook of Physical Chemistry, 6th Edition, McGraw Hill Education, 2016.
2. Samuel Glasstone, Thermodynamics for Chemists, 3rd Edition, EWP, 2008.
3. Keith J.Laidler, Chemical Kinetics, 3rd Edition, Pearson Education India, 2003.
4. K.Veera Reddy, Symmetry and Spectroscopy of Molecules, 2nd Edition, New Age International Publishers, 2009.
5. F. Albert Cotton, Chemical Applications of Group Theory, 3rd Edition, Wiley, 2008.


**Reference Books:**


1. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edition, Pearson Education India, 2013.
2. Swarnalakshmi, Saroja and Ezhilarasi, A Simple Approach to Group Theory in Chemistry, 1st Edition, Universities Press, 2008.

3. Gurudeep Raj, Advanced Physical Chemistry, 14th Edition, GOEL Publishing House, 2016.
4. Peter Atkins, Julio de Paula and James Keeler, Physical Chemistry, 11th Edition,Oxford University Press,2018.
5. C Kalidas, Chemical Kinetic Methods: Principles of Fast Reaction Techniques and Applications, 3rd Edition, New Age International Publishers, 2018.

**Web Resources:**

1. https://pdfs.semanticscholar.org/
2. https://www.chemguide.co.uk/physical/basicrates/introduction.html
3. http://nobel.scas.bcit.ca/wiki/index.php/Collision_theory
4. http://people.uleth.ca/~roussel/C4000foundations/slides/08collision.pdf
5. http://www.bhojvirtualuniversity.com/slm/mscche1p4.pdf
6. http://w0.rz-berlin.mpg.de/imprs-cs/download/symmetry2011_1_K_Horn.pdf

## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 1 | 3 | 3 |
| **CO3** | 2 | 3 | 2 | 3 | 3 |
| **CO4** | 2 | 3 | 2 | 3 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 3 |
| **Average** | **2.2** | **2.4** | **2.0** | **2.6** | **2.6** |

**KEY: PEDAGOGY:** Lecture, objective test, Powerpoint Presentation, Group quiz, seminar, models.

## SEMESTER I

## CORE ELECTIVE PAPER I

## POLYMER CHEMISTRY

**TOTAL HOURS: 75 Hrs** **SUB CODE: 20PCHET1001**

**CREDITS: 3** **L-T-P: 4-1-0**

## COURSE OBJECTIVES

1. To introduce and explains basic concepts of polymerisation.
2. To know about various types of polymers and their properties.
3. Application of the polymer in the present context and its biodegradation is included.

**COURSE OUTCOMES:** on completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Classify synthetic and biological polymers and explain differences between addition and stepwise polymerization account for reaction mechanisms. |
| CO2 | Explain the types of polymerization techniques and different properties of polymers (Molecular weight and size, Glass Transition Temperature and Crystallinity in polymers).. |
| CO3 | Explain the polymer production processes and elucidate the synthesis and applications of various synthetic resins and plastics. |
| CO4 | Elucidate the synthesis and applications of various synthetic fibers and rubbers. |
| CO5 | Describe the role of additives in improving the mechanical properties of polymers and explain the polymer degradation. |

# SYLLABUS

**Unit I: Methods of polymerization: (15Hrs)**

Basic concepts of polymer chemistry: Repeating unit, degree of polymerisation, classification, stereochemistry of polymers and nomenclature of stereoregular polymers.

Chain, free radical, ionic and ring opening polymerizations. Ziegler – Natta catalyst involment in step polymerisation ring opening polymerisation.

Copolymerisation: Block and graft copolymers – preparation.

**Unit II: Properties of polymers:- (15Hrs)**

Polymerisation techniques: Bulk, solution, suspension and emulsion polymerisation. Melt, solution and interfacial polycondensation. Solid and gas phase polymerisation.

Molecular weight and size: Number and weight average molecular weights. Polydispersity and molecular weight distribution in polymers, the practical significance of polymer molecular weights and size of polymers. (Molecular weight determination is not required)

Glass transition temperature: Concept, associated properties and determination. Glassy solids and glass transition. Factors influencing it.

Crystallinity in polymers: Polymer crystallisation, structural and others factors affecting crystallisability and effect of crystallinity on the properties of polymers.

**Unit III: Resins and plastics: (15Hrs)**

Processing: Calendering, die casting, rotational casting. Compression, injection, blow and extrusion moulding. Thermoforming, foaming and reinforcing techniques.

Synthetic resins and plastics: Manufacturing and applications of polyethylene, PVC, teflon, polystyrene, polymethylmethacrylate, polyurethane, phenol – formaldehyde resins, urea – formaldehyde and melamine – formaldehyde resins and epoxy polymers.

**Unit IV: Synthetic fibers and rubbers:- (15Hrs)**

Synthetic fibers: Rayon, nylons, polyesters, acrylics, modacrylics and spinning techniques.

Synthetic rubber: SBR, butyl rubber, nitrile rubber, neoprene, silicone rubber and polysulphides.

Conducting polymers and applications.

**Unit V: Degradation of polymers:- (15Hrs)**

Polymer degradation: Types - thermal, mechanical, photo, hydrolytic and oxidative degradations.

Additives for polymers: Fillers, plasticisers, thermal stabilizers, photo stabilizers, antioxidants and colourants.

Biodegradable polymers and their applications.

**Text Books**


1. V. R. Gowarikar, N.V. Viswanathan and JayadevSreedhar "Polymer Science" New Age international (P) ltd., Publishers New Delhi, 2005.
2. Fred W. Billmeyer, JR "Text book of polymer science" A wiley – interscience publication John wiley& sons, New Yark, 1994.
3. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
4. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).
5. Ayodhya sing "polymer Chemistry" campus Books, New Delhi, 2003


**Reference Books**


1. Anushu Srivastava and Shakun Srivastava, Fundamental of Polymer Science and Technology, 12th Edition, S.K.Kataria & Sons,2012.
2. Joel R.Fried, Polymer Science & Technology, 2nd Edition, Prentice Hall, 2003.

3. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
4. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
5. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987

**Web Resources**

- https://www.element.com/nucleus/2017/08/15/18/45/considerations-for-measuring-glass-transition-temperature
- https://omnexus.specialchem.com/selection-guide/epoxy-resins-a-to-z-technical-review-of- thermosetting-polymer
- https://www.britannica.com/science/synthetic-resin
- https://www.slideshare.net/vshastiraja/polymer-processing
- https://polymerdatabase.com/polymer%20chemistry/Thermal%20Degradation.html

**Pedagogy:**

- Lecture, Group Discussion, Seminar, Power point presentation, Context based learning.

## Mapping of CO with PSO:

| CO/ PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | 3 | 3 | 2 |
| **CO 2** | 2 | 3 | 2 | 1 | 2 |
| **CO 3** | 2 | 3 | 3 | 3 | 2 |
| **CO 4** | 1 | 2 | 3 | 3 | 2 |
| **CO 5** | 2 | 2 | 3 | 3 | 2 |
| **AVERAGE** | 1.8 | 2.2 | 2.8 | 2.2 | 2.0 |

## SEMESTER I

## ORGANIC CHEMISTRY PRACTICAL- I

**TOTAL HOURS:** **SUBCODE: 20PCHCP2001**

**CREDIT: 4** **L-T-P: 1 – 1- 4**

## COURSE OBJECTIVE

**CO 1:** To separate and analyze organic mixtures by micro methods

**CO 2:** To synthesis and purify an organic compound.

**CO 3:** To estimate the organic compound in titration methods.

### COURSE OUTCOMES

On successful completion of the course the student will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | Plan and perform an organic synthesis and produce the maximum yield of an organic compound |
| CO2 | Understand the nature of solvents used in the organic synthesis. |
| CO3 | Choose the right solvent for the separation of a binary mixture of organic compounds |
| CO4 | Analyze and identify the functional groups in the given components. |
| CO5 | Develop their ability to handle the organic compounds in the protective manner |

# SYLLABUS

## I. Analysis of the organic mixture

1. Solvent separation of the binary mixture by Pilot & Bulk Analysis
2. Systematic semi micro spot analysis and functional group identification
3. Derivatization of organic compounds

## II. Preparation of the following (Any five)

1. Sym-Tribromobenzene from aniline.
2. p-nitro aniline from acetanilide
3. m-Nitrobenzoic acid from methyl benzoate.
4. Methyl orange from sulphanilic acid.
5. m-Nitro benzoic acid from benzaldehyde
6. p-bromoaniline from acetanilide
7. p-Nitrobenzoic acid from p-Nitrotoluene
8. m-Nitroaniline from m-dinitrobenzene
9. Anthroquinone from anthracene

## III. Quantitative estimation of organic compounds

1. Estimation of aniline
2. Estimation of phenol
3. Estimation of glucose (Bertrands Methods)

**Reference Books:**


1. Arthur I. Vogel, A Text Book of Practical Organic Chemistry.
2. Raj K. Bansal, Laboratory Manual of Organic Chemistry, Wiley Eastern Limited.
3. Mann and Saunders, Laboratory manual of Organic Chemistry.
4. Syed Mumtazuddin, Organic Chemistry – A Laboratory Manual, Narosa Publishing House,New Delhi, 2014.

**Text Books:**

1. Syed Mumtazuddin, Advanced Practical Chemistry, Syed Mumtazuddin,Pragati Prakashan, Meerut, 2014

2. V K Ahluwalia & Sunita Dhingra, Advanced Experimental Organic Chemistry, Manakin Press, New Delhi, 2017.

3. Sonia Ratnani Experimental Organic Chemistry, PHI Learning Private Ltd., New Delhi, 2012

## Mapping of CO with PSO:

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 2 | 2 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 3 | 3 | 2 |
| **Average** | **2.6** | **2.6** | **2.8** | **3** | **2.8** |

**Key: PEDAGOGY (Teaching methodology to be adopted for the classroom instructional hours)**

Lecture, Power point presentation, Exercises and discussions (group and individual), Rapid fire question session.

**COURSE FRAME WORK**

**SEMESTER-II**

| SEM | COURSE CODE | COURSE TITLE | TITLE OF THE PAPER | HRS | CR | CA | SE | T |
|---|---|---|---|---|---|---|---|---|
| **II** | 20PCHCT2004 | Core Theory-IV | Organic Chemistry-II | **6** | **4** | **40** | **60** | **100** |
| **II** | 20PCHCT2005 | Core Theory-V | Inorganic Chemistry -II | **6** | **4** | **40** | **60** | **100** |
| **II** | 20PCHCT2006 | Core Theory-VI | Physical Chemistry-II | **6** | **4** | **40** | **60** | **100** |
| **II** | 20PCHET2002 | Core Elective-II | Nano Chemistry | **5** | **3** | **40** | **60** | **100** |
| **II** | 20PCHCP2002 | Core Practical -II | *Inorganic Chemistry Practical-I | **6** | **4** | **40** | **60** | **100** |
| **II** | 18MOOC2002 | | SWAYAM (MOOC) / NPTEL COURSE | **2** | **4** | **50** | **-** | **50** |
| | | | **Total** | **31** | **23** | | | |

## SEMESTER II

## CORE THEORY IV

## ORGANIC CHEMISTRY - II

**TOTAL HOURS: 90 Hrs** **SUB CODE: 20PCHCT2004**

**CREDIT: 4** **L-T-P: 4-1-1**

**COURSE OBJECTIVE:**

1. This paper explains the basic concepts of addition reaction of carbon carbon double bond and elimination reactions.
2. In addition mechanism of some of the important rearrangements in organic chemistry will be discussed.
3. The salient features of oxidation and reduction reactions in organic synthesis are discussed at the end.

**COURSE OUTCOMES:** On completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Explain the mechanism of substitution reactions and to understand chemistry of Ylides, carbenes and carbenoids and related naming organic reactions. |
| CO2 | Learn about mechanism of E1, E2 and E1CB reactions and generation and addition of free radicals and related naming reactions |
| CO3 | Know the concepts of aomaticity of benzenoid and non-benzenoid compound and annulunes and explain the various reactions take in photo chemistry of ketones. |
| CO4 | Explain brief mechanism of various molecular rearrangements. |
| CO5 | Understand the mechanism of oxidations reactions and hydroxylations reactions and some important reduction reactions. |

## SYLLABUS

**Unit I: Addition to carbon-carbon and carbon-hetero multiple bonds (15hrs)**

Nucleophilic addition to carbonyls and Stereo Chemical aspects through various model - Crams rule- Prevost rule on addition reaction. Mechanism of electrophilic, nucleophilic and neighbouring group participation in addition reactions. Addition of halogen and nitrosyl chloride to olefins, hydration of olefins and acetylenes, hydroboration, Lithium and boron enolates in aldol, Michael reactions. Alkylation and Acylation using Lithium enolates, hydrogenation of ethylene and acetylene- partial reductions- Homogeneous hydrogenation- Wilkinson's catalyst. Ylides: Chemistry of phosphorous and sulfur ylides – Wittig and related reaction, Peterson Olification. Diels Alder reaction, 1, 3-dipolar additions, carbenes and carbenoids - addition to double bonds - Simmon Smith reaction, Mannich, Knoevengal, Stobbe condensation, Shapiro reaction, Julia olefination, Acyloin condensations, Darzen, and benzoin reactions.

**Unit II: Elimination and Free radical reactions:- (15 Hrs)**

E1, E2 and E1cB mechanism - Orientation of the double bond. Regio selectivity and stereoselectivity of elimination reactions in cyclic systems, pyrolytic eliminations. Chugaev, Hofmann and Cope Elimination.

Long and short lived free radicals - methods of generation. Adddition of free radicals to olefinic double bonds. Sandmayer - Gombereg-Gauchmann, Pschorr, Ulmann and Hunsdicker reactions.

**Unit III: Organic Photochemistry and Aromaticity:- (15 Hrs)**

Aromaticity of benzenoid, non-benzenoid and heterocyclic compounds, Huckel's rule- Aromatic systems with pielectrons - numbers other than six non-aromatic (cyclooctatetraene etc)

and anti-aromatic systems (cyclobutadiene etc)- with more than 10 pi electrons – Annulenes up to $C_{18}$ (synthesis not expected).

Photo chemistry of ketones, photo oxygenation, photo reduction, photocycloaddition, Paterno - Buchi reaction, Di –pi- methane rearrangement. cis- trans isomerisation, Barton reaction, photo- Fries reaction, photochemistry of cyclohexadienones ,synthesis of Vitamin- D.

**Unit IV: Molecular rearrangements:- (15 Hrs)**

A detailed study of the mechanism of the following rearrangements with suitable examples Pinacol-Pinacolone (examples other than tetramethyl ethylene glycol) - Wagner-Meerwein, Demjanov, dienone-phenol, Favorski, Baeyer-Villiger, Cope, Claisen, Stevens, Sommelet-Hauser (in cyclic systems also) and Von Richter rearrangements.

**Unit V: Oxidation and reduction reactions:- (15 Hrs)**

Oxidation: Mechanism - study of the following oxidation reactions - oxidation with LTA, $SeO_2$, DDQ, Oxalyl chloride, Dess-martin reagent DMSO in combination with DCC or acetic anhydride in oxidizing alcohols – Hydroxylations with – $OsO_4$, $KMnO_4$, Woodward prevost, epoxidation (per oxides/per acids). Sharpless asymmetry epoxidation,asymmetry dihydroxylations,AD mix,Reduction and Selectrides and Alanes.

Reductions: Synthetic importance of Clemensen and Wolf-Kishner reductions and its Modifications, Birch reduction, MPV reduction.

**Text Books:-**


1. R.Bruckner, 2002, Advanced Organic Chemistry, Reaction Mechanism, Elsevier, New Delhi
2. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th Edition, Pearson Education, 2003.

3. W. Carruthers, Some Modern Methods of Organic Synthesis, 4th Edition, Cambridge University Press, 2015.
4. Reaction Mechanisms in Organic Chemistry, 2016, Subrata Sen Gupta
5. Francis A.Carey and Richard J.Sundberg, Advanced Organic Chemistry Part A: Structure and Mechanism, 5th Edition, Springer,2007.

**Reference books:**

1. March's Advanced organic chemistry:Reactions, Mechanisms and Structure by Jerry March, 7th edition, 2015.
2. Organic chemistry, 7th edition, Morrison Boyd & Bhattacharjee,2010.
3. S.N.Sanyal , reactions, Rearrangements and reagents,4th Edition, Bharathi Bhawan Publishers & Distributors, 2019.

**Websites:-**

1. http :// info dome . sdsu, ./research/ guides/ science/ org chemistryblr. html
2. http :// www.liv.ac.uk/chemistry/links /reactions.html
3. http ://orgchem.chem..uconn.edu/namereact/named.html
4. www.gcocities.com/ chempen softwar4ee/reactions.html

**Pedagogy:**
Lecture, Multiple Choice Questions, Seminar, Powerpoint Presentation.

**Mapping of CO with PSO:**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| CO 1 | 3 | 3 | 2 | 3 | 3 |
| CO 2 | 3 | 2 | 2 | 2 | 1 |
| CO 3 | 2 | 2 | 3 | 2 | 2 |
| CO 4 | 3 | 1 | 3 | 1 | 2 |
| CO 5 | 2 | 2 | 2 | 2 | 1 |
| Average | 2.6 | 2.0 | 2.4 | 2.0 | 1.8 |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):**

Lecture, Power point presentation, Permanent slides, Exercises (group and individual).

## SEMESTER II

## CORE THEORY V
## INORGANIC CHEMISTRY-II

**TOTAL HOURS: 90** **SUB CODE: 20PCHCT2005**

**CREDIT: 4** **L-T-P: 4 – 1 - 1**

**COURSE OBJECTIVES**

1. Principles concerning solid-state structures, structure and bonding in solids and various synthesis methods and properties of solids.

2. Alkyls and arene complexes, organometallic reaction, Wilkinson's catalysis, hydroformylation of olefins using cobalt or rhodium catalysts.

3. Nuclear isomerism, internal conversion, detection and determination of activity by cloud chamber, determination of radio activity, application of tracers and Inorganic Photochemistry.

| CO No. | CO Statement |
|---|---|
| CO1 | Predict the structure, bonding and discuss the reaction of solids with emphasis on some of the most important classes of inorganic materials and also describe the importance and properties of defects in solids. Also analyze the physical-chemical, electrical and magnetic properties of solids. |
| CO2 | Explain the synthetic route, structure and bonding involved in organometallic compounds |
| CO3 | Understand the reactivity of organometallic compounds including their industrial application in synthesis. |
| CO4 | Explain what happens when inorganic compounds are excited by irradiation |
| CO5 | Describe about the importance of nuclear chemistry and its applications. |

# SYLLABUS

**Unit I** : **Solid State Chemistry** **(18Hrs)**

Preparation Methods: Ceramic method – Sol-gel method – Hydrothermal synthesis – chemical vapour deposition: Structure of Solids: Structure of ZnS, Rutile, Pervoskite, Cadmium iodide and nickel arsenide; spinels and inverse spinels; defects in solids, non-stoichometric compounds - High Temperature Superconductors

Band theory, Semiconductors, Superconductors, Solid State Electrolytes, Types of Magnetic Behaviour - Dia, Para, Ferro, Antiferro and Ferrimagnetism, Hysterisis, Solid State Lasers, Inorganic Phosphorus, Ferrites, Garnets.

Reactions in solid state and phase transitions, diffusion, diffusion coefficient, diffusion mechanisms, vacancy and interstitial diffusion, formation of spinels.

Solid solutions: Order-disorder transformations and super structure.

**Unit II : Organometallic Chemistry** **(18Hrs)**

Carbon donors: Alkyls and aryls, metalation, bonding in carbonyls and nitrosyls, chain and cyclic donors, olefin, acetylene, and allyl systems. Metallocenes: synthesis, structure and bonding.

Reactions: Association, substitution, addition, elimination, ligand protonation, electrophilic and nucleophilic attack on ligands, carbonylation, decarboxylation and oxidative addition.

**Unit III: Industrial applications of Organo Metallic compounds** **(18Hrs)**

Catalysis – Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or rhodium catalyst(Oxo process), oxidation of olefins to aldehydes and ketones(Wacker process):polymerisation(Ziegler-Natta catalyst); Cyclo oligomerisation of acetylene using nickel catalyst(Reppe's catalyst), polymer bound catalysts. Ziegler-Natta catalysis (metallocene and Nom-Metallocene type catalyst).

**Unit IV: Inorganic Photochemistry** **(18Hrs)**

Principles of Inorganic Photochemistry – Photoredox reactions and photosubstitution reactions in coordination complexes with particular reference to Co(III), Cr(III) and Pt(II) complexes. Photosensitisation reactions of [Ru(bpy)3]2+ complex and its applications in solar energy conversions and DSSC's (Dye Sensitized Solar Cells)

**Unit V: Nuclear Chemistry** **(18Hrs)**

Nuclear properties-nuclear spin and moments, origin of nuclear forces. Types of radioactive decay: Orbital electron capture, nuclear isomerism, internal conversion, detection and determination of activity by cloud chamber, nuclear emulsion, bubble chamber, G.M., Scintillation and Cherenkov counters; Accelerators- Linear and Cyclotron

Nuclear reaction: Types, reaction cross section, Q-value, threshold energy, compound nucleus theory: high nuclear reactions, nuclear fission and fusion reactions as energy sources; photonuclear and thermo nuclear reactions.

Radioactive tracers: Preparations - principles of tracer technique - application of tracers in the study of reaction mechanism and in analytical chemistry - neutron activation analysis, isotope dilution analysis - radio chemical determination of age of geological specimen. Tracers as applied to industry and agriculture - radioactive tracer in the diagnosis and treatment in the field of medicine.

**Text Books:**


1. A.R. West, Solid State Chemistry and its Applications, John Wiley and Sons (2003)
2. F.A.Cotton, G.Wilkinson and P.Gaus – Basic Inorganic Chemistry, 3rd Edn. John Wiley and Sons (2003)
3. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, 5th Edn. Pearson Education (2005)
4. B.Sivasankar, Inorganic Chemistry, Pearson Education India (2013)
5. Fundamentals of Photochemistry – Rohatgi and Mukherje (New Age Bangalore) 2000.
6. W. Loveland, D. Morrissey, G. Seaborg. Modern Nuclear Chemistry, WileyInterscience, Hoboken, NJ, 2006.

7. R.H. Crabtree, The Organometallic Chemistry of Transition Metals, 4th Edn Wiley-VCH.
8. G.O. Spessard and G. L. Miessler, Organometallic Chemistry, 2nd Edn, Oxford University Press.
9. F. A. Cotton, Wilkinson, G. and P. L. Gaus, Basic Inorganic Chemistry, 3rdEdn., John Wiley & Sons, New York, l995.
10. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn., New Age International Publishers Ltd., New Delhi, 1995.

**Reference Books:**

1. D.F.Shriver and P.W.Atkins – Inorganic chemistry 3rd Edn. Oxford University Press (2004)
2. G. Choppin, J. O Liljenzin and J. Rydberg. Radiochemistry and Nuclear Chemistry. 3 rd ed. Butterworth-Heinemann, Oxford, 2002.
3. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Chapman and Hall, London, 1996.
4. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry - Principles of Structure and Reactivity, 4thEdn., Harper Collins, New York, l993.
5. J. P. Collman, Principles and Applications of Organotransition Metal Chemistry, Standford University. 8. S. E. Kegley and A. R. Pinhas, Problems and Solutions in Organometallic Chemistry, University Science Books.
6. C. Elschenbroich, Organometallics, 3rd Edn, Wiely VCH. 9. J. F. Hartwig, Organotransition Metal Chemistry: From Bonding to Catalysis, 1st Ed, University Science Books, 2010.

**Web resources:**

- https://www.sciencedirect.com/topics/chemistry/solid-state-chemistry
- https://www.nature.com/subjects/organometallic-chemistry
- https://onlinelibrary.wiley.com/doi/10.1002/0471718769.ch12
- https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch23/history.php
- https://www.nature.com/subjects/organometallic-chemistry
- https://nptel.ac.in/courses/104108062/
- https://nptel.ac.in/content/syllabus_pdf/104104109.pdf
- https://www.visionlearning.com/en/library/Chemistry/1/Nuclear-Chemistry/59

## Mapping of CO with PSO:

| CO/ PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| CO 1 | 3 | 2 | 3 | 2 | 3 |
| CO 2 | 3 | 2 | 3 | 2 | 2 |
| CO 3 | 3 | 2 | 2 | 2 | 2 |
| CO 4 | 3 | 2 | 2 | 2 | 2 |
| CO 5 | 2 | 2 | 2 | 2 | 3 |
| Average | 2.8 | 2.0 | 2.4 | 2.0 | 2.4 |

## Key: PEDAGOGY:

Lecture, Group Discussion, Seminar, Power point presentation, Context based learning.

## SEMESTER II

## CORE THEORY VI

## PHYSICAL CHEMISTRY-II

**TOTAL HOURS: 90** **SUB CODE: 20PCHCT2006**
**CREDIT: 4** **L-T-P: 4-1-1**

### Course Objectives:

1. Attain the knowledge of statistical thermodynamics
2. Known about concepts and applications of surface reaction kinetics.
3. Understand about basics of classical and quantum mechanics.

### Course Outcome:

On successful completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | Apply statistics to understand the thermodynamic properties of macroscopic systems. |
| CO2 | Understand the interrelationship between the properties of equilibrium and non-equilibrium process in thermodynamics. |
| CO3 | Implement the concept of kinetics in the homogeneous and heterogeneous catalysis. |
| CO4 | Get the overview of the fundamentals mathematical formalism of quantum Chemistry. |
| CO5 | Apply the concept of determine the wave function of different atoms. |

# SYLLABUS

**Unit I: Thermodynamics - II** **(18hrs)**

Concept of thermodynamic probability - distribution of distinguishable and non-distinguishable particles .Maxwell-Boltzmann, Fermi-Dirac and Bose Einstein statistics - modes of contribution to energy- Partition function - translational, vibrational and rotational partition functions for mono, diatomic and polyatomic ideal gases.

Thermodynamic functions in terms of partition functions, Sackur-Tetrode equation equilibrium constant for isotope exchange and dissociation of diatomic molecules;

**Unit II: Thermodynamics - III** **(18hrs)**

Heat capacity of solids (Einstein and Debye Models) ortho and para hydrogen -Planck's radiation law - electrons in metals.

Non equilibrium processes,entropy production in irreversible processes,microscopic reversibility,linear force and flux relations,Onsager's law,phenomenological equations, Curie's theorem

**Unit III: Chemical Kinetics – III** **(18hrs)**

Catalysis by Enzymes-rate of enzyme catalyzed reactions, Michaelis-Menten equation effect of substrate concentration, pH and temperature -inhibitions of enzyme catalyzed reactions – three types with mechanism.Heterogeneous catalysis, Langmuir and BET adsorption isotherms- Kinetics of Heterogeneous catalysis, Unimolecular and Bimolecular reaction. Kinetics and mechanism of surface reactions-catalysis by metals, Hydrogenations and semiconductor oxides.Kinetics of complex reactions – reversible, consecutive and parallel reactions. Chain reactions: general treatment. Rice Herzfeld Mechanism - Decomposition of acetaldehyde and hydrobrominations. Comparison of HCl and HBr formation and explosion limits.

Study of fast reactions-relaxation methods-temperature and pressure jump -stopped flow and flash photolysis methods.

**Unit IV: Quantum Chemistry - I** **(18hrs)**

Inadequacy of classical theory - black body radiation, photo electric effect - the Compton effect - Bohr's Quantum theory and subsequent developments -wave particle duality- de Broglie equation, Heisenberg uncertainty principle.

**Unit V: Quantum Chemistry – II** **( 18hrs)**

Quantum mechanical postulates-Eigen value and function - the Schrodinger wave equation-elementary applications of Schrodinger's equation-the particle in a box(one, two and three dimensional cases) - particle in a ring.

**Text Books**


1. Peter Atkins, Julio de Paula and James Keeler, Physical Chemistry: Thermodynamics and Kinetics, Oxford Publication (2018).
2. K.J.Laidler, Chemical Kinetics, Harper and Row, New York (2003).
3. D.A. McQuarrie, Quantum Chemistry (Revised Edition), Viva Student Edition (2011).
4. I.N. Levine, Quantum Chemistry, 7th Edition, Pearson Education India (2016).
5. R.K. Prasad, Quantum Chemistry, New Age International Publishers (2002).


**Reference Books**


1. R.G.Frost and Pearson, Kinetics and Mechanism, Wiley, New York.
2. W.J.Moore and R.G.Pearson Kinetics and Mechanism.
3. J.Goodman, Contemporary Quantum Chemistry, An Introduction, Plenum Press, New York.
4. Michael Le Bellac, Equilibrium and Non-Equilibrium Statistical Thermodynamics, Cambridge University Bridge
5. P.W.Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford.


**Web Resources**

1. https://www.mobt3ath.com/uplode/book/book-36973.pdf
2. https://nptel.ac.in/courses/104103112/
3. http://www.colby.edu/PChem/notes/CheainMech.pdf
4. https://www.southampton.ac.uk/assets/centresresearch/documents/compchem/pertubation_theory.pdf
5. http://vergil.chemistry.gatech.edu/notes

## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 1 | 2 | 2 | 3 |
| **CO3** | 2 | 3 | 2 | 2 | 3 |
| **CO4** | 2 | 2 | 1 | 2 | 1 |
| **CO5** | 2 | 2 | 3 | 2 | 3 |
| **Average** | **2.2** | **2.2** | **2.0** | **2.0** | **2.6** |

## KEY: PEDAGOGY:

Lecture, Power point presentation, Exercises (group and individual)

## SEMESTER II

## CORE ELECTIVE II

## NANO CHEMISTRY

**TOTAL HOURS: 75** **SUB CODE: 20PCHET2002**

**CREDIT: 3** **L-T-P: 4-1-0**

## COURSE OBJECTIVES:

1. Covers the whole spectrum of nanomaterials ranging from overview, synthesis, properties, and characterization of nanophase materials to application including some new developments in various aspects.

2. Provides an introduction to the theory on Nanomaterials and various techniques used for the fabrication and characterization of nanostructures and their application and the impact of nanomaterials on environment.

3. Apply their learned knowledge to develop Nanomaterials.

## COURSE OUTCOMES: on completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | Elucidate the Scientific revolutions of nanotechnology and also to learn about the properties of nanomaterials. |
| CO2 | Describe about the synthesis of nanomaterials and also to familiarize the classification of nanostructures, size dependency in nanostrucutures and quantum size effects in nanostructures. |
| CO3 | Explain about the various techniques used for the characterization of nanomaterials and their application and the impact of nanomaterials on environment |
| CO4 | Explain about the theories and techniques used for characterization of nanomaterials |
| CO5 | Outline the applications of metal nanoparticles in technologically imperative fields. |

# SYLLABUS

**UNIT - I** **(15 Hrs)**

**Fundamentals and overview of nanoscience**

Nano revolution -Basic idea of nano materials-Structure-Nucleation and grain growth-Grain boundaries-Properties at Nano scale: Strength and Hardness, optical, electrical, magnetic, mechanical and chemical properties.

**UNIT – II** **(15 Hrs)**

**Synthesis of nanomaterials**

Top down approach – Nanolithography, Chemical Vapour Deposition (CVD). Bottom up approach - sol-gel processing, chemical synthesis. self-assembly- Supramolecular approach. Reverse micelles and role of surfactants- capping of nanoparticles. Synthesis, purification, properties and uses of CNT, metal Nanoparticles. Nano tubes, Nano rods, Bucky balls-fullerenes, Nanofibers, Nanoshells. Semiconductor Nanoparticles- Energy band structure of Semiconductors Quantum dots-Quantization effect.

**UNIT – III** **(15 Hrs)**

**Characterisation of nanomaterials- I**

Theories and Techniques used for characterization-UV-Visible and PL spectroscopy-XRD-Electron microscopes-SEM, TEM, HR-TEM (SAED).

**UNIT –IV** **(15 Hrs)**

**Characterisation of nanomaterials- II**

Theories and Techniques used for characterization SPM, AFM, STM, XPS, XANES

**UNIT - V** **(15 Hrs)**

**Applications of nanomaterials**

Solar energy conversion and catalysis - Uses of Nano composites, Nanoelectronics, Liquid crystalline systems, Linear and non-linear optical and electro optical properties-photonics, plasmonics, chemical and biosensors. Nanomedicine and Nano biotechnology-NEMS. Nanoparticles in Pollution control. Nano materials in bone substitutes and dentistry, Food and cosmetic applications, textiles, paints, drug delivery and its application- nanoparticles in cancer targeting and treatment. Nanotechnology in agriculture, fertilizer and pesticides.

**Text Books:**


1. Pradeep, T., "Nano: the Essentials", Tata McGraw Hill, New Delhi, 2007.
2. Rao, C.N.R. and Cheetham, A.K., "The chem. of Nanomaterials: Synthesis, Properties and Applications", Wiley-VCH, 2004.
3. Hari Singh Nalwa, "Nanostructured materials and Nanotechnology", Acad. press, 2002.Charles P. Poole and Frank J. Owens, "Intro. to Nanotechnology" Wiley-Intersci., 2003.
4. A.Nabok, "Organic and Inorganic Nanostructures", Artech House, 2005.
5. Sulabha K. Kulkarni, "Nanotech.: Principles and Practices", Capital Publishing Co, 2007.


**References:**


1. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications", Imperial College Press, 2004.
2. C. N. R. Rao, A. Muller and A. K. Cheetham, "The Chemistry of nanomaterials: Synthesis, Properties and Applications", Wiley-VCH verlag GmBH & Co.KGA, 2004.
3. M. A. Ratner. and D. Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Prentice Hall PTR, First Edition, 2002.


**Web resources:**

- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/118102003/lec1.pdf
- https://www.brighthubengineering.com/manufacturing-technology/59084-what-are-nanomaterials-and-their-applications/
- https://www.understandingnano.com/nanomaterials.html
- https://www.nano.gov/you/nanotechnology-benefits
- http://www.essentialchemicalindustry.org/materials-and-applications/nanomaterials.html

**Mapping of CO with PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | 1 | 1 | 2 |
| **CO 2** | 3 | 3 | 3 | 2 | 2 |
| **CO 3** | 3 | 3 | 3 | 2 | 2 |
| **CO 4** | 3 | 3 | 3 | 2 | 2 |
| **CO 5** | 3 | 1 | 1 | 3 | 3 |
| **Average** | 2.8 | 2.2 | 2.2 | 2.0 | 2.2 |

## KEY: PEDAGOGY (Teaching methodology):

Lecture, Seminar, Assignments, Power point presentation, Exercises (group and individual).

## SEMESTER II

## INORGANIC CHEMISTRY PRACTICAL-I

**TOTAL HOURS: 30 Hrs** **SUB CODE: 16PCHCP2002**

**CREDIT: 4** **L-T-P: 1-1-4**

**Course Objectives:**

- The course provides training and experimental practices in qualitative and quantitative analysis.
- Develop skills to understand micro scale analysis methods in inorganic analysis and their advantages.
- To determine the concentration of a chemical element in a solution with the aid of a color reagent.

**COURSE OUTCOMES:** on completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Explain the qualitative analysis of a given salt mixture by semi micro method and know how to estimate the Inorganic cations. |
| CO2 | Explain the quantitative determination and know how to estimate the metal cations using the colorimetric method. |
| CO3 | Prepare the standard solutions. |

# SYLLABUS

**Syllabus:**

**Unit I**

Semi micro qualitative analysis of mixtures containing two common and two rare cations. The following rare cation are included: W, Mo, Ti, Te, Se, Ce, Th, Zr, V, U and Li.

**Unit-II Colorimetric analysis**

Spectrophotometric method: Estimation of iron, nickel, manganese and copper.

**Reference Books:**


1. Amita Dua, Navneet Manav, Practical Inorganic Chemistry, Manakin Press, 2017.
2. Jeyavathana Samuel, Chemistry Practical Book, G.G.Printers, Chennai, 2012.
3. Vickie. M .Williamson, M.Larry Peck, Lab manual for General Chemistry, Cengage Learning India Private Limited, New Delhi, 2009.
4. S. Mumtazuddin, Shailendra Kumar Sinha, Inorganic Lab Manual, Atlantic, 2009.
5. Vogel's "Textbook of Quantitative chemical Analysis", Pearson Education Ltd. Sixth Edition, 2008.
6. Dougles A. Skoog, Principles of Instrumental Analysis, 3rd Edition.
7. V.V. Ramanujam, Inorganic Semimicro Qualitative Analysis, The National Publishing Company, Chennai, third edition,1974.


**Web resources:**

- http://ncert.nic.in/ncerts/l/lelm107.pdf
- https://www.scribd.com/doc/8397989/Salt-Analysis-Chart
- https://study.com/academy/lesson/qualitative-analysis-of-inorganic-salts.html
- http://www.docbrown.info/page07/appendixtrans09.htm
- http://www.jbc.org/content/114/1/147.full.pdf

## Mapping of CO with PSO:

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 2 | 2 |
| **CO 2** | 3 | 2 | 3 | 2 | 2 |
| **CO 3** | 1 | 3 | 2 | 2 | 2 |
| **Average** | 2.3 | 2.6 | 2.3 | 2.0 | 2.0 |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):**

Lecture, Demonstrations, Power point presentation, Permanent slides, Exercises (group and individual)

## COURSE FRAME WORK

## SEMESTER III

| SEM | COURSE CODE | COURSE TITLE | TITLE OF THE PAPER | HRS/W | CREDITS | CA | SE | T |
|---|---|---|---|---|---|---|---|---|
| **III** | 16PCHCT3007 | Core Theory VII | Organic Chemistry-III | **6** | **4** | **40** | **60** | **100** |
| **III** | 16PCHCT3008 | Core Theory VIII | Inorganic Chemistry-III | **6** | **4** | **40** | **60** | **100** |
| **III** | 16PCHCT3009 | Core Theory IX | Physical Chemistry-III | **6** | **4** | **40** | **60** | **100** |
| **III** | 16PCHCE3003 | Elective III | Electrochemistry | **5** | **3** | **40** | **60** | **100** |
| **III** | 16PCHCP4003 | Core Practical-III | *Inorganic Chemistry practical-II | **6** | **4** | **40** | **60** | **100** |
| **III** | 18PSSRS3003 | Skill based elective | Research Skills | **2** | **3** | **50** | | **50** |
| **III** | 17PCHIP3001 | | INTERNSHIP | | **2** | **40** | **60** | **100** |
| | | | **TOTAL** | **31** | **24** | | | |

## SEMESTER III

## CORE THEORY VII

## ORGANIC CHEMISTRY III

**TOTAL HOURS: 90** **SUB CODE: 16PCHCT3007**
**CREDITS: 4** **L-T-P: 4-1-1**

## COURSE OBJECTIVES

1: To understand the different geometrical aspects of organic compounds in spectral techniques.

2: To learn the spectral interpretation of the organic compound.

3: To understand the molecular fragmentation of different organic compounds.

**COURSE OUTCOMES:** on completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Understand the detail about the magnetic resonance. |
| CO2 | Learn about the applications of UV,IR and NMR spectroscopy to the structural characterization of molecules. |
| CO3 | Predict the fragmentation of a molecule in a mass spectroscopy |
| CO4 | Applications of Spectroscopy for the structural determination. |
| CO5 | Combined spectroscopic approach for problem solving and structural analysis |

# SYLLABUS

**UNIT – I: IR AND RAMAN SPECTROSCOPY (18hrs)**

IR Spectroscopy : Skeletal vibrations and finger print regions – characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines, carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds) - Effect of Hydrogen bonding and solvent effect on vibrational frequencies – extension to various organic molecules for structural assignment

Raman Spectroscopy: Application in organic chemistry – Benzene: ortho, para, meta isomers- cis, trans isomers – structure determination by combined use of Raman and IR spectra

**UNIT – II: UV SPECTROSCOPY (18hrs)**

Types of transitions – Woodward Fieser rules – differentiation of geometrical isomers and position isomers (disubstituted benzene derivatives, nitrophenols) conjugated cyclic ketones, acetophenones, esters – study of steric effect in aromatic compounds – steric inhibition of resonance.Solvent effects.

**UNIT – III: $^{1}$H NMR SPECTROSCOPY (18hrs)**

Nuclear Magnetic Resonance Spectroscopy: Approximate chemical shift values of various chemically non-equivalent protons and correlation to protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic), Protons bonded to other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides, SH), Chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, and four interacting nuclei (first order spectra), Complex interaction, virtual coupling, stereochemically hindered rotation, Karplus curve, variation of coupling constant with dihedral angle, nuclear magnetic double resonance, simplification of complex spectra using shift reagents and Nuclear Overhauser Effect (NOE).

**Unit – IV: $^{13}$C NMR SPECTROSCOPY (18hrs)**

$^{13}$C NMR Spectroscopy: Chemical shift (aliphatic, olefinic, alkynes, aromatic, hetero-aromatic, carbonyl carbon), Coupling constants. Applications of IR, NMR, and Mass spectroscopy for structure elucidation of organic compounds.

**UNIT – V: MASS SPECTROMETRY** **(18hrs)**

Mass spectral fragmentation of organic compounds – common functional groups – molecular ion peaks – meta stable peak – McLafferty rearrangement – general rules for interpretation of the spectrum – molecular weight, isotope effect, nitrogen rule, ring rule – examples of mass spectral fragmentation of organic compounds with respect to their structure determination – applications – molecular weight determination, isotopic abundance, bonding information, determination of bond dissociation energies, impurity detection, identification of unknown compounds, characterization of polymers.

**Text Books**


1. D.L. Pavia, G.M. Lampman, G.S. Kriz, J.A. Vyvyan, *Introduction to spectroscopy,* 5th Edn., Brooks Cole, 2010.
2. R.M.Silverstein, F.X.Webster and D.Kiemel, *Spectroscopic Identification of Organic Compounds,* 7th Edn., John Wiley & sons, 2005.
3. W.Kemp, *Organic Spectroscopy,*5th Edn., McMillan Ltd., 2009.
4. Russel Drago, *Physical Methods in Inorganic Chemistry* ,2010
5. D.N. Sathyanarayana, *Magnetic Resonance Spectroscopy – ESR, NMR, NQR,* 2014.


**Reference Books**


1. Y. R. Sharma, *Organic Spectroscopy,* 2017.
2. R.S. Macomber , *A complete Introduction to Modern NMR Spectroscopy,* John Wiley & sons Ltd.,
3. M.Balci, *Basic $^{1}H$ and $^{13}C$ NMR Spectroscopy,* Elsevier, 2005.
4. M.F.Lappert, *Physical Inorganic Chemistry – Inorganic Electron Spectroscopy*, 1968.


**Web Resources**

1. https://nptel.ac.in/content/storage2/courses/115101003/downloads/module2/lecture23.pdf
2. https://www.vanderbilt.edu/AnS/Chemistry/Rizzo/chem220a/Ch13slides.pdf
3. https://nptel.ac.in/content/storage2/courses/115101003/downloads/module2/lecture24.pdf
4. https://en.wikipedia.org/wiki/Fluorine-19_nuclear_magnetic_resonance_spectroscopy
5. http://www.chem.ucla.edu/~harding/notes/notes_14C_solvspec.pdf
6. https://as.vanderbilt.edu/chemistry/Rizzo/Chem220b/combined_spectra_problems.pdf

**Mapping Co with PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 2 | 3 |
| **CO 2** | 3 | 3 | 2 | 3 | 3 |
| **CO 3** | 2 | 3 | 3 | 3 | 2 |
| **CO 4** | 2 | 2 | 3 | 2 | 3 |
| **CO 5** | 3 | 3 | 2 | 3 | 3 |
| **Average** | **2.6** | **2.6** | **2.6** | **2.6** | **2.8** |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):** Lectures, PPT presentations, Seminars and Discussions Context based learning.

## SEMESTER III

## CORE THEORY VIII

## INORGANIC CHEMISTRY-III

**TOTAL HOURS: 90** **SUB CODE: 16PCHCT3008**

**CREDIT: 4** **L-T-P: 4 – 1 - 1**

**COURSE OBJECTIVES**

1. To learn the Orgel and Tanabe-Sugano diagram for the different electronic configuration.
2: To study the vibrational frequencies for various inorganic metal complexes.
3: To understand the crystal diffraction studies for the molecules.

**COURSE OUTCOMES:** on completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Explain IR and Raman Spectroscopy of various metallic, olefinic, organo metallic complexes and isomerism involved in it. |
| CO2 | Able to get a brief idea on selction rules in electronic spectra, orgel and Tanabe sugano diagram in co-ordination compounds and also learn about John teller distortion in tetrahedral complexes |
| CO3 | Gain knowledge about NMR in $^{31}P$, $^{19}F$. Also know about NQR in nitrosyl compounds and Mossbauer spectroscopy in Fe and Sn system |
| CO4 | To know the detail study of the Electron Spin Resonance and its applications in various metal complexes and simple molecules and also learn about fundamentals of photo emission spectroscopy |
| CO5 | Familiar with x-ray diffraction, electron and optical microscopic methods and X-ray fluorescent methods. |

# SYLLABUS

**Unit I: IR and Raman Spectra Application (18hrs)**

Effect of coordination on ligand bands- Ammine, Nitro, nitrito, thiocyanato.

Urea complexes, dithiocarbamato complexes, carboxylate complexes, nitrosyl complexes, cyano complexes- nitrate, sulphate and perchlorate complexes- differentiation of geometric isomers. Metal carbonyls, olefin complexes, sandwich complexes.

Raman spectroscopy of metal complexes, organometallic and simple inorganic compounds with special reference to coordination sites, isomerism.

**Unit II: Electronic Spectra application (18hrs)**

Classification of Transitions – Selection Rules – Free ion terms – Racah Parameter – Ligand field perturbations on the free ion terms – Spectra of Octahedral complexes:$d^n$ configurations- Weak field and strong field ligands – Orgel and Tanabe-Sugano Diagrams – Evaluation of $10D_q$ – Spectra of distorted octahedral complexes – Jahn-Teller Distorion – Tetrahedral Complexes - Nephelauxetic effect – Charge Transfer Spectra.

**Unit III: NMR, NQR and Mossbauer (18hrs)**

NMR, NQR, Mossbauer spectra: NMR spectra of $^{31}P$, $^{19}F$, NMR shift reagents, NQR-Nitrosyl compounds. Mossbauer of Fe and Sn systems.

**Unit IV: Application of ESR and Photo electron spectroscopy to coordination complexes (18hrs)**

ESR introduction-Zeeman equation, g value, nuclear hyperfine splitting, Interpretation of ESR spectrum of simple carbon centered free radicals. Anisotropy in g value and hyperfine

splitting constant. McConnels equation, Kramer's theorem, esr of transition metal complex of copper, manganese and vanadyl complexes.

Photoelectron spectroscopy – UPS and XPS-Photoelectron spectra – Koopman's theorem,-Fine structure in PES, Chemical shift and Correlation with electronic charges.

**Unit V: X-ray diffraction and Microscopy application (18hrs)**

Basic Principles of diffraction – Bravis Lattices- Use of X-ray power diffraction data in identifying inorganic crystalline solids. Single crystal diffraction in crystal structure analysis. Optical Microscopy, Electron Microscopy – SEM and TEM. X-ray Flourescence Spectroscopy – structure determination.

**Text Books:**


1. L.Smart, E.Moore – Solid State Chemistry – An Introduction-2nd Edition
2. A.R.West – Basic Solid state Chemistry 1961 – John Wiley
3. A.R.West – Solid state Chemistry and its applications 2007 – John Wiley
4. W.E Addison, 1961, Structural principles in Inorganic Chemistry, Longman
5. Structural principles in inorganic Chemistry –Adams
6. Physical methods in inorganic Chemistry – E.A.V Ebsworth, Rankin and Caddock. 1987.
7. Vibrational Spectroscopy Theory and Applications – New Age, D.N.Sathyanarayana, 2011.
8. Magenetic Resonance Spectroscopy-ESR, NMR, NQR-IK International D.N. Sathyanarayana, 2014.


**References:-**


1. R.B.Heslop and K.Jones, inorganic Chemistry, Elsevier Scintific Publ .1976.
2. H.A.O Hill and P.Day, physical methods in dvanced Inorganic Chemistry, John wiley 1968.
3. C.N.R Rao, J.R.Ferraro, Spectrosopy in inorganic chemistry, Vol.I and Vol II, Academic press, 1970.
4. G.Aruldhas, molecular structures and spectroscopy-Prentice hall.
5. M.F.Lappert –Physical inorganic Chemistry-inorganic Electron Spectrosopy 1968.

6. Physical methods in inorganic Chemistry – Russel Drago

**Web Resources:**

1. https://www.dalalinstitute.com/books/a-textbook-of-inorganic-chemistry-volume-1/
2. http://ocw.nctu.edu.tw/course/ichemistry/ichemistry_lecturenotes/ich-8-2.pdf
3. https://www.slideshare.net/solairajananant/nmr-spectroscopy-13887430
4. https://ccsuniversity.ac.in/bridge-library/pdf/chem-ESR-Lecture-5.pdf
5. https://www.ch.ntu.edu.tw/~sfcheng/HTML/UPS-XPS.pdf
6. https://www.microscopy.ethz.ch/methods.html

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 2 |
| **Average** | **2.6** | **2.8** | **2.4** | **2.6** | **2.0** |

**KEY: PEDAGOGY**

Lecture, Group Discussion, Seminar, Power point presentation, Context based learning.

.

## SEMESTER III

## CORE PAPER IX

## PHYSICAL CHEMISTRY-III

**TOTAL HOURS: 90** **SUB CODE: 16PCHCT3009**

**CREDIT: 4** **L-T-P: 4-1-1**

## COURSE OBJECTIVES:

1. To understand the spectral transition of different molecules.
2. To apply the concepts of quantum mechanics to solve problems in microscopic systems.
3. To understand the quantum mechanical approach to the atomic and molecular electronic structure.

**COURSE OUTCOMES:** on completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | Understand the quantization of energy and the interaction of electromagnetic radiation with matter and also explain the fundamentals and principles of molecular spectroscopy |
| CO2 | Apply solutions of the Schrödinger equation for simple systems to real systems for use in determining the energy of stationary states. |
| CO3 | Understand the mathematical foundations of different branches of spectroscopy and know the application of spectroscopy to study the structure of molecules. |
| CO4 | Identify the unique features of the hydrogen atom that make it important for calculations in quantum mechanics. |
| CO5 | Recognize the most significant and elementary solutions of Schrodinger equation in molecular quantum mechanics through a study of time independent perturbation theory, valence bond and molecular orbital theories. |

# SYLLABUS

**Unit I: Spectroscopy I** **(18hrs)**

Electromagnetic radiation: Quantization of energy- rotational, vibrational and electronic energy levels and transitions in molecules- regions and representation of spectra. Resolution and intensity of spectral transition: signal to noise ratio- width of spectral lines- collision broadening – Doppler broadening – Heisenberg uncertainty principle – intensity of spectral lines- selection rules and transition probability- transition moment integral- Einstein absorption coefficient.

Electronic spectra of polyatomic molecules, Franck-condon principle- selection rules – types of transition in saturated and unsaturated hydrocarbons, effect of conjugation and solvent effects.

**Unit II : Spectroscopy - II** **(18hrs)**

Rotational spectroscopy of a rigid rotar – non-rigid rotor-diatomic and polyatomic molecules. Vibrational spectroscopy-harmonic oscillator-anhormonicity –Vibration – rotation spectra of diatomic vibrating molecules selection rules-P,Q and R branches.

Vibrational spectra of polyatomic molecules- fundamental vibrations – normal modes of vibration- overtones, combination and difference bands- Fermi resonance. Raman spectra: Classical theory of Raman effect and molecular polarisability – pure rotational Raman spectra – Vibrational Raman spectra – Rotational fine structure – Rule of mutual exclusion – Polarization of light and Raman effect.

**Unit III: Spectroscopy – III** **(18hrs)**

Resonance spectroscopy-Zeeman effect-equation of motion of spin in magnetic fields. AX and AMX type molecules- $H^1$ , $^{13}C$, $^{19}F$, $^{31}P$ NMR spectra - a brief qualitative discussion of Fourier transform spectroscopy. ESR: principle, spin-orbit coupling. Hyperfine interaction. McConnell reactions.

Mass spectra: Theory and instrumentation,Mossbauer spectroscopy- Doppler effects, isomer shift, electron-neutron hyperfine interactions. Quadrupole interactions and Magnetic interactions.

**Unit IV: Quantum Chemistry – III** **(18hrs)**

The harmonic oscillator- the rigid rotor- the hydrogen atom- the Schrodinger equation for hydrogen atom- angular momentum - term symbols -the solution- the origin of quantum numbers (angular momentum and spin) -their physical significance.

**Unit V: Quantum Chemistry – IV** **(18hrs)**

Approximation methods –perturbation and variation method –application to hydrogen ,helium atoms –R.S. coupling and term symbols for atoms in the ground state – Slater orbital and HF –SCF methods Born – Heimer approximation –valence bond theory for hydrogen molecule –LACO –MO theory for di and polyatomic molecules –concept of hybridization – Huckel theory for conjugated molecules (ethylene , butadiene and benzene)- semi empirical methods .

**Text Books:**


1. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th ed., Tata McGraw Hill, New Delhi, 2000.
2. K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.
3. P. Atkins and J. de Paula, Physical Chemistry, 7th ed., Oxford University Press, Oxford, 2002.
4. I. N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.
5. R.K.Prasad, Quantum Chemistry, 4th Revised Edition, New Age International Publishers, 2010.
6. Jay Martin Anderson, Mathematics for Quantum Chemistry,1st Revised Edition, Dover Publication, 2005.
7. A. Rahman, Nuclear Magnetic Resonance-Basic Principles, Springer-Verlag, New York, 1986.
8. J. P. Lowe, Quantum Chemistry, K. A. Peterson, 3rd edition, Academic Press, 2006.


**Reference Books:**


1. D. L. Andrews, Lasers in Chemistry, 3rd ed., Springer-Verlag, London, 1997.
2. K. Nakamoto, Infrared and Raman Spectra of Inorganic and coordination Compounds, Part B: 5th ed., John Wiley & Sons Inc., New York, 1997.
3. R. S. Drago, PhysicaI Methods in Chemistry; Saunders: Philadelphia, 1977.
4. J. A. Weil, J. R. Bolton and J. E. Wertz, Electron Paramagnetic Resonance; Wiley Interscience: 1994.

5. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 4th ed., Tata McGraw-Hill Publishing Company, New Delhi, 1988.
6. Lowe J.P, Quantum Chemistry, 3rd Edition, Elseiver Science, 2012.
7. Donald A. Mcquarrie, Quantum Chemistry, 5th Edition, viva Books, 2016.

**Web Resources**

1. https://www.coursera.org/learn/spectroscopy
2. https://www.sciencedirect.com/topics/chemistry/molecular-spectroscopy
3. https://nptel.ac.in/content/syllabus_pdf/104101099.pdf
4. https://chem.libretexts.org/Courses/Pacific_Union_College/Quantum_Chemistry/13%3A_Molecular_Spectroscopy
5. https://www.youtube.com/watch?v=ovuNVBpDUQc
6. https://www2.ph.ed.ac.uk/~ldeldebb/docs/QM/lect17.pdf.

## Mapping of CO with PSO:

| CO/PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | 1 | 2 | 1 | 2 | 1 |
| **CO 2** | 2 | 1 | 1 | 2 | 2 |
| **CO 3** | 3 | 3 | 2 | 2 | 3 |
| **CO 4** | 2 | 2 | 2 | 3 | 3 |
| **CO 5** | 2 | 2 | 3 | 2 | 2 |
| **Average** | 2.0 | 2.0 | 1.8 | 2.2 | 2.2 |

**KEY: PEDAGOGY** Lecture, Power point presentation/Seminar, Exercises and discussions.

## SEMESTER III

## CORE ELECTIVE III
## ELECTROCHEMISTRY

**TOTAL HOURS: 75** **SUB CODE: 16PCHCE4004**
**CREDIT: 3** **L-T-P: 4-1-0**

### Course Objectives:

1. The objectives of this course are based on the acquisition and general knowledge about the basic aspects of the applied electrochemistry.
2. A first part of the course aims to the understanding some important concepts of thermodynamic and kinetics in electrochemistry.
3. The definition of galvanic and electrolysis cells; electrodes and their characteristics.

### Course Outcome:

On successful completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | Acquisition of basic knowledge of the electrode kinetics and some relevant thermodynamic aspects. |
| CO2 | Kinetic control of electrochemical reactions. Butler and Volmer equation. Tafel equation. Management and prediction of some important redox species to the equilibrium conditions. |
| CO3 | Knowledge of the main practical applications of electrochemistry for the production of species of interest. |
| CO4 | Energy storage systems: Primary batteries (or batteries): conventional cells (Pile Leclanché, Alkaline batteries, secondary batteries, fuel cells, batteries with intercalation, etc |
| CO5 | Construction and use of potential-pH diagrams (Pourbaix). Evans diagrams. Types of corrosion. |

# SYLLABUS
# ELECTROCHEMISTRY

**UNIT – I Ionic phenemenona in solution- I (15hrs)**

The Born model of ion-solvent interaction.The concept of ionic atmosphere.DebyeHuckel equations for the mean activity coefficient of electrolytes-verification and experimental validity of the equation.Bjerrum ion pair theory – Bjerrum modification of Debye Hukel equation.

**UNIT – II Ionic phenemenona in solution- II (15hrs)**

Ion association treatment – diffusion – Fick's law of diffusion – Einstein Smolunchowki equation – conduction – Stoke Einstein equation – transport number of ions – Onsager phenomenological equation – Plank Henderson equation – influence of ionic atmosphere on conductivity of electrolytes. Debye Huckel Onsager equation for the equivalent conductivity of electrolyte – Experimental verification.

**UNIT – III Structure and theories of Electrified Interface (15hrs)**

The electrode electrolyte interface – electrical double layer – electro capillary phenomena – parallel plate condenser model – Guoy Chapman diffuse model – Stern model.

Significance of equilibrium exchange, current density and symmetry factor.Butler-Volmer equation for one electron transfer.Electro kinetic phenomena – membrane potential. – Tisselius method of seperation of proteins – Butler Volmer equation for one electron transfer. Significance of equilibrium exchange current density and symmetry factor.

**UNIT – IV Electrochemical systems of technological interest (15hrs)**

Corrosion and the stability of metals. Theories of corrosion – charge transfer reaction of corrosion, short circulated energy producing cell, corrosion of ultrapure metals – corrosion current & corrosion potential. Evans diagrams – potential – pH diagram (Pourbaix diagram) – Prevention of corrosion – electronic approach to the stability of metals.

**UNIT – V** **(15hrs)**

Electrode, SHE, dropping calomel electrode, Quinhydrone electrode, glass electrode – merits and demerits. Fuel cells – kinds of fuel cells and their relative merits – electricity storage – Lead storage battery – Lechlanche cell – silver – zinc cell and sodium-sulphur cell.

**Reference books**


1. J. O. M.Bockris and A. K. N. Reddy, Modern Electrochemistry, vol.1 & 2, Plenum Press, New York, 1970.
2. S. Glasstone, Electrochemistry, Affiliated East-West Press Pvt. Ltd., New Delhi, 1974..
3. L. Andropov, Theoretical Electrochemistry, Mir Publications, Moscow, 1977.
4. J. Rajaram and J. C. Kuriakose, Kinetics and Mechanism of Electrochemical Transformations, Macmillan India Ltd., New Delhi, 1993.


## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 1 | 3 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |
| **Average** | **3** | **3** | **2.6** | **3** | **2.4** |

## KEY: PEDAGOGY:

Power point presentation, Lecture, seminar, quiz and discussion (group and individual)

## SEMESTER III

## INORGANIC PRACTICAL III

**TOTAL HOURS: 90** **SUB CODE: 16PCHCP4003**

**CREDIT: 4** **L-T-P: 1 – 1- 4**

## COURSE OBJECTIVE

- Quantitative analysis of mixtures of metal ions by volumetric and gravimetric analysis.
- Preparation of various metal complexes

**On Successful completion of the course the students will be able to**

| CO No | CO statement |
|---|---|
| **CO 1** | understand the reaction involved in formation metal complexes and analyse it |
| **CO 2** | Estimate the amount of metal ions in the given solutions. |
| **CO 3** | Acquire skills on Re-Crystallisation, Separation, Digestion and Co-precipitation methods. |

## Syllabus

**Unit I: Preparation of the following:**

1. Sodium bis(thiosulphato)cuprate (I)
2. Sodium hexanitrocobaltate (III)
3. Hexamminenickel (II) chloride
4. Tris (thiourea) copper (I) chloride
5. Potassium tris (oxalato) chromate (III) trihydrate
6. Tris (thiourea) copper (I) sulphate

**Unit II: Quantitative analysis: Mixture of metal ions (gravimetrically and volumetrically)**

1 Magnesium and Iron in the mixture of Iron and magnesium

2 Nickel and copper in the mixture of copper and nickel

3 Zinc and copper in the mixture of copper and zinc.

4 Nickel and Iron in the mixture of iron and Nickel.

**Reference Books:**


1. Vogel's "Textbook of Quantitative chemical Analysis", Pearson Education Ltd. Sixth Edition, 2008.
2. Dougles A. Skoog, Principles of Instrumental Analysis, 3rd Edition.
3. J. Mendham, R.C. Denney, J. Basset and G.H. Jeffery, Vogel's Text book of quantitative Inorganic Analysis, fourth edition ELBS, Longmann, 1978.
4. G. Brauer (Ed.), Handbook of Preparative Inorganic Chemistry, Vols. I and II, Academic Press, 1963.


**Web Resources:**

1. http://egyankosh.ac.in/bitstream/123456789/15906/1/Experiment-17.pdf
2. https://www.slideshare.net/mjkwezi/synthesis-of-tris-thiourea-copper-i-sulphate-by-kwezi-mwaka-julius

3. https://thosci.com/synthesis-of-hexaamminenickelii-chloride/.

**On Successful completion of the course the students will be able to**

**CO 1:**understand the reaction involved in formation metal complexes and analyse it.

**CO 2:** Estimate the amount of metal ions in the given solutions.

**CO 3:**Acquire skills on Re-Crystallisation, Separation, Digestion and Co-precipitation methods.

## Mapping CO with PSO

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 2 | 2 |
| **CO 2** | 3 | 2 | 3 | 2 | 1 |
| **CO 3** | 1 | 3 | 2 | 2 | 2 |

## COURSE FRAME WORK

## SEMESTER IV

| SEM | COURSE CODE | COURSE TITLE | TITLE OF THE PAPER | HRS /W | CREDITS | CA | SE | T |
|---|---|---|---|---|---|---|---|---|
| **IV** | 16PCHCT4010 | Core Theory X | Organic Chemistry-IV | **6** | **4** | **40** | **60** | **100** |
| **IV** | 16PCHCE4004 | Core Elective IV | Research Methodology | **5** | **3** | **40** | **60** | **100** |
| **IV** | 16PCHCE4005 | Core Elective V | Analytical Techniques in Chemistry | **5** | **3** | **40** | **60** | **100** |
| **IV** | 16PCHCP4004 | Core Practical IV | *Physical Chemistry Practical | **6** | **4** | **40** | **60** | **100** |
| **IV** | 16PCHPR4001 | | Project & Viva-Voce | **6** | **4** | **40** | **60** | **100** |
| **IV** | 18MOOC4004 | Soft Skill NPTEL COURSE | SWAYAM (MOOC) | **2** | **4** | **50** | **-** | **50** |
| | | | **TOTAL** | **30** | **22** | | | |

## SEMESTER IV

## CORE THEORY X

## ORGANIC CHEMISTRY-X

**TOTAL HOURS: 90** **SUB CODE: 16PCHCT4010**

**CREDIT: 4** **L-T-P: 4 – 1 - 1**

## COURSE OBJECTIVES

1: To understand the various types and mechanisms of organic reaction

2: To know the various synthetic routes of organic transformation.

3: TO know the structural elucidation of the natural products

**COURSE OUTCOMES:** on completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Interpret the symmetry orbital overlapping with the thermal/ photochemical condition. |
| CO2 | Apply the properties amino acids compounds for their higher education/ research aspects. |
| CO3 | Acquire knowledge on the role of modern synthetic reagents in organic transformation. |
| CO4 | Understand the introduction of Retro synthesis as well as role on disconnection approach |
| CO5 | Apply the techniques of Retro analysis to plan synthesis of given target molecule. |

# SYLLABUS

**Unit I: Pericyclic Reactions (18hrs)**

Pericyclic reactions-classification, electrocyclic, cycloaddition reactions.Woodword Hoffman rules, FMO-Analysis of electrocyclic, cycloaddition and sigmatropic reactions-correlation diagram for cycloaddition reaction, butadiene – cyclobutene system and Inter conversion of hexatriene to cyclohexadiene.

**Unit II: Alkaloids and Proteins (18hrs)**

Structural elucidation and total synthesis of morphine.

Peptides and their synthesis (Synthesis of tripeptide using amino acids - Glycine, Alanine, Lysine, Cysteine, Glutamic acid, Arginine).Merrified synthesis, Determination of primary, secondary and tertiary structure of proteins.

**Unit III: Modern synthetic methodology (18hrs)**

Application of synthetic methodology for the synthesis of simple cyclic and acyclic target molecules -synthesis of cubane, 5 - hexenoicacid , bicyclo (4, 1, 0) heptane-2-one.,trans 9-methyl-1- decalone ,longifolene and onocerin. Concept of Synthones, synthetic equivalents and intermediates. Formation of C-C and C=C bonds. Reversal carbonyl polarity – Umpolung addition.

**Unit IV: Retrosynthetic analysis, Protection and Deprotection (18hrs)**

Retro synthetic analysis and synthesis of simple organic molecules such as 1,2, 1,3, 1,4 and 1,5 dicarbonyl compounds both acylic and cyclic. Formation of 3, 4, 5 and 6 membered cyclic compounds - Baldwin's rules.Use of standard reactions, like Grignard reactions, Robinson annulations.Protection and deprotection of functional groups (R-OH, RCHO, R-CO-R, R-$NH_2$ and R-COOH).Use of PTC (Phase-transfer catalyst) and Crown ethers in organic synthesis.

**Unit V: Novel reagents in organic synthesis (18hrs)**

Synthesis and applications of Organolithium, Organomagnesium, Organozinc and Organo Copper and Gilman reagents. Modern synthetic methods: metal mediated C-C coupling reactions: Mechanism and synthetic applications of Heck, Stille, Suznki, Negishi, Sonogashira, McMurray, Metathesis and Carbonylation reactions. Green reactions and reagents.

**Text Books**


1. Vinay Prabha Sharma and rakesh Kumar, Pericyclic Reactions and Organic photochemistry, A Pragati Edition,(2008).
2. O.P.Agarwal, Organic Chemistry:Natural Products, Krishna Prakashan Publisher (2000).
3. W. Carruthers., Modsern Methods of Organic Synthesis, Cambridge University Press, (2005).
4. V.K. Ahluwalia and Rakesh Kumar Paraskar, Organic reaction Mechanisms, 4th edition, Narosa Publishing House, (2010).
5. Stuart Warren, Organic Synthesis: the disconnection Approach, 1st Edition, Wiley Publisher.


**Reference Books**


1. P.S.Kalsi., Organic Synthesis through Disconnection Approach, 2nd revised edition, Medtech Publishers, (2015).
2. S.Sankararaman, Pericyclic Reactions- A textbook: Reactions, Applications and Theory, Wiley- VCH Verlag Publisher (2005).
3. George S. Zweifel and Michael H. Nantz, Modern Organic Synthesis: an Introduction, W. H. Freeman and Company, New York (2007).
4. Jonathan Clayden, Nick Greeves and Stuart Warren, Organic Chemistry, 2nd Edition, Oxford University Press (2012).
5. Jagadamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, 4th Edition, New Age International Publishers (2019).

**Web Resources**

1. http://infodome.sdsu,./research/guides!science!orgchemistryblr.html
2. http://www.liv.ac.uklchemistry/links/reactions.html
3. http://orgchem.chem..uconn.edu/namereacVnamed.html
4. www.gcocities.com/chempensoftwar4ee/reactions.html
5. https://nptel.ac.in/content/storage2/courses/104103023/download/module3.pdf

## Mapping of CO with PSO:

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 2 |
| **Average** | **2.4** | **2.8** | **2.6** | **2.4** | **2.4** |

## KEY: PEDAGOGY:

Lecture, Group Discussion, Seminar, Power point presentation, Context based learning.

## SEMESTER IV

## CORE ELECTIVE IV

## RESEARCH METHODOLOGY

**TOTALHOURS: 75** **SUB CODE: 16PCHCE4004**

**CREDITS: 3** **L-T-P: 4-1-0**

### Course Objectives:

**1:** To provide awareness about the developing avenues in Chemistry

**2:** To give training in seminars, group work, communication and thesis writing Skill

**3:** To equip the students in using computing techniques in solving problems, to visualize and draw molecules

### Course Outcome:

On successful completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| CO1 | Understand the basics, types and interpret current chemical research. |
| CO2 | Employ the online tools to survey chemical literature and related Journals |
| CO3 | Learn the concept of formatting, statistical data analysis and ethical guidelines for research. |
| CO4 | Identify the accurate format of writing scientific report and thesis |
| CO5 | Acquire the skill of presenting the research work to public forums using modern software tools |

# SYLLABUS

**UNIT I: Research Problem** **(15hrs)**

Objectives of research, types of research – basic, applied, and other types.

Problem selection – project proposal - funding agencies.

**UNIT II: Source of Literature** **(15hrs)**

Chemistry literature survey –primary, secondary and tertiary sources.

Journals published by the ACS and RSC – CA and its importance –Indian Journals – reviews, monographs, data books and indexes. Methods of searching, compilation,

Preservation and retrieval of collected literature .Impact factor and citation index.

**UNIT III: Research planning, methods and materials** **(15hrs)**

Planning and conducting experiments.

Methods of collecting data – primary and secondary –sources of secondary data.

Classification and tabulation of data – types of classification –general rules for tabulation–types of tables.

Simple sampling techniques and size of the sample.

**UNIT IV: Analysis of data** **(15hrs)**

Presentation of data - Types of errors – Gross, systematic and random errors.

Measures of central tendency, mean, standard deviation and measures of variability.

Linear regression, correlation and method of least squares.

**UNIT V: Report writing** **(15hrs)**

Project report writing – general, chapter and page format.

Procedure for presenting tables, graphs and figures, foot-notes, bibliography and appendices. Abbreviations, symbols and SI units. Plagiarism, copy right and patent laws. Publication of research paper.

**Text Books**


1. Thesis and Assignment Writing – J Anderson, B.H. Dursten and M. Poole, Wiley Eastern (1977).
2. Kothari C.R. and Gaurav Garg. Research Methodology: Methods and Techniques. New Delhi: New Age International, 2019.
3. Gopalan, R. Thesis Writing. Chennai: Vijay Nicole Imprints, 2005.
4. Statistical Method, Gupta S. P, Sultan Chand and Sons, New Delhi, 2004.
5. Hand Book for Authors –Journal of the American Chemical Society Publications Chemical publications – Their nature and uses.


**Reference Books**


1. Christopher J. Cramer. Essentials of Computational Chemistry Theories and Models,New York: Wiley,2004.
2. Johnson, K.J. Numerical Methods in Chemistry, New York:Marcel Dekkar,1980.
3. Leach A. R. Molecular Modeling Principles and Practice,New York: Prentice-Hall, 2001.
4. Janet C. Dodds,The ACS Style Guide – A Manual for Authors and Editors, American Chemical Society,2006


**WEB RESOURCES**

1. https://www.researchgate.net/publication/2174858_Research_Methodology
2. http://www.sciencedirect.com/
3. http://ww42.scifinder.com/
4. https://www.acs.org/content/acs/en/education.html
5. https://www.researcher-app.com/

## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 3 |
| **Average** | **3** | **2.8** | **2.2** | **2.6** | **2.4** |

## KEY: PEDAGOGY:

Power point presentation, Lecture, seminar, quiz and discussion.

## SEMESTER IV

## CORE ELECTIVE-V

## ANALYTICAL TECHNIQUES IN CHEMISTRY

**TOTALHOURS: 75** **SUB CODE: 16PCHCE4005**

**CREDIT: 3** **L-T-P: 4-1-0**

## COURSE OBJECTIVES

1: To understand the instrumentation aspects of various techniques.

2: To learn the spectral interpretation of the organic and inorganic compounds.

3: To understand the thermal analysis of the different compounds.

**COURSE OUTCOMES:** On completion of the course the students will be able to…

| CO No. | CO Statement |
|---|---|
| CO1 | Understand on theories of instrumental methods in colorimetric analysis such as UV-Visible, IR and Raman Spectroscopy and its applications . |
| CO2 | Gain knowledge on instrumentation and structural determination of NMR. Also know about NQR in nitrosyl compounds and Mossbauer spectroscopy in Fe and Sn system. |
| CO3 | Extend skills in procedure and instrumental methods applied in ESR and also acquire knowledge on magnetic susceptibility measurement methods |
| CO4 | Describe the various stages of thermal degradation using TGA and DTA methods and also develop theoretical knowledge on instrumentation and applications in Mass spectrometer |
| CO5 | Obtain detail Knowledge about Atomic absorption and Flame emission spectroscopy |

## SYLLABUS

**Unit I: Colorimetric analysis, UV-Vis, IR and Raman spectrum (15hrs)**

Colorimetric analysis and UV-Visible spectroscopy: Beer Lambert's law, Principles of single and double beam instruments – applications for analysis of inorganic and organic samples.

Infrared spectrophotometric analysis – principle, instrumentation and structure determination.

Raman Spectra – principle, basic instrumentation and structural analysis.

**Unit II: NMR and NQR (15hrs)**

Nuclear Magnetic Resonance – Principle, instrumentation, structure determination. NMR of $^{1}H$, $^{13}C$, $^{31}P$, $^{19}F$.

NQR - Nitrosyl compounds, Mossbauer of Fe and Sn systems.

**Unit III: ESR and Magnetic properties (15hrs)**

Electron Spin Resonance – Principle, instrumentation, applications to coordination compounds.

Magnetic Susceptibility and measurements- Guoy method, Faraday method-applications.

**Unit IV: TGA, DTA and Mass Analysis (15hrs)**

Thermo gravimetric and differential thermal analysis, thermometric titrations, differential scanning colorimetry – basic instrumentation and applications.

Mass Spectrometry- Principle, basic instrumentation, fragmentation patterns -structural determination of organic molecules.

**Unit V: Atomic absorption spectroscopy and Photoelectron spectroscopy (15hrs)**

Atomic absorption spectroscopy: Theory, atomizers, flame and electro thermal. radiation sources, instrumentation, spectral and chemical interferences and application.

Photoelectron spectroscopy (UV and X-Ray)-photo electron spectra-Koopman's theorem, fine structure in PES, chemical shift and correlation with electronic charges.

**Text Books**


1. D.A .Skoog, Principles of Instrumental Methods of analysis, III Edition,Saunders College Publ.1985.
2. Willard Merrit, Dean and Settle, Instrumental methods of analysis, VI Edition, CBS Publ. 1986.
3. A.I. Vogel, Textbook of Qualitative Inorganic Analysis, III Edition, ELBS.1976.
4. C.N.R. Rao, J.R. Ferraro, 1970, Spectroscopy in Inorganic Chemistry, Vol. I and Vol. II, Academic Press.
5. H.A. Strobel, 1976, Chemical Instrumentation, Addition- Wesely Publ Co.
6. D.A. Skoog and D.M. West, 1982, Fundamentals of Analytical Chemistry, IV Edition, old Reinhord & Winston, Publication,1982.


**Suggested Reference Books:-**


1. G.D.Christian & J.E.O. Reily, Instrumental Analysis, II Edition, Allegn Recon,1986.
2. H.A.O. Hill and P. Day, Physical methods in Advanced Inorganic Chemistry, JohnWiley, 1968.
3. K. Burger, Coordination Chemistry, Experimental methods, Butterworths,1973.
4. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London,2000.
7. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004


**Web Resources:**

1. https://lab-training.com/2013/12/28/comparison-between-single-beam-and-double-beam-atomic-absorption-spectrometer-systems/
2. https://microbenotes.com/electron-spin-resonance-esr-principle-instrumentation-applications/
3. https://www.slideshare.net/solairajananant/nmr-spectroscopy-13887430

4. https://www.scribd.com/doc/175906208/Electron-Spin-Resonance-It-s-Principles-and-Applications
5. https://crimsonpublishers.com/mapp/pdf/MAPP.000509.pdf.
6. https://sites.chem.colostate.edu/diverdi/C431/experiments/atomic%20absorption%20spectroscopy/references/Agilent%20-%20analytic%20methods.pdf.

**Mapping CO with PSO**

| CO/PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 3 | 1 | 2 |
| **CO 2** | 2 | 1 | 3 | 2 | 2 |
| **CO 3** | 2 | 2 | 3 | 1 | 2 |
| **CO 4** | 3 | 2 | 2 | 3 | 1 |
| **CO 5** | 2 | 3 | 1 | 2 | 2 |
| **Average** | **2.4** | **2** | **2.2** | **1.8** | **1.8** |

**KEY: PEDAGOGY (TEACHING METHODOLOGY**

Lecture, Power point presentation, Exercises (group and individual).

## SEMESTER IV

## CORE PRACTICAL IV

## PHYSICAL CHEMISTRY PRACTICALS

**TOTAL HOURS: 90** **SUB CODE: 16PCHCP4004**

**CREDIT: 4** **L-T-P: 1-1-4**

**COURSE OBJECTIVES:**

1. To equip the students with the basic skills related to theoretical knowledge and apply them in laboratory as well as field conditions and industries.
2. To demonstrate and make the students to use the laboratory instrument/equipment's practically.
3. To help the students focus in initiating scientific thinking, research and decision making approach.

**COURSE OUTCOMES:** on completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| **CO1** | To impart practical knowledge on the theoretical subjects handled. |
| **CO2** | To understand and verify the principles and theory of physical chemistry experiments.To learn and understand the working principles of the laboratory tools and techniques, and utilize them practically. |
| **CO3** | To evaluate, interpret and analyze the acquired data. To carry out conductometric and potentiometric experiments in order. |
| **CO4** | To acquire skill in the determination of equivalent conductance and solubility product etc. |
| **CO5** | . To help the student with innovative thoughts and scientific thinking and research. |

## SYLLABUS

1. Construction of phase diagram for a simple binary system; naphthalene – biphenyl, naphthalene –p-dichlorobenzene, naphthalene-diphenylamine.
2. Determination of partition coefficient, equilibrium constant and unknown concentration of potassium iodide of the reaction between iodine and potassium iodide by partition method.
3. Kinetic study of the reaction between acetone and iodine in acidic medium and determination of the order with respect to iodine and acetone
4. Comparison of acid strengths for hydrolysis of methylacetate catalyzed by acids
5. Determination of the rate constant and order for the reaction between potassium persulphate and potassium iodide
6. Conductometric titrations of single and mixture of strong and weak acids against strong base.
7. Potentiometric Experiments
    1. Determination of pH and pKa
    2. Determination of solubility product of a sparingly soluble salt.
    3. Potentiometric titrations
        a. single and mixture of strong and weak acids and strong base
        b. Redox titrations by emf measurements.
        c. Precipitation titration of mixture of halides.

## Text Books

1. Yadav, J. B (2005): Advanced Practical Physical Chemistry, 22 ndedition, Goel publishing House, Krishna Prakashan Media Ltd. 2. Venkatesan, V,Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.

## References

1. Findlay's (1985): Practical Physical Chemistry, Revised and edited by B.P. Levitt 9 th edition, Longman, London.

2. Chatwal, G.R. andAnand,S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi.

## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 2 | 2 | 3 | 2 | 2 |
| **CO 4** | 2 | 2 | 3 | 3 | 2 |
| **CO 5** | 2 | 2 | 3 | 3 | 3 |
| **Average** | **2.4** | **2.4** | **3** | **2.8** | **2.6** |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):** Lecture, Power point presentation/Seminar, Exercises and discussions (group and individual), Field Trips, Rapid fire question session, brain storming.

## SEMESTER IV

# PROJECT

**TOTAL HOURS: 90** **SUB CODE: 16PCHPR4001**

**CREDIT: 4** **L-T-P: 1-2-3**

**COURSE OBJECTIVES:**

1. The project is designed to cater to the needs of all categories/multidisciplinary approach of subjects related to chemistry, crystal growth, nano materials, polymer chemistry, life sciences etc.
2. To infuse the students fresh mind and help them with creative ideas and innovative thoughts which will help them in novel thinking, researching, analyzing and decision making skills.
3. The project will be a buffet tablet which will help each and every student with something in their exponential career.

**COURSE OUTCOMES:** on completion of the course the students will be able to

| CO No. | CO Statement |
|---|---|
| **CO1** | To know, understand and able to do the literature survey for the selected topic. |
| **CO2** | Acquire skills in practical work, experiments, laboratory techniques and field based studies with multidisciplinary work and tasks. |
| **CO3** | Handle instruments for analysis and discuss their experimental results |
| **CO4** | To discuss, compare, evaluate and interpret the results and to prepare reports/presentation and defend their work. |
| **CO5** | To facilitate students for taking up and shaping a successful careers in chemistry, biochemistry, material science /multidisciplinary fields. |

## Mapping of CO with PSO:

| CO / PSO | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 2 | 2 |
| **CO 2** | 3 | 3 | 3 | 3 | 2 |
| **CO 3** | 3 | 2 | 3 | 3 | 3 |
| **CO 4** | 2 | 3 | 1 | 3 | 2 |
| **CO 5** | 2 | 3 | 2 | 3 | 3 |
| **Average** | **2.6** | **2.8** | **2.4** | **2.8** | **2.4** |

**KEY: PEDAGOGY (TEACHING METHODOLOGY):** Lecture, Power point presentation/seminar, exercises, discussions (group and individual), visit labs, , brain storming, literature survey, practical's and data interpretation, report writing.

# PG QUESTION PAPER PATTERN
# FOR OBE ONLINE ASSESSEMENT
# (2020 - 2021)

| Bloom's Category Level | Sections | Marks | Description of answer | Total | Meaning of K's |
|---|---|---|---|---|---|
| **INTERNAL SETTING** | | | | | |
| K1,K2,K3 | **Section A**<br>Multiple Choice Questions<br>25 Questions<br>*1 Marks (No Choice) | 25X1=25 | Choose the right option. | 50 | K 1 & K2 - Understanding Level<br>K 3 - Apply Level<br>K 4 - Analyze Level<br>K 5 – Evaluate Level<br>K 6 – Create Level |
| **EXTERNAL SETTING** | | | | | |
| K2,k3,K4, K5,K6 | **Section B**<br>5 out of 7 Questions<br>*5 Marks | 25 | Short answers/500 Words | | |

*** 50 marks to be converted as 60 marks.**

**Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women**

**(Autonomous)**

**Re-accredited with "A+" Grade by NAAC**

**Amendments in the regulations from 2020 – 2021 onwards**

**PG Changes in Part-II**
**Semester – I**

| Title | Internal Marks | External Marks | Credits |
|---|---|---|---|
| Skill based elective-Teaching Skills | 50 | - | 3 |

**Semester – II**

| Title | Internal Marks | External Marks | Credits |
|---|---|---|---|
| Soft Skills – SWAYAM (MOOC) | 50 | - | 4 |

**Semester – III**

| Title | Internal Marks | External Marks | Credits |
|---|---|---|---|
| Skill based elective -Research Skills | 50 | - | 3 |

**Semester – IV**

| Title | Internal Marks | External Marks | Credits |
|---|---|---|---|
| Extra Disciplinary– SWAYAM (MOOC) | 50 | - | 4 |