ANNAMALAI UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

M. Sc. CHEMISTRY (INTEGRATED)

(5 - YEAR)

PROGRAMME CODE: SCHE 51

CURRICULUM AND SYLLABI - 2019

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE FIVE YEAR INTEGRATED POSTGRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Five Year Integrated Master's Programmes in the Faculties of Arts, Science, Languages, Marine Sciences, and Education from the academic year 2019-2020 onwards.

1. Definitions and Nomenclature

1.1 University refers to Annamalai University.

1.2 Department means any of the academic departments and academic centres at the University.

1.3 Discipline refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 Programme encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 Course is an individual subject in a programme. Each course may consist of Lectures/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/viva-voce etc. Each course has a course title and is identified by course code.

1.6 Curriculum encompasses the totality of student experiences that occur during the educational process.

1.7 Syllabus is an academic document that contains complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 Academic Year refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 Semester is a half-year term that lasts for a minimum of 90 working days. Each academic year is divided into two semesters.

1.10 Choice Based Credit System A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 Core Course is mandatory and an essential requirement to qualify for the Degree.

1.12 Elective Course is a course that a student can choose from a range of alternatives.

1.13 Value Added Courses are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 Experiential Learning is a process of learning through experience. It is specifically defined as "learning through reflection on doing".

1.15 Extension activities are the activities that provide a link between the University and the community such as lab-to-land, literacy, population education, and health awareness programmes. These are integrated within the curricula with a view to sensitise the students about Institutional Social Responsibility (ISR).

1.16 Credit refers to the quantum of course work in terms of the number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.17 Credit Hour refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.18 Programme Outcomes (POs) are statements that describe crucial and essential knowledge, skills, and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.19 Programme Specific Outcomes (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.20 Learning Objectives (also known as Course Objectives) are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

1.21 Course Outcomes (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.22 Grade Point Average (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in Section 11.3.

1.23 Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student in all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters.

1.24 Letter Grade i**s** an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, and RA.

2. Programmes Offered and Eligibility Criteria

The Integrated Programmes offered by the University and the eligibility criteria are detailed below.

Faculty of Arts	
Programme	**Eligibility**
M.A. History M.A. Political Science M.A. Economics M.A. Sociology M.A. Population and Development M.Lib.I.Sc. M.A. Rural Development	A pass in H.S.E. (10+2 level) OR Equivalent thereto.
M.Com.	A pass in H.S.E. (10+2 level) OR Equivalent thereto (Commerce and Accountancy Group only).
Faculty of Science	
M.Sc. Mathematics	A pass in H.S.E. (10+2 level) OR Equivalent thereto with a minimum aggregate of 40% marks under academic stream in the following subjects viz. Mathematics, Physics & Chemistry.
M.Sc. Physics	A pass in H.S.E. (10+2 level) OR Equivalent thereto with a minimum aggregate of 40% marks under academic stream in the following subjects viz. Physics, Chemistry & Mathematics.
M.Sc. Chemistry	A pass in H.S.E. (10+2 level) Examination OR Equivalent thereto with a minimum aggregate of 40% marks in any one of the following combinations: 1. Mathematics, Physics & Chemistry 2. Biology, Physics & Chemistry 3. Botany, Physics & Chemistry 4. Zoology, Physics & Chemistry.
M.Sc. Botany	A pass in H.S.E. (10+2 level) regular or vocational with Botany/Biology or Vocational course with Agriculture/Plant Protection as one of the courses.
M.Sc. Biotechnology	A pass in H.S.E. (10+2 level) OR Equivalent thereto under academic stream with a minimum aggregate of 40% marks in any one of the following combinations: 1. Physics, Chemistry & Mathematics 2. Physics, Chemistry &

	Biology 3. Physics, Chemistry & Botany 4. Physics, Chemistry & Zoology 5. Physics, Chemistry & Biochemistry.
M.Sc. Microbiology	A pass in H.S.E. (10+2 level) OR Equivalent thereto under academic stream with Physics, Chemistry and Biology or Computer Science or Biochemistry or Home Science or Agri. or any Vocational Course with Biology or Botany and Zoology.
M.Sc. Geology	A pass in H.S.E. (10+2 level) OR Equivalent with Science Subjects.
M.Sc. Statistics	A pass in H.S.E. (10+2 level) OR an Equivalent examination thereto under academic stream with Mathematics / Statistics / Business Mathematics / Computer Science as one of the subjects.
M.Sc. Zoology	A pass in H.S.E. (10+2 level) OR Equivalent thereto with a minimum aggregate of 40% marks under academic stream in the following subjects viz. Physics, Chemistry and Biology or Zoology and Botany.
M.Sc. Software Engineering	A pass in H.S.E. (10+2 level) OR Equivalent thereto under academic stream with Mathematics, as one of the Subjects.
M.Sc. Information Technology	A pass in H.S.E. (10+2 level) OR Equivalent thereto under academic stream with Mathematics as one of the subjects.
Faculty of Marine Sciences	
M.Sc. Ocean Science & Technology	A pass in H.S.E. (10+2 level) OR Equivalent thereto under Academic Stream in the following subjects viz. Mathematics, Physics, Chemistry & Biology.
Faculty of Languages	
M.A. Tamil	A pass in H.S.E. (10+2 level) OR Equivalent thereto.
M.A. English	A pass in H.S.E. (10+2 level) OR Equivalent thereto.
Faculty of Education	
M.Sc. Clinical Psychology	A pass in H.S.E. (10 + 2) OR Equivalent thereto.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for all the above Programmes.

3. Reservation Policy

Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Five Year Master's Programmes consist of five academic years and ten semesters.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Five Year Integrated Programme consists of Language Courses, Core Courses, Allied Courses, Elective Courses, Soft Skills, Experiential Learning and Project. Students shall also participate in Extension Activities as part of their curriculum.

5.2 Language Courses

5.2.1 Each student shall take two languages of four courses each, one in each semester for the first two years of the programme.

5.2.2 Language-I shall be Tamil or another language such as Hindi or French.

5.2.3 Language-II shall be English.

5.3 Core courses

5.3.1 These are a set of compulsory courses essential for each programme.

5.3.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.4 Allied Courses

5.4.1 Each student shall take courses in two disciplines allied to the main subject (Allied-I and Allied-II) of the programme in the first four semesters.

5.4.2 In Arts, Languages, and Education, there will be three Theory Courses each for Allied-I and Allied-II.

5.4.3 In Science and Marine Sciences, there will be two Theory courses and one Practical course each for Allied-I and Allied-II. (Allied Maths two theory paper only)

5.5 Elective Courses

5.5.1 Departmental Electives (DEs) are the electives that students can choose from a range of Electives offered within the Parent Department offering the Programme.

5.5.2 Interdepartmental Electives (IDEs) are electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.5.3 *Students shall take a combination of both DEs and IDEs.*

5.6 Soft Skills

5.6.1 Soft skills are intended to enable students to acquire attributes that enhance their performance and achieve their goals with complementing hard skills.

5.6.2 Soft skills include communication skills, computer skills, social skills, leadership traits, teamwork, development of emotional intelligence quotients, among others.

5.6.3 Each student shall choose four courses on soft skills from a range of courses offered from the First to the Sixth Semester.

5.7 Value Education

All students shall take a course on Value Education that includes human values, sustainable development, gender equity, ethics and human rights.

5.8 Experiential Learning

5.8.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.8.2 In-plant training/field trips/internships/industrial visits (as applicable) fall under this category.

5.9 Extension Activities

5.9.1 It is mandatory for every student to participate in extension activities.

5.9.2 All the students shall enrol under NSS/NCC/YRC/RRC or any other Service Organisation in the University.

5.9.3 Students shall put in a minimum attendance of 40 hours in a year duly certified by the Programme Co-ordinator.

5.9.4 Extension activities shall be conducted outside the class hours.

5.10 Project

5.10.1 Each student shall undertake a Project in the final semester.

5.10.2 The Head of the Department shall assign a Project Supervisor to the student.

5.10.3 The Project Supervisor shall assign a topic for the project and monitor the progress of the student periodically.

5.10.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Project Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.11 Value Added Courses (VACs)

5.11.1 Students may also opt to take Value Added Courses beyond the minimum credits required for the award of the Degree. VACs are outside the normal credit paradigm.

5.11.2 VACs enhance the students' employability and life skills. VACs are listed on the University website and in the Handbook on Interdepartmental Electives and VACs.

5.11.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.11.4 Classes for VACs are conducted beyond the regular class hours and preferably in the VIII and IX Semesters.

5.12 Online Courses

5.12.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.11.2 Students who successfully complete a course in the MOOC platform shall be exempted from one elective course of the programme.

5.12 Credit Distribution

The credit distribution is detailed in the Table.

	Credits
Semester I to VI	
Language-I (Tamil or any other Language)	12
Language-II (English)	12
Core Courses	60-65
Allied-I	10
Allied-II	10
Electives	15
Soft skills	12
Environmental studies (UGC mandated)	2
Value Education	2
Experiential learning	4
Extension activities	1
Total Credits (Semester I to VI)	**140-145**
Semester VII to X	

Core Courses	65-75
Electives	15
Project	6-8
Total Credits (Semester VII to X)	**90-95**
Total Credits Semester I to X (Minimum requirement for the award of Degree)	***230-240**

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 230-240 credits.*

5.13 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of *Attendance and Assessment Record* for students who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition, the Record shall also contain the organisation of lesson plan of the Course Instructor.

6.3 The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student should earn a minimum of 75% attendance in the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness.

7. Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8. Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and fieldwork through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy, viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments, seminars, and viva-voce that would be suitable for the course. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5 CIA Tests will be for one to three hours duration depending on the quantum of syllabus.

8.4.6 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.5 End Semester Examinations (ESEs)

8.5.1 The ESEs for the odd semester will be conducted in November and for the even semester in May.

8.5.2 A candidate who does not pass the examination in any course(s) will be permitted to reappear in such course(s) in the subsequent semester/year.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1. Each course, both Theory and Practical, as well as Project/Internship/Fieldwork/In-plant training, shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE, 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will constitute 40% and the ESE 60% of the marks.

9.2. Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	15
Test-II	15
Viva-voce and Record	10
Total	40

9.3 Assessment of End-Semester Examinations

9.3.1 Double Evaluation for the ESE is done by the University Teachers.

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of Review of literature, experimentation/fieldwork, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise of the Head of the Department, Project Supervisor, and a senior faculty.

9.4.7 The marks shall be distributed as follows:

<table>
<tr><td colspan="2">Continuous Internal Assessment (25 Marks)</td><td colspan="2">End Semester Examination (75 Marks)</td></tr>
<tr><td rowspan="2">Review-I 10</td><td rowspan="2">Review-II: 15</td><td>Project / Dissertation Evaluation</td><td>Viva-voce</td></tr>
<tr><td>50</td><td>25</td></tr>
</table>

9.5 Assessment of Value Added Courses

9.5.1 VACs shall be evaluated completely by Internal Examiners.

9.5.2 Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A candidate is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.4 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms of Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed from the first semester to the current semester.

11.3 The GPA is calculated by the formula

$$GPA = \frac{\sum_{I=1}^{n} C_i G_i}{\sum_{I=1}^{n} C_i}$$

where C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

11.4 CGPA is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{I=1}^{m} \sum_{I=1}^{n} C_i G_i}{\sum_{I=1}^{m} \sum_{I=1}^{n} C_i}$$

where C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

m is the number of semesters.

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

Letter Grade	Grade Points	Marks %
S	10	90 and above
A	9	80-89
B	8	70-79
C	7	60-69
D	6	55-59

E	5	50-54
RA	0	Less than 50
W	0	Withdrawn from the examination

11.6 Classification of Results. The successful candidates are classified as follows:

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme *in the first attempt* with a CGPA of 8.25 or above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (*See Section 12 for details*).

11.6.2 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 to less than 6.5.

11.6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.7 Course-Wise Letter Grades

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A candidate is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course completed successfully, cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the student has re-appeared.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one or more courses in **ANY ONE** of the semesters **ONLY** for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.3 Application for withdrawal shall be considered **only** if the student has registered for the course(s), fulfilled the requirements for attendance and CIA tests.

12.4 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.5 Withdrawal is **not** granted for arrear examinations of courses in previous semesters (for which the student has secured RA Grade) and for the final semester examinations.

12.6 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) in the subsequent semester.

12.7 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the student to qualify for First Class with Distinction.

13. Academic misconduct

Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing department library or computer resources, stealing other students' notes/assignments, electronically interfering with other students'/ University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitised on issues of academic integrity and ethics.

14. Transitory Regulations

Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after the implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. *Notwithstanding anything contained in the above pages as Rules and Regulations governing the Five Year Integrated Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.*

PROGRAMME OUTCOMES

PO1. Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO2. Resource Utilisation: Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

PO3. Analytical and Technical Skills: Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO4. Critical thinking and Problem solving: Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO5. Project Management: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.

PO6. Individual and teamwork: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7. Effective Communication: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

PO8. Environment and Society: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO9. Ethics: Commitment to professional ethics and responsibilities.

PO10. Life-long learning: Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PROGRAMME SPECIFIC OUTCOMES

PSO1 Gains complete knowledge about all fundamental aspects of all branches of chemistry.

PSO2 Understands the basic concepts of organic chemistry like reagents in organic syntheses, stereochemistry, instrumental method of chemical analysis and natural products etc.

PSO3 Identify the importance inorganic chemistry includes coordination chemistry, role of metal ions in biological processes and organometallic chemistry.

PSO4 Gathers attention about the physical aspects of molecules like molecular spectroscopy, role of catalysts, polymer chemistry, materials chemistry and bio-physical chemistry.

PSO5 Learns about the potential uses of analytical industrial chemistry, medicinal chemistry, and environment oriented chemistry. Apply the various analytical techniques like IR, mass, NMR, NQR, EPR, XRD to structural characterization of unknown compounds.

PSO6 Carry out experiments in the area of organic analysis, estimation, separation derivative process, inorganic semi microanalysis, preparation, conductometric and potentiometric analysis.

PSO7 Obtain knowledge in Spectral, Analytical, Qualitative & Quantitative techniques and contribute new scientific insights or innovative applications of chemical research to the next generation.

ANNAMALAI UNIVERSITY

DEPARTMENT OF CHEMISTRY

M. Sc. Chemistry (5-Year Integrated) Programme
PROGRAMME CODE: SCHE51
Programme Structure
(For students admitted from the academic year 2019 - 2020)

Total Credits: 228

Course Code	Course Title	L	P	C	Inter. Mark	Exter. Mark	Total
FIRST SEMESTER							
19ITAC11	Language – I: Course 1	3		3	25	75	100
19IENC12	Language – II: Course 1	3		3	25	75	100
19ICEC13	Civics, Environmental and Health Sciences	3		3	25	75	100
19ICHT14	Inorganic, Organic and Physical Chemistry - I	5		4	25	75	100
	Elective 1: Department Elective	3		3	25	75	100
19ICHA16	Ancillary - I: Mathematics - I / Botany - I	4		5/4	25	75	100
	Total credits			21/20			
SECOND SEMESTER							
19ITAC21	Language – I: Course 2	3		3	25	75	100
19IENC22	Language - II: Course 2	3		3	25	75	100
19ICEC23	Computer Applications – I	3		3	25	75	100
19ICHT24	Inorganic, Organic and Physical Chemistry - II	5		5	25	75	100
19ICHP25	Practical – I: Volumetric Analysis		6	5	40	60	100
19ICHA26	Ancillary I: Mathematics - II / Botany – II	4		5/4	25	75	100
19ICHP27	Ancillary: Botany Practical – I		5	2	40	60	100
	Total credits			25/24			
THIRD SEMESTER							
19ITAC31	Language – I: Course 3	3		3	25	75	100
19IENC32	Language – II: Course 3	3		3	25	75	100
19ICHT33	Inorganic, Organic and Physical Chemistry - III	5		5	25	75	100
19ICHP34	Practical – II: Inorganic Qualitative Analysis		10	5	40	60	100
	Elective 2: Department Elective	3		3	25	75	100
19ICHA36	Ancillary - II: Physics – I	4		4	25	75	100
	Total credits			23			
FOURTH SEMESTER							
19ITAC41	Language – I: Course 4	3		3	25	75	100
19IENC42	Language – II: Course 4	3		3	25	75	100
19ICHT43	Inorganic, Organic and Physical Chemistry – IV	4		4	25	75	100
19ICHP44	Practical – III: Preparation and Analysis of Organic Compounds		5	5	40	60	100
19ICHT45	Analytical Chemistry	4		5	25	75	100
19ICHA45	Ancillary - II: Physics – II	4		4	25	75	100
19 ICHP46	Ancillary: Physics Practical		5	2	40	60	100
	Total credits			26			
FIFTH SEMESTER							
19ICHT51	Organic Chemistry – I	4		5	25	75	100
19ICHT52	Inorganic Chemistry – I	4		5	25	75	100
19ICHT53	Physical Chemistry – I	4		5	25	75	100
	Elective 3: Department Elective	3		3	25	75	100
19ICHP55	Practical – IV: Gravimetric Analysis		12	6	40	60	100
	Total credits			24			

SIXTH SEMESTER							
19ICHT61	Organic Chemistry – II	4		5	25	75	100
19ICHT62	Inorganic Chemistry – II	4		5	25	75	100
19ICHT63	Physical Chemistry – II	4		5	25	75	100
19ICHT64	Pharmaceutical Chemistry	4		5	25	75	100
19ICHP65	Practical – V: Basic Physical Chemistry Practical		12	6	40	60	100
	Total credits			26			
SEVENTH SEMESTER							
19ICHT71	Organic Reaction Mechanisms	4		4	25	75	100
19ICHT72	Coordination Chemistry and Inorganic Reaction Mechanisms	4		4	25	75	100
19ICHT73	Chemical Thermodynamics, Photochemistry and Group Theory	4		4	25	75	100
19ICHP74	Organic Chemistry Practical- I		5	3	40	60	100
19ICHP75	Physical Chemistry Practical- I		5	3	40	60	100
	Elective 4: Inter Department Elective	3		3	25	75	100
	Total credits			21			
EIGHTH SEMESTER							
19ICHT81	Organic Photochemistry and Molecular Rearrangements	4		4	25	75	100
19ICHT82	Solid-State and Organometallic Chemistry	4		4	25	75	100
19ICHT83	Chemical Kinetics and Quantum Mechanics	4		4	25	75	100
19ICHP85	Organic Chemistry Practical–II		5	3	40	60	100
19ICHP86	Inorganic Chemistry Practical–I		5	3	40	60	100
	Elective 5: Inter Department Elective	3		3	25	75	100
	Elective 6: Department Elective	3		3	25	75	100
	Total credits			24			
NINTH SEMESTER							
19ICHT91	Synthetic Organic Chemistry	4		4	25	75	100
19ICHT92	Green Chemistry, Computational Chemistry, Drug Design and Spectroscopy	4		4	25	75	100
19ICHT93	Spectral and Analytical Techniques	4		4	25	75	100
19ICHT94	Electrochemistry and Spectroscopy	4		4	25	75	100
19ICHP96	Inorganic Chemistry Practical – II		5	3	40	60	100
19ICHP97	Physical Chemistry Practical – II		5	3	40	60	100
	Elective 7: Inter Department Elective	3		3	25	75	100
	Elective 8: Department Elective	3		3	25	75	100
	Total credits			28			
TENTH SEMESTER							
19ICHT101	Nuclear, Bioinorganic and Materials Chemistry	4		4	25	75	100
19ICHT102	Nano Materials, Macromolecular and Surface Chemistry	4		4	25	75	100
19ICHP103	Organic Chemistry Practical–III		4	2	40	60	100
19ICHP104	Inorganic Chemistry Practical–III		4	2	40	60	100
19ICHP105	Physical Chemistry Practical–III		4	2	40	60	100
19ICHPJ106	Project Work / Inplant training		10	6	25	75	100
	Total credits			20			
	TOTAL CREDITS			**237**			
	Value Added Courses						
	Online Courses (SWAYAM, MOOC, NPTEL)						

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

DEPARTMENT ELECTIVE COURSES

COURSE CODE	COURSE TITLE	L	P	C	INTER. MARK	EXTER. MARK	TOTAL
19ICHE15A	Applied Chemistry	3	-	3	25	75	100
19ICHE15B	Industrial Chemistry	3	-	3	25	75	100
19ICHE35A	Chemistry for mankind	3	-	3	25	75	100
19ICHE35B	Food chemistry	3	-	3	25	75	100
19ICHE54A	Clinical Chemistry	3	-	3	25	75	100
19ICHE54B	Agricultural Chemistry	3	-	3	25	75	100
19ICHE84A	Selective materials, techniques and environmental chemistry	3	-	3	25	75	100
19ICHE84B	Applied chemistry	3	-	3	25	75	100
19ICHE95A	Scientific Research Methodology	3	-	3	25	75	100
19ICHE95B	Organic chemical technology	3	-	3	25	75	100

INTERDEPARTMENTAL ELECTIVES (IDE)

S. No.	Course Code	Course Title	Department	Hours/ week		C	Marks		
				L	P		CIA	ESE	Total
1.	19 SOSE115.1	Soft Skills	English	3	0	3	25	75	100
2.	19 MATE215.1	Discrete Mathematics	Mathematics	3	0	3	25	75	100
3.	19 MATE215.2	Numerical Methods		3	0	3	25	75	100
4.	19 MATE315.1	Differential Equations		3	0	3	25	75	100
5.	19 STSE 15.1	Statistical Methods	Statistics	3	0	3	25	75	100
6.	19 STSE215.2	Mathematical Statistics		3	0	3	25	75	100
7.	19 STSE315.1	Bio-Statistics		3	0	3	25	75	100

8.	19 PHYE215.1	Classical Mechanics and Special Theory of Relativity	Physics	3	0	3	25	75	100
9.	19 PHYE215.2	Physics of the Earth		3	0	3	25	75	100
10.	19 PHYE315.1	Bio-Medical Instrumentation		3	0	3	25	75	100
11.	19 PHYE315.2	Energy Physics		3	0	3	25	75	100
12	19 BOTE215.1	Plant Tissue Culture	Botany	3	0	3	25	75	100
13	19 BOTE215.2	Plant Science – I		3	0	3	25	75	100
14	19 BOTE315.1	Gardening and Horticulture		3	0	3	25	75	100
15	19 BOTE315.2	Plant Science – II		3	0	3	25	75	100
16	19 ZOOE215.1	Animal Culture Techniques	Zoology	3	0	3	25	75	100
17	19 ZOOE315.1	Environmental Science		3	0	3	25	75	100
18	19 GEOE215.1	Environmental Geosciences	Earth Sciences	3	0	3	25	75	100
19	19 GEOE315.1	Applied Geophysics		3	0	3	25	75	100
20	19 MIBE315.1	Microbiology	Microbiology	3	0	3	25	75	100
21	19 CISE215.1	R Programming	Computer & Information Science	3	0	3	25	75	100

INTER-DEPARTMENT ELECTIVES OFFERED TO OTHER DEPARTMENTS

COURSE CODE	COURSE TITLE	L	P	C	INTER. MARK	EXTER. MARK	TOTAL
19ICHEX87	APPLIED CHEMISTRY	3	-	3	25	75	100
19ICHEX97A	BASIC CHEMISTRY	3	-	3	25	75	100
19ICHEX97B	INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS	3	-	3	25	75	100

ANCILLARY COURSES OFFERED TO OTHER DEPARTMENTS

COURSE CODE	COURSE TITLE	L	P	C	INTER. MARK	EXTER. MARK	TOTAL
19ICHA-I	CHEMISTRY I	4		4	25	75	100
19ICHA-II	CHEMISTRY II	4		4	25	75	100
19ICHPA	CHEMISTRY PRACTICAL I		4	4	25	75	100

SEMESTER - I **Credits: 4**

Hours: 4

19ICHT14 - Inorganic, Organic and Physical Chemistry – I

Learning Objectives:

To learn the basic principles of atomic structure, bonding and the concepts of gaseous and liquid states

Unit–I: Atomic Structure and Periodic Properties

Atomic orbitals, quantum numbers, shapes of s, p and d orbitals. Aufbau principle, Pauli exclusion principle. Hund's rule. Electronic configuration of atoms. Screening effect. Effective nuclear charge. Calculation of effective nuclear charge using Slater rules. Periodic classification of elements based on electronic configuration. Atomic and ionic radii. Ionization energy, Electron affinity and electronegativity. Trends in periodic table.

Unit–II: Study of s block elements I – Hydrogen and alkali metals

Hydrogen – preparation, properties and uses - hydrogen as a fuel - Isotopes of hydrogen.

Alkali metals – Electronic structure, sizes of atoms and ions. Chemical properties: Oxides, hydroxides, peroxides and superoxides, hydrides and halides of alkali metals.

Compounds of Li, Na and K - preparation, properties and uses of LiCl, Li_2CO_3, washing soda, baking soda, sodium nitrite, sodamide, KI and KCN.

Unit–III: Formation and Characters of Covalent Bond Involving Carbon

Types of hybridization of carbon. Structures of methane, ethane, ethylene and acetylene. C-C bond lengths in ethane, ethylene and acetylene. Inductive effect, resonance, hyperconjugation, aromaticity, classification of organic compounds. Types of organic reactions. Types of intermediates like carbocations, carbanions and radicals. Factors influencing the stabilities of intermediates.

Unit–IV: Alkanes, Alkenes and Alkynes

Nomenclature. Methods of preparation of alkanes – physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes – reactivity and regioselectivity.

Methods of preparation of alkenes. Mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides. Saytzeff rule. Hofmann's rule. Physical properties and chemical reactions of alkenes. Markovnikov's rule – Hydroboration – epoxidation – ozonolysis – hydroxylation.

Oxidation, reduction and polymerization. Uses of ethylene and propene. Cumulative, conjugated and isolated double bonds. 1,3 Butadiene, 1,4-addition. Diels – Alder reaction, polymerization reactions of butadiene.

Unit–V: Gaseous and Liquid States

Kinetic theory of gases. Deviation from ideal behaviour van der Waals equation of state. PV isotherm of real gases. Continuity of state. Critical phenomena – critical constants for a van der Waals gas. Law of corresponding states – reduced equation of state. Qualitative idea of structure of liquids. Structure of nematic and cholesteric phases. Applications of liquid crystals.

Text Books

1) J.D. Lee, Concise Inorganic Chemistry, 5th Ed. Blackwell Science Ltd, London, 2012.
2) B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2016.
3) I.L.Finar, Organic Chemistry, Volume 1, 6th Ed., Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2012.
4) B.R. Puri, L.R. Sharma, S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co. New Delhi, 2017.

Supplementary Reading

5) B.S.Bahl, Arun Bahl, Advanced Organic Chemistry, S. Chand & Co. Ltd., New Delhi, 2012.

6) S.H. Maron, C.F. Prutton, Principles of Physical Chemistry, IV Ed. Macmillan, 1990.

Course Outcomes:

CO1 Students will know the important basics of chemistry

CO2 Students will start the basic building of chemistry principles in inorganic, organic and physical chemistry.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								

SEMESTER - II **Credits: 5**
Hours: 5

19ICHT24 - Inorganic, Organic and Physical Chemistry – II

Learning Objectives:

To learn the basic principles of periodic classification, organic functional groups and thermodynamics

Unit – I: Study of s block elements II - Alkaline Earth Metals

Electronic structure – sizes of atoms and ions. Chemical properties – Oxides, hydroxides, peroxides, nitrides, carbides, hydrides and halides of alkaline earth metals comparison of Be and Mg with other alkaline earth metals – Comparison of alkaline earth metals with alkali metals - Plaster of Paris, Portland cement – Hardness of water.

Unit – II: Arene, Alkyl Halides and Aryl Halides

Nomenclature of benzene derivatives. Isolation of benzene from coal tar. Mechanism of electrophilic substitution. Activating and deactivating substituents. Orientation, effect of substituents.

Preparation, physical properties and chemical reactions of alkyl halides. S_N1 and S_N2 mechanisms. Manufacture, properties, reactions and uses of $CHCl_3$ and CCl_4, vinyl chloride, allyl chloride and chlorobenzene. Relative reactivities of alkyl, aryl, vinyl and allyl halides.

Unit – III: Alcohols and Phenols

Alcohols: Classification: Monohydric alcohols – nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols.

Dihydric alcohols – nomenclature, methods of formation, chemical reactions of vicinal diols, oxidative cleavage by $Pb(OAc)_4$ and HIO_4 and pinacol-pinacolone rearrangement. Glycerol – manufacture, properties, reactions and uses.

Phenols: Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Gattermann synthesis, Houben – Hoesch reaction and Reimer – Tiemann reaction.

Unit – IV: Chemical Kinetics and Catalysis

Rate of a chemical reaction. Factors influencing rates of chemical reactions. Order and molecularity. Rate equations for zero-, first- and second-order reactions. (For second-order reaction with equal and unequal concentrations of reactants). Half-life period. Determination of order of reaction- differential method, method of integration, half-life period method, isolation method. Method of following kinetics by titrimetric procedures. Acid- and base- catalysed hydrolysis of ester and iodination of acetone as examples. Arrhenius equation, concept of activation energy. Simple collision theory. Catalysis, characteristics of catalysed reactions, classification of catalysts.

Unit – V: Thermodynamics - I

Definition of system and surroundings. Types of systems, thermodynamic properties - intensive and extensive properties. State and path functions - Concept of heat and work – thermodynamic equilibrium – reversible and irreversible processes.

First law of thermodynamics: statement - heat capacities at constant volume and constant pressure, relationship between C_p and C_v.

Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Thermochemistry: standard state, standard heat of formation – Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Heat of neutralization - temperature dependence of heat of chemical reaction – Kirchoff's equation.

Text Books

1) J. D. Lee, Concise Inorganic Chemistry, 5th Ed. Blackwell Science Ltd, London, 2012.
2) B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2016.
3) I.L. Finar, Organic Chemistry, Volume 1, 6th Ed., Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2012.
4) B.S. Bahl, Arun Bahl, Advanced Organic Chemistry, S. Chand & Co. Ltd., New Delhi, 2012.
5) Jerry March, Advanced Organic Chemistry, 7th Ed. John Wiley, 2016.
6) B.R. Puri, L.R. Sharma, S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co. New Delhi, 2017.

Supplementary Reading

7) K.J. Laidler, Chemical Kinetics, 3rd Ed. Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2008.
8) G.L.Agarwal, Basic Chemical Kinetics, Tata Mc Graw Hill, 1990.
9) J. Rajaram, J.C. Kuricose, Thermodynamics for Students of Chemistry, Shoban Lal Nagin Chand & Co. New Delhi, 1999.
10) S. Glasstone, Thermodynamics for Chemists; Affiliated East West Press, 2008.

Course Outcomes:

CO1 Students will know the important basics of chemistry

CO2 Students will start the basic building of chemistry principles in inorganic, organic and physical chemistry.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								

SEMESTER - II **Credits: 5**
Hours: 6

19ICHP25: Practical – I: Volumetric Analysis

Learning Objectives

To learn the basic principles of acid base titrations, important concepts of redox, precipitation titrations.

1. Acid-base Titrations:
   a) Determination of NaOH and Na_2CO_3 in a mixture by double titration.
   b) Estimation of barium chloride
   c) Determination of ammonium ion
2. Redox Titrations:
   a) Permanganametry – Estimation of ferrous and ferric ions in a mixture
   b) Estimation of oxalic acid and oxalate ion.
   c) Dichromatory – Estimation of Fe^{2+} and Fe^{3+} ions
   d) Iodometry – Estimation of copper
3. Precipitation Titration: Determination of chloride

Text Book:

1. A. I. Vogel, Textbook of Quantitative Inorganic Analysis, CBS Publishers, 1969.

Course outcomes:

CO1 Students will know the important basics of practical chemistry

CO2 Students will understand the principles involved in practical physical chemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								

SEMESTER - III **Credits: 5**
Hours: 5

19ICHT33 - Inorganic, Organic and Physical Chemistry – III

Learning Objectives:

To learn the basic principles of chemical bonding, classifications of organic compounds and the concepts of electrochemistry

Unit – I: Chemical Bonding

Ionic bonding: Formation and general properties. Radius ratio rule and its limitations. Hydration energy and lattice energy and their applications. Born-Haber cycle. Fagan's rules.

Covalent bond: Valence bond theory. Formation and general properties. Orbital overlap. Hybridization, sigma and pi bonds, VSEPR theory and geometries of H_2O, NH_3. CH_4, PCl_5, SF_6, IF_7, BF_3 molecules.

Partial ionic character of covalent bond and percentage of ionic character.

Molecular Orbital Theory: Bonding and anti-bonding molecular orbitals, bond order.

MO diagrams of H_2, Ne_2, O_2, O_2^+, O_2^- and CO.

Unit – II: Acids, Bases and Non Aqueous Solvents

Bronsted definition, Lewis definition, Lux-Flood definition – Usanovich's generalized definition – K_a K_b, pK_a and pK_b for Bronsted acids and bases. Relative strengths of Bronsted acids and bases- pH of Buffer solution- Henderson's equation. Theory of acid base indicators.

Non-aqueous solvents, liquid NH_3, liq.SO_2 and HF.

Unit – III: Ethers, Epoxides, Aldehydes and Ketones

Preparation, properties and chemical reactions of ethers with special reference to diethyl ether. Uses of diethyl ether. General methods of preparation of epoxides. Preparation, properties and chemical reactions of ethylene oxide. Polar nature of carbonyl group. Nomenclature of aldehydes and ketones. Important methods of preparation of aldehydes and ketones. Reactions and Industrial applications of aldehydes and ketones with special reference to formaldehyde, acetaldehyde, benzaldehyde, acetone, acetophenone and benzophenone.

Unit – IV: Carboxylic Acids and their Derivatives

Nomenclature. Important methods of preparing carboxylic acids. Reactions of carboxylic acids with special reference to formic acid, acetic acid and benzoic acid. Halogenated acids: chloroacetic acid, α-chloro and β-chloro propionic acid. Hydroxyacids: glycollic acid, lactic acid, tartaric acid, malic acid and citric acid. Preparation, properties and reactions of carboxylic acid derivatives with special reference to acetyl chloride, acetic anhydride, acetamide, ethyl acetate, benzoyl chloride and benzamide. Unsaturated acids: Acrylic acid and Crotonic acid. Dicarboxylic acids: oxalic acid, succinic acid and phthalic acid.

Unit – V : Electrochemistry - I

Electrical transport. Conduction in metals and in electrolyte solutions. Specific conductance and equivalent conductance. Measurement of equivalent conductance. Variation of equivalent and specific conductances with dilution.

Migrations of ions. Kohlrausch law. Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes. Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes. (elementary treatment only). Transport number: definition and determination by Hittorf method and moving boundary method.

Applications of conductivity measurements: determination of the degree of dissociation, determination of K_a of acids, determination of solubility product of a sparingly soluble salt and conductometric titrations.

Text Books

1) B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand & Co. New Delhi, 2017.

2) J. D. Lee, Concise Inorganic Chemistry, 5th Ed. Blackwell Science Ltd, London, 2012.

3) F.A. Cotton, G. Wilkinson, P.L.Gaus, Basic Inorganic Chemistry, 6th Edition, John Wiley, 2013.

4) I.L. Finar, Organic Chemistry, Volume 1, 6th Ed., Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2012.

5) R. T. Morrison, R.N. Boyd, Introduction to Organic Chemistry, Prentice Hall of India, 1992.

6) B.R. Puri, L.R. Sharma, S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co. New Delhi, 2017.

7) S. Glasstone, An Introduction to Electrochemistry, Affiliated East West Press, 2005.

Course Outcomes:

CO1 Students will understand the important basics of chemical bonding

CO2 Students will gain knowledge in various organic functional groups

CO3 Students will appreciate the fundamentals of electrochemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			

SEMESTER - III **Credits: 5**
Hours: 10

19ICHP34: Practical II - Inorganic Qualitative Analysis

Learning Objectives:

To analyze the inorganic mixture containing two cations and two anions

Analysis of mixture containing two cations and two anions of which one will be an interfering ion. Semi micro methods using the conventional scheme with hydrogen sulphide may be adopted.

Cations to be studied: Lead, Copper, Bismuth, Cadmium, Iron, Aluminium, Zinc, Manganese, Cobalt, Nickel, Barium, Calcium, Strontium, Magnesium and Ammonium.

Anions to be studied: Carbonate, Sulphide, Sulphate, Nitrate, Chloride, Bromide, Fluoride, Borate, Oxalate and Phosphate.

Text Book: V. V. Ramanujam, Semi micro Qualitative analysis, National publishers, 1995.

Course Outcomes:

CO1 Students will able to perform inorganic analysis systematically and independently

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√		√	√	√	√	√	√	√	

SEMESTER - IV **Credits: 4**
Hours: 4

19ICHT43 - Inorganic, Organic and Physical Chemistry – IV

Learning Objectives:

To learn the basic principles of metallurgy, important classifications of organic compounds and stereochemistry and to learn the concepts of Thermodynamics.

Unit – I: Metallurgy

Occurrence of metals. Extraction and concentration of ore. Various methods of concentration of ore. Various processes involved in metallurgy such as calcination, roasting, smelting, zone refining and froth flotation. Various types of reductions of metallic oxides into metals. Types of furnaces used in metallurgy. Reverberatory furnaces and blast furnace. Extraction of titanium, vanadium, chromium, iron and copper from their ores. Refining of metals-Electrolytic refining, Zone refining. Important physical and chemical properties of Ti, Th, U, Pb, Zn, Al, Fe and Cu. Important alloys of Ti, V, Cr, Pb, Zn, Al, Fe and Cu with special reference to steel and alloy steels.

Unit – II: Organic Compounds of Nitrogen

Preparation and reactions of nitroalkanes with special reference to nitromethane. Preparation and reactions of nitrobenzene. Preparation and reactions of aliphatic and aromatic nitriles with special reference to CH_3CN and C_6H_5CN. Primary, secondary and tertiary amines. Methods of preparation of amines. Separation of a mixture of primary, secondary and tertiary amines. Reactions of amines with special reference to methylamine, ethylamine, dimethylamine, diethylamine, triethylamine, aniline, N-methylaniline and N,N-dimethylaniline. Preparation and reactions of benzene diazonium chloride.

Unit – III: Stereochemistry of Organic Compounds

Asymmetric carbon. Optical activity and optical isomerism. Enantiomers and their representation by Fischer projection and flying wedge formula. R-S notation. Isomerism in compounds with two asymmetric carbons. Meso and dl-forms of tartaric acid and their representation by Fischer projection formula and flying wedge formula. Geometrical isomerism about C=C bond. Reason for high energy barrier to rotation about C=C bond. Geometrical isomerism of fumaric and maleic acids. E – Z notation. Use of dipole moment in differentiating E and Z 1,2-dihaloethenes.

Unit – IV: Thermodynamics - II

Second law of thermodynamics: Need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change during physical change, Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A and G as criteria for the thermodynamic equilibrium and spontaneity Variation of G and A with P, V and T.

Unit – V: Colloidal State and Adsorption

Definition and classification of colloids.

Sols: Kinetic, optical, electrical properties and stability of sols. Protective action. Hardy-Schulze law. Gold number.

Emulsions: Types of emulsions. Preparation. Emulsifier. Gels: classification, preparation and properties. Applications of colloids.

Difference between adsorption and absorption. Physical and chemical adsorptions. Freundlich adsorption isotherm and its experimental verification. Adsorption indicators.

Text Books:

1. B.R. Puri, L.R. Sharma, K.K. Kalia, Principles of Inorganic Chemistry, 32nd Ed. Milestone Publishers, New Delhi, 2016.

2. Jerry March, Advanced Organic Chemistry, 7th Ed. John Wiley, 20`6.
3. E.C. Eliel, Stereochemistry of Carbon Compounds, 42nd Ed. Tata Mc- Graw Hill, 2011.
4. R. T.Morrison, R.N. Boyd, Introduction to Organic Chemistry, 7th Ed. Prentice Hall of India, 2014.
5. B.R. Puri, L.R. Sharma, S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co. New Delhi, 2017.

Supplementary Reading

6. J. Rajaram, J.C. Kuricose, Thermodynamics for Students of Chemistry, Shoban Lal Nagin Chand & Co. New Delhi, 1999.
7. N. Kundu, S.K. Jain, Physical Chemistry, S.Chand and Co. Ltd., 2003.
8. W.J. Moore, Physical Chemistry, 4th Ed. Longmann Press, 1998.

Course Outcomes:

CO1 Students will know the important basics of chemical bonding

CO2 Students will understand various organic compounds and stereochemistry

CO3 Students will appreciate the fundamentals of physical chemistry particularly thermodynamics

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			

SEMESTER - IV **Credits: 5**
Hours: 5

19ICHP44: Practical III - Preparation and Analysis of Organic Compounds

Course Objectives:

To understand single step preparations of organic compounds

Preparations: Single step preparation involving reactions such as nitration, bromination, hydrolysis and acetylation.

Qualitative Analysis

a) Detection of N, S and Cl in organic compounds

b) Characterization of organic compounds as acidic, basic and neutral

c) Differentiation of organic compounds as saturated, unsaturated and aromatic and non-aromatic

d) Finding the presence of the following functional groups in organic compounds containing only one such functional group – phenolic, carboxyl, dicarboxyl, ester, nitro, amide, ketone, aldehyde

e) Analysis of carbohydrates (reducing and non-reducing)

Course Outcomes:

CO1 Students will able to perform single step preparations independently

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									

SEMESTER - IV **Credits: 5**

Hours: 4

19ICHT45 - Analytical Chemistry

Learning Objectives:

To learn the basic concepts of analytical Chemistry, basic principles error analysis and the important concept of separation methods

Unit – I: Basic concepts of analytical chemistry

Role of Analytical Chemistry. Classification of analytical methods – classical and instrumental. Types of instrumental analysis. Selecting an analytical method - Neatness and cleanliness - Laboratory operations and practicals - Analytical balance - Techniques of weighing, Errors, Volumetric glassware-cleaning and calibration of glassware. Sample preparations – dissolution and decompositions. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

Unit – II: Errors and their Evaluation

Definition of terms mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of errors in experimental data-determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics.

Unit – III: Titrimetric Analysis

Theoretical considerations of titrimetric analysis – classification of reactions in titrimetric analysis – standard solutions – concentration units – primary and secondary standards – Neutralisation indicators – apparent indicator constant – universal or multiple – Range indicators. Neutralisation curves – Neutralisation of strong acid with strong base, weak acid with strong base, weak base with strong acid, weak acid with weak base and polyprotic acid with strong base. precipitation titrations, redox titrations, self indicators, external indicators, starch, EMF as an indicator of End Point.

Complexometric titration, EDTA titrations, EBT and murexide indicator. Titrations in non-aqueous solvents – solvents for non-aqueous titrations - Indicators for non-aqueous titrations.

Unit– IV : Gravimetric Analysis

Principles of gravimetric analysis – characteristics of precipitating agents – choice of precipitants and conditions of precipitation – specific and selective precipitants – DMG, cupferron, salicyladehyde, ethylene diamine – use of sequestering agents – co precipitation – post precipitation – peptisation – differences reduction of error – precipitation from homogeneous solutions – calculations in gravimetric methods – use of gravimetric factor.

Thermal analytical methods – Principle involved in thermogravimetric analysis and differential thermal analysis.

Unit – V : Separation Methods

Solvent extraction: Principles and process of solvent extraction – Distribution law and the partition coefficient – Batch extraction – Continuous extraction.

Classification of chromatographic methods, Principles of differential migration and adsorption phenomenon – Nature of the adsorbent solvent systems – R_f values – Paper chromatography – various modes of development: ascending, descending and horizontal, Detection of spots – Two dimensional - reversed phase and preparative paper chromatography, Thin layer chromatography – Coating materials – Preparation of plates – Solvents for development and detection – Preparative TLC – Application. Column chromatography: Adsorption and partition methods: Nature of the column materials, preparation of the column, solvent system and detection methods.

Text Books:

1. G.D.Christian, Analytical Chemistry, 5th Ed., John Wiley, 1994.
2. D.A.Skoog, D.M.West, F.J.Holler, W.B. Saunders, Fundamentals of Analytical Chemistry.
3. J.H.Kennedy, W.B.Saunders, Analytical Chemistry: Principles.
4. R.A.Day, Jr. and A.L.Underwood, Qualitative Analysis, Prentice Hall.

5. S.M.Khopkar, Basic Concepts of Analytical Chemistry, Wiley Eastern.

Supplementary Reading:

6. L.G.Hargis, Analytical Chemistry: Principles and Techniques, Prentice Hall, 1988.
7. D.A.Skoog, J.L.Loary, W.B.Saunders, Principles of Instrumental Analysis.
8. F.Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall.

Course Outcomes:

CO1 Students will know the advanced basics of analytical chemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									

SEMESTER - V **Credits: 5**
Hours: 4

19ICHT51 - Organic Chemistry – I

Learning Objectives

To learn the important classifications and nomenclature of organic compounds and to learn the concepts of conformational analysis**.**

Unit – I: Nomenclature – Electron Displacements

Rules of IUPAC nomenclature – nomenclature of condensed carbocyclic and aromatic systems – heterocyclic rings (containing one, two and three hetero atoms) - Fused ring systems.

Unit – II: Preparation and Synthetic uses of Malonic Esters, Ethyl acetoacetate and Grignard Reagents

Carbanions in organic synthesis – Malonic ester - preparation and synthetic application - synthesis of carboxylic acids –heterocyclic compound. Preparation of acetoacetic ester – acid hydrolysis and ketonic hydrolysis – synthetic applications of acetoacetic ester - preparation of alkyl magnesium halides and their synthetic applications.

Unit – III: Conformational Analysis

Conformations of ethane, n-butane, 1,2-dichloroethane and 1,2-ethanediol - relative stabilities of gauche and anti conformations – Representation of conformations of 1,2-disubstituted ethanes, meso- and dl-tartaric acids, erythro- and threo-1,2-dibromo-1-phenylpropane by Newman projection and Sawhorse formulae. Conformation of cyclohexane and its monosubstituted derivatives, conformational energy of a substituent, OH, CH_3, CH_3CH_2, $CH(CH_3)_2$ and $C(CH_3)_3$.

Unit – IV: Heterocyclic Compounds

Five membered heterocyclic compounds – furan, thiophene and pyrrole – six membered heterocyclic compounds – pyridine – structure – source, electrophilic substitution, reactivity and orientation – nucleophilic substitution in pyridine. Comparison of basicity of pyridine – piperidine and pyrrole. Synthesis of quinoline, isoquinoline and indole. Special reference to Fischer - Indole and Skraup synthesis.

Unit – V: Alkaloids and Terpenoids

General methods of structure elucidation of alkaloids and terpenoids – classification of terpenoids – isoprene rule – structure and synthesis of piperine and nicotine.

Structure and synthesis of citral, geraniol and α-terpineol.

Text Books :

1. L. N.Ferguson, The Modern Structural theory of Organic Chemistry, Prentice Hall of India, 2009.
2. I. L. Finar, Organic Chemistry, Volume 1 & 2, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2012.
3. E. L. Eliel, Stereochemistry of Carbon Compounds, 42nd Ed. Tata Mc Graw Hill, 2011.
4. P.S. Kalsi, Organic Reactions and their Mechanism, New Age International Publishers, 2017.

Supplementary Reading

5. D. Nasipuri, Stereochemistry of Organic Compounds, 3rd Ed. New Age International, 2016.
6. P.L. Soni, Text book of Organic Chemistry, S.Chand Publications, New Delhi, 29th Edition, 2012.
7. O.P. Agarwal, Natural Products, Vol. I & II, 44th Ed. Goel Publishing, 2015.

8. R. T. Morrison, R.N. Boyd, Introduction to Organic Chemistry, 7th Ed. Prentice Hall of India, 2014.

Course Outcomes

CO1 Students will know the important basics conformational analysis

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									

SEMESTER - V **Credits: 5**
Hours: 4

19ICHT52 - Inorganic Chemistry – I

Learning Objectives:

To learn the basic principles of chemical bonding, classifications of inorganic compounds and the concepts of nuclear chemistry.

Unit – I: Nature of Bonding of Main Group Elements

Types of compounds and E – H, E – X, E – O and E – N bond types for B, C, N, Si, P and S, element – element single and multiple bonds, catenation and heterocatenation – polysilanes and polyphosphazenes, alkali and alkaline earth metal complexes of alkylamines, alkaloids and calixarenes; Electron deficient, precise and electron rich compounds, fullerenes – types and structures, carbon nanotubes.

Unit – II: Metallic Bonding

Packing of atoms in metals [BCC, CCP, HCP] – Theories of metallic bonding. Drude & Lorentz theory – Sommerfield free electron theory – Block theory – Band theory, Alloy systems: Classification – Substitutional and interstitial solid solutions – Lauve Zintle phases – Alloys of two true metals (Cu – Au systems) – Alloys of a true metal and B – Sub group element – System of type T_2B compounds – Hume – Rothery rules – Theoretical basis of Hume – Rothery rules.

Unit – III: Study of p- Block Elements

Nitrogen family, comparative study of N, P, As, Sb and Bi elements- oxides, oxyacids, halides, hydrides. Structure and uses of hydrazine, hydroxylamine, hydrazoic acids- Preparation and uses of $NaBiO_3$ - Nitrogen fertilizers.

Oxygen family- comparative study of O, S, Se, Te elements-catenation- Chemistry of ozone-Hydrides, oxides, oxyacids of Sulphur including peroxy acids and thionic acids.

Properties of Halogens - Halogen oxides-Oxoacids - Interhalogen compounds.

Noble gases: Electronic configuration - reason for placing in zero group position in the periodic table - Chemical inertness of noble gases – reasons - applications - Clathrates and compounds of Xenon.

Unit – IV: Chemistry of d and f Block Elements

Chemistry of d-block elements – characteristics of d block elements – variable valency – magnetic properties and colour – comparative study of Ti, V, Cr, Mn and Fe group metals – occurrence, oxidation states, magnetic properties and colour – preparation and uses of ammonium molybdate, V_2O_5 and VF_6.

Chemistry of f-block elements – comparative account of lanthanides and actinides, occurrence, elements oxidation states, magnetic properties colour and spectra – lanthanide contraction – causes, consequences and uses – comparison between 3d and 4f block elements.

Unit – V: Nuclear Chemistry – I

Nuclear properties: Nuclear radii, Spin and moments – Nuclear structure: n-p ratio in stable and metastable nuclei, nuclear forces – Nuclear models: liquid drop, shell and collective models.

Modes of radioactive decay: α and β decay, Radioactive decay constant. Radioactive equilibrium, Orbital electron capture, nuclear isomerism, internal conversion – Detection and determination of radioactivity – Cloud chamber, Nuclear emulsion, Bubble chamber, Proportional counter, Geiger – Muller counter, scintillation and Cherenkov counters - particle accelerators: linear, cyclotron, synchrotron, betatron and bevatron.

Text Books:

1. H.J. Arnikar, Essentials of Nuclear Chemistry, New Age International, 2018.
2. S. Glasstone, Source Book on Atomic Energy, Affiliated East – West Press, 1967.
3. J.E. Huheey, Inorganic Chemistry, 4th Ed. Addison Wesley, 2011.
4. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Ed. Wiley Eastern, 2013.

Supplementary Reading

5. G.T. Seaborg, Man Made Elements, Prentice Hall,1963.
6. G. Friedlander, J.W. Kennedy, N.M. Miller, Nuclear and Radio Chemistry, John Wiley, 1981.
7. R. C. Evans, An Introduction to Crystal Chemistry, Cambridge University Press, 1964.

Course Outcomes

CO1 Students will know the important basics of chemical bonding

CO2 Students will understand various Inorganic compounds

CO3 Students will appreciate the fundamentals of nuclear chemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			

SEMESTER - V **Credits: 5**
Hours: 4

19ICHT53 - Physical Chemistry - I

Learning Objectives

To learn the advanced concepts of electrochemistry, basic principles Phase equilibria and important concepts of molecular structure

Unit – I: Electrochemistry - II

Types of reversible electrodes – Metal – metal ion, metal – insoluble salt – anion, glass and redox electrodes. Electrode reactions, Single electrode potential, Nernst equation, galvanic cell, E.M.F and its measurement, calculation of thermodynamic parameters from E.M.F. standard hydrogen electrode, use of calomel as reference electrode, standard electrode potential and its determination, electrochemical series and its significance, Reversible and irreversible cells, conventional representation of electrochemical cells, polarization, overpotential and hydrogen overvoltage.

Unit – II : Phase Equilibrium

Equilibrium between two phases of one component, Clapeyron equation and Clausius-Clapeyron equation - applications.

Statement and meaning of the terms – phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system – water, CO_2 and sulphur systems.

Phase equilibrium of two component system – simple eutectic Bi-Cd and Pb - Ag systems, compound formation and formation of solid solution, phase diagram for Fe-C system.

Unit – III: Binary Systems

Solution, concentration units - molarity, molality and normality – ideal solution ΔH, ΔV, ΔS thermodynamics of ideal solution ΔH_{mix}, ΔV_{mix} and ΔS_{mix}.

Binary liquid systems, Raoult's law, vapour pressure of ideal solution, deviations from ideal behaviour – vapour pressure – composition curves and temperature – composition curves.

Fractional distillation of binary liquid solution, azeotropic distillation.

Partially miscible liquid pairs – phenol – water, triethylamine-water and nicotine-water systems CST and effect of impurities on CST – Immiscible liquids.

Theory and application of steam distillation – Solution of gases in liquids – factors influencing the solubility of gas in a liquid, Henry's law.

Unit – IV: Colligative Properties

Theory of dilute solutions – colligative properties – lowering of vapour pressure, osmotic pressure, elevation of boiling point and depression of freezing point - basic explanation - Thermodynamic derivation of elevation of boiling point and depression in freezing point – determination of molecular mass from boiling point measurements, freezing point measurements and osmotic pressure measurements – abnormal molar mass and van 't Hoff factor – distribution law – distribution coefficient – condition for the validity of the distribution law and thermodynamic derivation – association and dissociation of the solute in one of the solvents.

Unit – V: Group theory

Symmetry elements – symmetry operations– various point groups with examples – point groups – identification and determination – comparison of molecular and crystallographic symmetry-group multiplication table-Matrix representation of symmetry operations.

Text Books:

1. John O'M. Bockris, Amulya K.N. Reddy, Modern Electrochemistry, 2A, 2B, Springer, 2014.
2. W.J. Moore, Physical Chemistry, 4th Ed. Longmann, 1998.

3. N. Kundu, S.K. Jain, Physical Chemistry, S. Chand and Co. Ltd., 2003.
4. S. Glasstone, Text Book of Physical Chemistry, Mac Millan, 1966.
5. B. R. Puri, L.R. Sharma, S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co. New Delhi, 2016.
6. K. V. Raman, Group Theory and its Application to Chemistry, Tata McGraw Hill, 2004.

Supplementary Reading:

7. S. Glasstone, An Introduction to Electrochemistry, Affiliated East West Press, 2005.
8. F. A. Cotton, Chemical Applications of Group Theory, Wiley Eastern, India, 2013.

Course Outcomes

CO1 Students will know the advanced basics of electrochemistry

CO2 Students will appreciate the fundamentals of physical chemistry like phase equilibria and molecular structure.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								

SEMESTER - V **Credits: 6**

Hours: 12

19ICHP55 - Practical IV - Gravimetric Analysis

Learning Objectives:

To learn the gravimetric analysis of various anions and cations

1. Estimation of sulphate as barium sulphate
2. Estimation of barium as barium sulphate
3. Estimation of barium as barium chromate
4. Estimation of lead as lead chromate
5. Estimation of silver as silver chloride
6. Estimation of calcium as calcium oxalate monohydrate
7. Estimation of calcium as calcium carbonate
8. Estimation of nickel as Ni-DMG complex
9. Estimation of zinc as zinc oxinate
10. Estimation of magnesium as magnesium oxinate.

Text Book:

1. A. I. Vogel, Textbook of Quantitative Inorganic Analysis, CBS Publishers, 1969.

Course Outcomes:

CO1 Students will understand the gravimetric analysis of various anions and cations

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									

SEMESTER - VI **Credits: 5**
Hours: 4

19 ICHT61 - Organic Chemistry – II

Learning Objectives:

To learn the carbohydrates, amino acids, polymers, basic principles dyes and the important concept of spectroscopy

Unit – I: Carbohydrates

Classification of carbohydrates – Monosaccharides – structure of glucose and fructose. Reactions of glucose – tests for monosaccharides – osazone formation – lengthening of the carbon chain of aldoses – Kiliani – Fischer synthesis. Shortening of the carbon chain of aldoses – the Ruff degradation. Ring structure of glucose - mutarotation. Interconversion of glucose and fructose – An introduction to disaccharides (sucrose, maltose and lactose) and polysaccharides (starch and cellulose) without involving structure determination. Deoxy and amino sugars.

Unit – II: Amino Acids and Proteins

Preparation of amino acids – reactions of amino acids – structure of amino acids – peptides – structure of peptides – Oxytocin and N- terminal residue analysis – synthesis of peptides. Protein – classification – colour tests – structure of proteins – primary, secondary and tertiary structures.

Unit – III: Polymers

Macromolecules – polymers – methods of polymerization – Addition chain – growth polymerization – free radical polymerization – ionic vinyl polymerization. Copolymerization – polymerization with Zeigler – Natta catalysts. Structure and properties of macromolecules. Uses of polymers.

Unit – IV: Synthetic Dyes, Fats, Oils and Detergents

Classification of dyes and synthesis of methyl orange, congo red, crystal violet, phenolphthalein.

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerols, hydrogenation of unsaturated oils, Saponification value, iodine value, acid value soaps, synthetic detergents, alkyl and aryl sulphonates.

Unit V: Organosulphur compounds

Thiols and Thioethers – Thiocarboxylic acids – classifications – preparations and properties – aromatic sulphonic acid and its derivatives – Introduction – nomenclature – preparations – physical and chemical properties – uses – Benzene sulfonic acid – Benzene sulfonyl chloride – Saccharin – Sulphonylamide.

Text Books:

1. P. L. Soni, Text Book of Organic Chemistry, S.Chand Publications, 29th Edition, 2012.
2. I. L. Finar, Organic Chemistry, Volume 1 & 2, Longman Scientific and Technical, 2012.
3. V.R. Gowarikar, N.V. Viswanathan, Polymer Science, 2nd Ed. New Age International, 2017.
4. P. C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company, 2009.

Supplementary Reading

5. S.Venkataraman. Synthetic Dyes, Vol. I & II, Academic Press, 1952.
6. R. T. Morrison, R.N. Boyd, Introduction to Organic Chemistry, Prentice Hall of India, 2014.

Course Outcomes:

CO1 Students will know the basics of natural products

CO2 Students will appreciate the fundamentals of organic spectroscopy and molecular structure

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2												√	√	√	√		

SEMESTER - VI **Credits: 5**
Hours: 4

19ICHT62 - Inorganic Chemistry – II

Learning Objectives:

To learn the concepts of coordination compounds, basic principles nanophase materials and the important concept of environmental chemistry

Unit – I: Coordination Compounds

Werner's coordination theory, Effective atomic number rule, Nomenclature of coordination compounds, Isomerism in coordination compounds, Chelates. Applications of coordination compounds, Complexometric titrations using EDTA, Application of valance bond theory to coordination compounds.

Unit - II: Nanophase Materials

Introduction – techniques for synthesis of nanophase materials –sol-gel synthesis-electrodeposition –inert gas condensation-mechanical alloying –properties of nanophase materials –applications of nanophase materials, composite materials: Introduction –types.

Unit – III: Thermodynamics of Inorganic Reactions

Basic principles of Thermodynamics – Kinetics and Spontaneity of reactions – Formal potential – Electromotive force diagram – Ellingham diagram - Latimer and Frost diagrams – Pourbaix diagram – Relation to spontaneity and application in the prediction of chemical reaction – Oxidation-reduction reactions in water as a function of pH.

Unit – IV: Analytical Applications of Chemical Equilibria

Acid-base equilibria – Common ion effect, Buffer solution, Solubility equilibria, Distribution equilibria, Complex ion equilibria, Factors influencing equilibria.

Principle of inorganic qualitative analysis: Reactions involved in the separation and identification of cations and anion in the analysis- Spot test reagents: Aluminon, Cupferon, DMG, thiourea, Magneson, Alizarin and Nessler's reagent-Semi micro techniques

Unit – V: Environmental Chemistry

Pollution and its control: Sources of air pollution CO_2, Pb, CO, oxides of nitrogen and sulphur, Freons, smog, greenhouse effect, global warming, methods of control.

Pollution of soil: Fertilizers, insecticides, solid waste and acid rain, methods to control.

Pollution of water: Industrial and domestic waste, effluents, sewage waste, Fertilizer, insecticides oil, toxic metal, COD and BOD. Consequences, methods to control, Rainwater harvesting – its need, methods and advantages.

Noise pollution and radioactive pollution, health hazards.

Text Books:

1. J.E. Huheey, Inorganic Chemistry, Addison Wesley, 2011.
2. A.I.Vogel, A Text Book of Quantitative Inorganic Analysis, ELBS, 1999.
3. R.L. Pecsok, L.D. Shields, Modern Methods of Chemical Analysis, New York, 1976.
4. B.E.Douglas, D.H.McDaniel, J.J.Alexander, Concepts and Models of Inorganic Chemistry, John Wiley and Sons, Blaisdell Publishing co., 2017.
5. D.F. Shriver, P.W. Atkins, Inorganic Chemistry, Langford – Oxford University Publication, 2010.
6. H. Uhlig, Corrosion and Corrosion Control, 4th Edition, John Wiley,1985.
7. R.J.D. Tilley, Defect Crystal Chemistry and its Applications, Chapman Hall Publication, 1987.

Supplementary Reading:

8. L.F. Lindoy, The Chemistry of Macrocyclic Ligand Complexes, Cambridge University Press, 1990.
9. S.Emeleus, A.G. Sharpe, Modern Inorganic Chemistry, Pearson Publication, London, 1st edition, 2007.
10. S.M. Khophar, Environmental Pollution Analysis, New Age International, 1993.

11. P.C. Jain, M.Jain, Engineering Chemistry, Dhanpat Rai Publishing Company, 2009.
12. Kenneth J. Klabunde, Nanoscale Materials in Chemistry, John Wiley & Sons Inc., 2004.

Course Outcomes

CO1 Students will know the basics of coordination compounds

CO2 Students will appreciate the fundamentals of nanophase materials

CO3 Students are enable to understand the chemistry of environment

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2												√	√	√	√		
CO3													√	√	√	√	√

SEMESTER - VI **Credits: 5**
Hours: 4

19ICHT63 - Physical Chemistry – II

Learning Objectives:

To learn the advanced concepts of spectroscopy, the basic principles of photochemistry and the important concept of quantum chemistry

Unit – I: Spectroscopy - I

Electromagnetic radiation, concept of frequency, wavelength, wavenumber, energy, energy levels, quantization, interaction of electromagnetic energy into matter, basic aspects of atomic and molecular spectroscopy.

Types of molecular spectra, microwave spectroscopy – rotational spectra of diatomic molecule, conditions for a molecule to be active in microwave region, origin of molecular spectra - rotational spectra - rigid rotor and non-rigid rotor, rotational constants (B), selection rule for rotational transition -Intensity of spectral lines – Effect of isotopic substitution.

Unit – II: Photochemistry - I

Light absorption, Beer – Lambert law, its limitations. Laws of photochemistry – Grothus – Draper law, Stark – Einstein law, quantum yield and its determination, chemical actinometers, photochemical decomposition of HI, photochemical combinations of H_2 and Br_2, H_2 and Cl_2 reactions. Difference between photochemical and thermal reactions.

Unit – III: Solid State

Classification of solids – isotropic and anisotropic crystals, laws of crystallography, representation of planes, miller indices, space lattice, crystal systems, seven primitive unit–cells. X-ray diffraction, derivation of Bragg's equation, determination of structure of NaCl by Debye Scherrer (powder) method and rotating crystal method, determination of Avagadro's number, discussion of structures of KCl & CsCl. Defects in crystals – stoichiometric and nonstoichiometric. Packing of ions in crystals – radius ratio rule and its limitations.

Unit – IV: Quantum Mechanics - I

Black body radiation, Planck's radiation law, photoelectric effect, Compton effect, Bohr's model of hydrogen atom (no derivation), its demerits, wave-particle duality, de Broglie equation, Heisenberg uncertainty principle, wave nature of electron, Schrodinger's time – independent wave equation (no derivation), wave function and its physical interpretation, Normalization and orthogonal function.

Unit – V: Polymer Science

Polymerization reaction, types of polymerization reactions, addition polymerization and condensation polymerization, mechanism of polymerization, kinetics of polymerization, molecular mass of polymers, number average and mass average molecular mass, determination of molecular mass by osmotic pressure measurement and sedimentation method – important physical properties of polymers.

Text Books

1. C.N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill, 2017.
2. K.K. Rostogi Mukerjee, Photochemistry, Wiley Eastern, 2005.
3. Lesley Smart and Elaine Moore, Solid state chemistry, 2004.
4. W.Levine, Quantum Chemistry, Prentice Hall, 2014.
5. A.K.Chandra, Introductory Quantum Chemistry, Tata Mc Graw Hill, 1997.
6. R.K. Prasad, Quantum Chemistry, New Age International, 2017.
7. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International, 2017.

Supplementary Reading

8. W.J. Moore, Basic Physical Chemistry, Prentice Hall, 1998.
9. W. Billmeyer, Text book of Polymer Science, John Wiley & Sons, New York, 2002.

10. B.K. Sen, Quantum Chemistry, Tata Mc Graw Hill, 1995.

Course Outcomes:

CO1 Students will know the basics of spectroscopy and quantum Chemistry

CO2 Students will appreciate the fundamentals of physical chemistry like solid state and polymers

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2												√	√	√	√		

SEMESTER - VI **Credits: 5**
Hours: 4

19ICHT64 - Pharmaceutical Chemistry

Learning Objectives:

To learn the advanced concepts of pharmaceutical Chemistry, basic principles of drugs and the important concept of vitamins and enzymes

Unit – I Basic Pharmaceutical Chemistry

Definition of the following terms: drug, pharmacophore, pharmacology, Pharmacopeia, bacteria, virus and vaccine. Causes, symptoms and drug for anaemia, jaundice, cholera, malaria and filarial. Indian Medicinal plants and uses – Tulasi, Neem, Kizhanelli, Mango, Semparuthi, Adadodai and Thoothvelai.

Unit – II Antibacterials

Sulpha drugs-examples and actions-prontosil, sulphathiazole, sulphafurazole. Antibiotics-definition and action of penicillin, streptomycin, chloramphenicol, erythromycin-tetracyclin – SAR of chloramphenicol only. Antiseptics and disinfectants – definition and distinction – phenolic compounds, chlorocompounds and cationic surfactant.

Unit – III Analgesics and CNS stimulants

Analgesics: Definition and Actions – narcotic and non-narcotic – morphine and its derivatives, pethidine and methadone – disadvantages and uses. Antipyretic analgesics - salicylic derivative, paracetamol, ibuprofen. Drugs affecting CNS – Definition, distinction and examples for tranquilisers, sedatives, hypnotics, psychedelic drugs – LSD, Hashish – their effects

Unit – IV Anesthetics and Drugs for Chronic diseases

Anaesthetics - definition – local and general – volatile nitrous oxide, ether, Chloroform, cyclopropane – uses and disadvantages – non – volatile intravenous – thiopental sodium, methohexitone, propanidid. Causes, medicines and their mode of action for the treatment of cancer – antineoplastics – diabetes – hypoglycemic agents AIDS – AZT, DDC.

Blood: Grouping, composition, Rh factor, blood pressure, hypertension and hypotension.

Unit – V Vitamins, Harmones and Enzymes

Vitamins – fat soluble vitamins – (i) vitamin A, (ii) vitamin D, (iii) vitamin B complex, (iv) vitamin C, (V) vitamin E, (vi) vitamin K, (vii) vitamin P.

Hormones – Introduction, properties and function of hormones, chemical nature of hormones. Physiological function of some hormones: Adrenaline, thyroxin, oxytocin, insulin, the sex hormones.

Enzymes – Chemical nature of enzymes, classification of enzymes, properties of enzymes, mechanism of enzyme action. Action of Co-enzymes.

Text Books:

1. Jayashree Ghosh, A Text Book of Pharmaceutical Chemistry, 3rd Edition, S.Chand & Company Ltd., New Delhi, 2014.

Course Outcomes

CO1 Students will know the advanced basics of pharmaceutical chemistry

CO2 Students will appreciate the fundamentals of drugs, vitamin, hormone and enzymes

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2												√	√	√	√		

SEMESTER - VI **Credits: 6**
Hours: 12

19ICHP65: Practical V - Physical Chemistry Practicals

Learning Objectives

To learn the basic concepts of experimental physical chemistry, basic principles electrochemistry and the important concept of distribution law and kinetics

1. Critical Solution Temperature
2. Effect of impurity on Critical Solution Temperature
3. Transition Temperature - Determination of molecular weight by depression of freezing point method
4. Rast Method - Determination of molecular weight by depression of freezing point methods
5. Phase Diagram (Simple eutectic system)
6. Kinetics of Ester Hydrolysis
7. Partition Co-efficient of iodine between water and organic solvents.
8. Association factor of benzoic acid / acetic acid between benzene and water
9. Conductometric Acid-Base Titration
10. Potentiometric Redox Titration
11. Determination of cell constant

Text Books:

1. B.P. Levitt, Ed., Findlay`s practical Physical Chemistry, 9th Ed., Longman, 1985.
2. J.N. Gurtu, R. Kapoor, Advanced Experimental Chemistry, Vol.I, S.Chand& Co., 1987

Course outcome:

CO1 Acquire the necessary practical skills to perform physical chemistry practicals.

CO2 Gain expertise in the instrumental analysis.

CO3 Systematically evaluate calculations involving in physical chemistry

CO4 Apply the gained knowledge in industries

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2												√	√	√	√		
CO3													√	√	√	√	√
CO4											√	√	√	√			

SEMESTER - VII **Credits: 4**
Hours: 4

19ICHT71: ORGANIC REACTION MECHANISMS

Learning Objectives:

To learn the fundamental mechanisms underlying different chemical reactions, basic aspects of stereochemistry and conformational analysis of six member ring systems

Unit – I: Organic Reaction Mechanisms – I

Aromaticity - Electronic Effects **-** Types of organic reactions - Reaction intermediates - formation, structure and stability of carbocations, carbanions, radicals, carbenes and nitrenes.

Aliphatic nucleophilic substitution - S_N1, S_N2 and S_Ni mechanisms with examples. Aromatic nucleophilic substitution: Unimolecular, bimolecular and benzyne mechanisms.

Esterification and transesterification - Ester hydrolysis - acid catalysed acyl oxygen and alkyl oxygen fission mechanisms - explanation of the principle of microscopic reversibility.

Unit – II: Organic Reaction Mechanisms – II

Addition to carbon-carbon and carbon-oxygen multiple bonds - electrophilic and nucleophilic addition - addition to conjugated system. Hydration of olefins - Hydroboration

Elimination reactions: E1, E2, E1cB & E2C mechanisms - Pyrolytic eliminations - cis elimination - orientation of double bond - Bredt's rule, Hofmann and Saytzeff rules.

Aliphatic electrophilic substitution - S_E1, S_E2 and S_Ei mechanisms with examples. Aromatic electrophilic substitution - mechanisms of nitration, halogenation and sulphonation reactions. Friedel-Crafts reaction and its modifications. Influence of substituents on reactivity and orientation. Electrophilic substitution of naphthalene - formation of two isomers - explanation of kinetic and thermodynamic controls by sulphonation of naphthalene.

Unit – III: Organic Stereochemistry- I

Optical isomerism - chirality - asymmetry and dissymmetry - enantiotopic and diastereotopic hydrogens. Enantiomers and diastereomers and their representation by flying wedge and Fischer projections – R and S notation.

Walden inversion, asymmetric transformation and asymmetric induction - enantio and diastereo selective synthesis - enantiomeric excess and diastereomeric excess.

Atropisomerism of biphenyls, allenes and spiranes. Geometrical isomerism about C=C bond - E-Z notation - determination of configuration of geometrical isomers - geometrical isomerism in acyclic oximes.

Unit – IV: Organic Photochemistry – I

Principles of photochemistry - Jablonski diagram - Photochemical reactions of saturated ketones - Norrish type - I and II reactions - photoreductions of ketones - Paterno-Buchi reaction - reaction of α,β-unsaturated ketones- isomerisation and cycloadditions - photoreactions of cyclohexadienones. Photochemical cis-trans isomerisation of simple alkenes - photochemical oxidation, oxidative couplings and Barton reaction. Application of photochemical reactions in organic synthesis.

Unit – V: Natural Products – I

Amino acids - classification, general methods of preparation and general properties of amino acids. Proteins - classification - peptides synthesis - primary structure of peptides - end terminal analysis - -secondary structure of proteins - tertiary and quaternary structure of proteins. Classification of enzymes and their specificity - Ribonucleosides and ribonucleotides - RNA - types - structures of DNA and RNA.

Introduction - chemical classification of alkaloids and terpenoids - isoprene rule - General methods of structure elucidation of alkaloids and terpenoids. Structure and synthesis of citral and papaverine.

Unit – VI (Not for final examination)

Nomenclature of alicyclic, bicyclic and tricyclic compounds (basic skeletal structure only with or without one substituent). Biogenesis- The building blocks and construction mechanism of 1. Terpeniods – Mono Sesqui, Di and Triterpeniods. 2. Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan.

Text Books:

1. M. B. Smith, March's Advanced Organic Chemistry, John Wiley & Sons, 7th Ed, **2016.**
2. F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science + Business Media, 5th Ed, **2007.**
3. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed, **2012**.
4. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, **2003**.
5. I. L. Finar, Organic Chemistry Vol 1 & 2: Pearson, 7th Ed., **2009.**

Supplementary reading:

6. E. N. Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill Ed, Reprint **2008.**
7. D. Nasipuri, Stereochemistry of Organic Compounds, New Age International (P) Ltd, Reprint, **2005.**
8. Kalsi. P. S, Organic Reactions: Stereochemistry and Mechanism through solved problems, New Age International (P)Ltd, 4th Ed, **2007.**
9. E. L. Eliel & S. H. Wilen, Stereochemistry of Organic Compounds, Wiley India Ed, **2008.**
10. J.M. Coxon and B. Halton, Organic Photochemistry, Cambridge University Press 2nd Ed., **2000**.

Course outcomes:

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

CO1: Understand various types of reaction mechanisms involved in synthetic organic transformation.

CO2: Appreciate various types of reaction mechanisms involved in synthetic organic transformation

CO3: Analyse basic stereochemistry concepts in a proper perspective.

CO4: Evaluate the principles of Photochemistry

CO5: Apply the concepts of asymmetric synthesis

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - VII **Credits: 4**
Hours: 4

19 ICHT72: Coordination Chemistry and Inorganic Reaction Mechanisms

Learning Objectives:

To learn the fundamental mechanisms underlying Coordination Chemistry, reaction mechanism and photoinorganic chemistry

Unit-I Coordination Chemistry of Transition Metal ions

Nomenclature of coordination compounds - Stability constants of complexes and their determination (pH metric and spectrophotometric methods). Factors influencing stability, stabilization of unusual oxidation states by complex formation.

Pearson's HSAB concept, acid-base strength and hardness and softness, symbiosis, theoretical basis of hardness and softness. Electronegativity and hardness and softness.

Stereoisomerism of coordination complexes.

Unit-II Theories of Coordination Compounds

VB theory-Crystal field theory- splitting of d-orbitals under various geometries- CFSE-factors affecting the magnitude of 10Dq-Evidences for CFSE- Spectrochemical series-Distortions in octahedral complexes- Jahn-Teller theorem, Jahn-Teller effect, Molecular orbital theory-MO concepts of octahedral and tetrahedral complexes- MO energy level diagrams of sigma and pi bonding in octahedral complexes, nature of metal-ligand pi bonds- Evidences for pi back bonding

Unit-III Reaction Mechanism-I

Substitution reactions of octahedral complexes: Labilities, inertness, stability and instability of coordination compounds- Nature of substitution reactions- Theoretical approach to substitution mechanisms-Mechanism of substitution reactions of complexes of cobalt-acid hydrolysis-base hydrolysis of cobalt(III) complexes.

Racemisation and isomerisation: Twist mechanisms for isomerisation – Intramolecular mechanisms for racemisation.

Unit-IV Reaction Mechanism-II

Substitution reactions of square planar complexes: Reactions of Pt(II) complexes- Trans effect- Theories of trans effect-Mechanism of substitution- kinetics of Pt(II) complexes.

Electron transfer reactions-Electron tunnelling hypothesis-Marcus-Hush theory. Atom transfer reaction-one electron and two electron transfer-inner sphere and outer sphere mechanism.

Unit-V Photoinorganic Chemistry

Excited states of metal complexes-Energy transfer under conditions of weak interaction and strong interaction-exciplex formation. Conditions of the excited states to be useful as redox reactants-photosubstitution, photooxidation and photoreduction- Photochemical reactions involving Ruthenium(II) bipyridyl complex. Application to photovoltaics-water photolysis-carbon dioxide reduction.

Unit – VI (Not for final examination)

Applications of coordination compounds: Metal complexes in analytical chemistry, medicinal chemistry, industrial process, water suffering process and agriculture.

Photochemistry of Cr(III), Co(III), Pt(II) and Pt(IV) complexes.

Textbooks:

1. Huheey, J.E., Inorganic chemistry, Addison Wesley, 2011
2. Shriver, D.F., Atkins, P.W., Inorganic chemistry, Langford-Oxford University Publications, 2010
3. F. Basalo, R.G.Pearson, Mechanism of Inorganic Reactions, Wiley Eastern Publication, 1967
4. S.F.A. Kettle, Coordination Compounds, Publisher Thomas Nelson, 1969.

Supplementary reading

5. M.L. Tobe, Inorganic Reaction Mechanism, Published by Nelson, 1972.

Course outcomes:

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

CO1: Understand the basics of coordination Chemistry.

CO2: Appreciate various theories of inorganic complexes

CO3: Evaluate inorganic reaction mechanisms

CO4: Analyse substitution reaction mechanisms and electron transfers

CO5: Apply the concepts of energy transfer to photovoltaics.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√						√	√		
CO2	√		√						√					√		√	
CO3	√			√						√				√			
CO4	√	√				√	√	√								√	√
CO5	√			√		√				√						√	

SEMESTER - VII **Credits: 4**
Hours: 4

19ICHT73: Chemical Thermodynamics, Photochemistry and Group Theory

Learning Objectives:

To learn the fundamental of thermodynamics, photochemistry and group theory.

Unit – I: Classical Thermodynamics

Calculation of adiabatic flame temperature, Maxwell's relations, thermodynamic equation of state, thermodynamics of open systems, partial molar quantities, chemical potential, Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, third law of thermodynamics-Determination of absolute entropies of solids, liquids and gases –residual entropy. Nernst heat theorem, chemical equilibrium-Van't Hoff isotherm, standard free energy change of reactions, variation of equilibrium constant with temperature and pressure.

Unit – II: Thermodynamics of Non-Ideal and Irreversible Systems

Fugacity of gases – determination of fugacity using graphical method and van der Waals equation – variation of fugacity with temperature and pressure. Concept of activity and activity coefficients – mean ionic activity and mean activity coefficients - determination of activity and activity coefficients using EMF measurements.

Non-equilibrium thermodynamics - conservation of energy and mass, entropy production in chemical reactions – Microscopic reversibility and Onsager reciprocal relation. General application of non-equilibrium thermodynamics.

Unit –III: Statistical Thermodynamics

Thermodynamic probability and entropy. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

Partition function – translational, rotational, vibrational and electronic partition functions. Calculations of thermodynamic properties and equilibrium constant in terms of partition functions. Theories of heat capacity of solids-Einstein and Debye theories.

Unit – IV: Photochemistry and Radiation Chemistry

Photophysical process, primary and secondary processes, Quantum yield, Kinetics of collisional quenching – Stern Volmer equations. Photosensitization, Chemiluminescence, Photosynthesis, solar energy conversions, Semiconductor photocatalysis, lasers.

Radiation Chemistry-linear energy transfer, G-value, dosimeters, radiolysis of water, solvated electrons.

Unit – V: Principles and Applications of Group Theory

Reducible and irreducible representations, properties of irreducible representations orthogonality theorem. Construction of character tables of C_{2v} and C_{3v}. Selection rules for IR and Raman spectra, procedure for determining symmetry of normal modes of vibration of H_2O and NH_3 molecules - hybrid orbitals in BF_3, CH_4 and NH_3.

Unit – VI (Not For Final Examination)

Application of Bose-Einstein statistics to photon gas and superfluidity of liquid helium Application of Fermi-Dirac statistics to electron gas and thermionic emission.

Applications of Group theory to IR, Raman and Electronic spectra - SALC procedure - evaluation of energies and MO's for systems like ethylene, butadiene

Metal Oxide Semiconductors and Doped Metal Oxide Semiconductors and its applications. Mechanism of photocatlysis and its applications.

Text Books:

1. Gurdeep Raj, Thermodynamics, Goel Publishers, 2004.
2. W. J. Moore, Basic Physical Chemistry, Orient Longman ,India, 1998.
3. Peter Atkins, Julio de Paula, Physical Chemistry, Oxford press, 2013.
4. K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, New Age International, 2005.
5. F. A. Cotton, Chemical Applications of Group Theory, Wiley Eastern, India, 2003.
6. K. V. Raman, Group Theory and its Application to Chemistry, Tata McGraw Hill, 2004.

Supplementary Reading

7. S. Glasstone, Text Book of Physical Chemistry, Mc Millan, 1966.
8. J.C.Kuriacose, J. Rajaram, Thermodynamics for Chemistry, Shoban Lal Nagain Chand, New Delhi, 1986.

Course outcomes:

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

CO1: Understand basics of Thermodynamics

CO2: Evaluate basic reaction mechanisms involved in Photochemistry

CO3: Understand the fundamentals of statistical thermodynamics

CO4: Appreciate the fundamentals of photochemistry and radiation Chemistry

CO5: Apply the principles of Group theory

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√				√					
CO2	√						√	√	√				√				
CO3	√						√			√							√
CO4	√	√				√		√					√				
CO5	√									√		√					

SEMESTER - VII **Credits: 3**
Hours: 5

19ICHT74: Organic Chemistry Practical – I

Learning Objectives:

To learn different types of organic reactions and its mechanisms and to undertake experiments on organic reactions.

Preparations:

Preparation of organic compounds involving two step reactions.

Textbook:

1. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, 1996

Supplementary reading:

2. V.K. Ahluwalia, P. Bhagat, R. Aggarwal, Laboratory Techniques in Organic Chemistry, I.K. Int. 2005.
3. N.S. Gnanaprakasam, G. Ramamurthy, Organic Chemistry Lab Manual, S.V. Printers, 2000

Course outcomes:

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

CO1 Acquire basic laboratory skills required to carry out organic reactions

CO2 Independently perform two step organic preparations

CO3 Analyse the mechanisms of reactions.

CO4 Gain the expertise to apply it to specific research problems.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√

SEMESTER - VII **Credits: 3**
Hours: 5

19ICHT75: Physical Chemistry Practical – I

Learning Objectives:

To learn the principles and verification of electrochemistry and binary solutions and to perform experiments in study the important concepts electrochemistry and binary systems

I. Conductivity Experiments

1) Determination of cell constant
2) Determination of the solubility of sparingly soluble salt
3) Verification of DHO equation – Equivalent conductance of strong electrolyte
4) Dissociation constant of weak electrolyte (verification of Ostwald's dilution law)

II. Conductometric titrations

5) Acid-base titrations
   i) HCl vs NaOH, ii) CH_3COOH vs NaOH,
6) Displacement titrations (NH_4Cl vs NaOH)
7) Precipitation titrations
   i) $CuSO_4$ vs NaOH, ii) $BaCl_2$ vs Na_2CO_3, iii) KCl vs $AgNO_3$
8) Titration of mixtures
   i) HCl + CH_3COOH vs NaOH, ii) HCl + $CuSO_4$ vs NaOH iii) HCl + NH_4Cl vs NaOH

III. Distribution Law Experiments

1) Partition coefficient of iodine between two immiscible solvents
2) Study of the equilibrium constant of the reaction: $KI + I_2 \leftrightarrows KI_3$
3) Distribution of ammonia between water and chloroform
4) Determination of formula of cuprammonium complex

Text Books:

1. B.P. Levitt, Ed., Findlay`s Practical Physical Chemistry, 9th Ed., Longman, 1985.
2. J.N. Gurtu, R. Kapoor, Advanced Experimental Chemistry, Vol.I, S. Chand & Co., 1987

Course outcomes:

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

CO1 acquire practical knowledge on important equations in thermodynamics

CO2 acquire the practical knowledge of understanding important equations in distribution experiments

CO3 perform conductometric experiments

CO4 acquire the practical knowledge of understanding important equations in distribution experiments

CO5 evaluate their knowledge to analyze analytical problems.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√				√				√	
CO2	√		√						√					√	√		
CO3	√			√						√		√		√		√	
CO4	√	√				√	√	√				√				√	
CO5	√			√		√				√		√					

SEMESTER - VIII **Credits: 4**
Hours: 4

19ICHT81: ORGANIC PHOTOCHEMISTRY AND MOLECULAR REARRANGEMENTS

Learning Objectives:

To understand addition, elimination, rearrangement and name reactions along with their mechanism and synthetic utility and to understand various types of oxidation and reduction reactions.

Unit – I: Organic Photochemistry – II

Classification of pericyclic reactions - electrocyclic reactions – cycloaddition reaction - sigmatropic shifts - Woodward-Hoffmann selection rule – analysis of pericyclic reactions - Correlation diagram – Frontier Molecular Orbital approach and Perturbation Molecular Orbital approach - Sommlet-Hauser, Cope and Claisen rearrangements.

Molecular Rearrangements.

A detailed study of the following rearrangements: Carbon-carbon **migration:** Pinacol-Pinacolone, Wagner-Meerwein and Favorskii. **Carbon-nitrogen migration:** Hoffmann, Schmidt, Lossen, Curtius and Beckmann, **Carbon- oxygen migration:** Baeyer-Villiger. Nature of migration, migratory aptitude.

Unit – II: Organic Stereochemistry- II

Conformational analysis of 1,2-disubstituted ethanes - relative stabilities of gauche and anti conformations. Representations of the conformations of diastereomers with two asymmetric carbons using Newmann and Sawhorse projections - relative stabilities of diastereomers.

Conformational analysis of cyclohexane, mono and disubstituted derivatives – reactivity of cyclohexane derivatives - Conformation and stereochemistry of cis and trans decalin and 9 - methyldecalin.

Unit – III: Synthetic Dyes and Supramolecular Chemistry

Colour and constitution (Electronic concept). Classification of dyes, Chemistry and Synthesis of methyl orange, congo red, malachite green, crystal violet, fluorescein, alizarin and indigo.

Definition of Supramolecular Chemistry, Nature of binding interactions in supramolecular structure: ion-ion, ion-dipole, dipole-dipole, Hydrogen bonding, cation-π, anion-π, π-π and Van der Waals interaction. Synthesis of crown ethers, cryptands, calixarenes, cyclodextrins, cyclophanes, cryptophanes and dendrimers.

Unit – IV: Small Ring and Higher Ring Heterocycles

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes. Benzo-Fused Five-Membered Heterocycles -Synthesis and reactions of benzopyrroles, bezofurans and benzothiophenes.

Six membered Heterocycles with two or more Heteroatoms. Synthesis and reactions of diazones, triazines, tetrazines and thiazines. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Seven-and Large-membered Heterocycles - Synthesis and applications of azepines, oxepines, thiepines, diazepines thiazepines, azocines, diazocines, dioxocines and dithiocines.

Unit – V: Natural Products – II

Antibiotics: classification, structure and uses of penicillins, fluoroquinolones, chloramphenicol, and streptomycin - Structural elucidation and synthesis of chloramphenicol. **Vitamins:** Classification, structure and uses of vitamins A, B1, B6, C, D, E and K.

Steroids: Occurrence - Diel's hydrocarbon - nomenclature of Steroids - Structure and biological importance of cholesterol, cholic acid, estrone, estradiol, testosterone and androsterone.

Unit – VI (Not for final examination)

Problems in each type of photochemical reactions and molecular rearrangements. Aromatic transition state – general rule for pericyclic reactions. Structural elucidation of tetracyclins, streptomycin, penicillins. Estriol and progesterone.

Textbooks:

1. S. Sankararaman, Pericyclic Reactions – A Text Book, Narosa, 1st Ed., **2015.**
2. M. B. Smith, March's Advanced Organic Chemistry, John Wiley & Sons, 7th Ed, **2016.**
3. F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science + Business Media, 5th Ed., **2007.**
4. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed, **2012**.
5. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, **2003.**
6. Stuart Warren, Organic Synthesis: Disconnection Approach, Wiley India (P) Ltd, **2007**.

Supplementary Reading

7. V. K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 1st Ed, **2012.**
8. V. K. Ahluwalia, Reduction in Organic Synthesis, CRC Press, 1st Ed, **2012.**
9. C. K. Ingold, Structure and Mechanism in Organic Chemistry, CBS Pub., 2nd Ed, **1994.**
10. S. M. Mukherji & S. P. Singh, Reaction Mechanism in Organic Chemistry, Trinity Press, Revised Ed, **2016.**
11. E. L. Eliel & S. H. Wilen, Stereochemistry of Organic Compounds, Wiley India Ed, **2008.**
12. I. L. Finar, Organic Chemistry Vol 1 and 2: Pearson, 7th Ed., **2009.**

Course outcomes:

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

CO1 Understand the theoretical basis and mechanisms underlying additions and elimination reactions.

CO2 Appreciate reaction mechanisms involved in rearrangements

CO3 Evaluate the chemistry of dyes and their synthetic utilities.

CO4 Differentiate the various types of heterocyclic molecules.

CO5 Understand the relationship between the structure and function of various classes of natural compounds

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√			√						√
CO2	√		√						√			√					
CO3	√			√						√			√				
CO4	√	√				√	√	√			√				√	√	√
CO5	√			√		√				√			√		√		

SEMESTER - VIII **Credits: 4**
Hours: 4

19ICHT82: Solid State and Organometallic Chemistry

Learning Objectives:

To learn the principles of solid state, polymeric inorganics and organometallic Chemistry.

Unit-I: Solid State Structures and Structural Defects

Ionic bonding, Lattice energy, Born equation and its derivation, Limiting radius ratio rules, Radius ratio for trigonal, tetrahedral, octahedral and cubic sites.

Structures of some ionic crystals (sodium chloride, caesium chloride, rutile, wurtzite, fluorite).

Crystal defects: Stoichiometric defects-Schottky and Frenkel defects – colour centres in alkali halide crystals – Nonstoichiometric defects- metal excess and metal deficiency defects – extended defects – line and plane defects.

Unit-II: Polymeric Inorganic Compounds

Structures and classification of higher boranes - carboranes - metallocarboranes- silicates-silicones - Phosphazenes - Linear and cyclic phosphazenes -Sulfur - nitrogen compounds-S_4N_4- one-dimensional conductor $[(SN)_x]$–Metal clusters-binuclear metal halide clusters-structure and bonding in octachlorodirhenate(III). Isopoly and heteropolyacids- structure and bonding of 6- and 12- isopoly and heteropolyanions.

UNIT – III: Phase Transitions

Buerger's classification – Thermodynamic classification – Ubbelohde's classification – Kinetics of phase transitions – Nucleation rate – Avrami equation – Factors that affect the kinetics of phase transitions – Crystal chemistry and phase transitions – Martensitic transformations – Order- disorder transitions.

Unit-IV: Organometallic Chemistry-I

Types of ligands- Concept of haptacity-18 electron rule and its limitations- bonding in metal carbonyls- - Polynuclear carbonyls with and without bridging groups-Applications of IR spectra in the study of structure of metal carbonyls-structure and bonding in metal nitrosyls and dinitrogen complexes-Preparation, structure and bonding in metal alkenes (Zeise's salt), alkynes and allyl complexes- Metallocenes: preparation, properties, structure and bonding in ferrocene.

Unit-V: Organometallic Chemistry –II (Catalysts and Reaction Mechanisms)

Homogeneous catalysis: Alkene hydrogenation, synthesis gas, hydroformylation, synthetic gasoline and Monsanto acetic acid process, Wacker process, polymerization by Ziegler-Natta Catalysis – Isomerization of alkenes – Fluxional behaviour of organometallic compounds – Isolobal concept in organometalic compounds and metal clusters.

Unit – VI (Not for final examination)

Structure and properties of solid – prototypical oxides, fluorides, sulfides and related compounds. Monoxides of 3d metals, higher oxides and glasses – layered MS_2 compounds and intercalations.

Organosilicon compounds – organometallic compounds of arsenic, antimony and bismuth – catenated and multiply bonded compounds.

Textbooks

1. E. L. Keiter, R. L. Keiter, O. K. Medhi, Pearson Press, 5th edition, 2011
2. Huheey, J.E., Inorganic chemistry, Addison Wesley, 2012
3. Lee, J.D., Concise inorganic chemistry, Wiley India, 2006
4. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, Wiley Eastern, 6th edition, 2016.

5. B. Douglas, Concept and Models of Inorganic Chemistry, Wiley, 3rd edition, 2017

Supplementary Reading

6. Anthony R. West, Solid-state Chemistry and its applications, John Wiley,New Delhi,2016

7. Shriver, D.F., Atkins, P.W., Inorganic chemistry, Langford-Oxford University Publications, 5th edition, 2011

Course outcomes:

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

CO1 Correlate the structure of solids with their applications

CO2 Understand the various classes of polymeric inorganic compounds

CO3 Appreciate the classification and factors influencing phase transitions

CO4 Evaluate the structure and applications of organometallic compounds

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√				√				√	
CO2	√		√						√		√			√	√		
CO3	√			√						√		√		√		√	
CO4	√	√				√	√	√				√	√			√	√

SEMESTER - VIII **Credits: 4**
Hours: 4

19ICHT83: Chemical Kinetics and Quantum Mechanics

Learning Objectives:

To acquire knowledge on the basic concepts in chemical kinetics and to learn quantum theory.

Unit – I: Chemical Kinetics and Catalysis

Absolute Reaction Rate Theory in thermodynamic terms – Significance of entropy and volume of activation. Ionic reactions – primary and secondary salt effects - Acid-base catalysis – Bronsted relations, catalytic coefficients and their determination. Enzyme catalysis - Michaelis-Menten equation – Heterogeneous catalysis-Langmuir-Hinshelwood and Eley-Rideal mechanisms

General features of fast reactions – Study of fast reactions by flow methods.

Unit – II: Chemical Dynamics

Potential energy surfaces, Kinetic isotopic effects - Dynamics of unimolecular reactions – Lindemann-Hinshelwood – Rice Ramsperger Kassel (RRK) theory and Rice Ramsperger Kassel – Marcus (RRKM) theory.

Study of fast reactions by laser, relaxation, flash Photolysis and nuclear magnetic resonance methods.

LFERs – Hammett equation, Taft equation, separation of polar, resonance and steric effects.

Unit – III: Quantum Mechanics of Simple System -I

Operators and commutation relations-Postulates of quantum mechanics – derivation of Schrodinger's time-independent wave equation and its application to particle in a one-dimensional box, particle in a three-dimensional box, harmonic oscillator, rigid rotor and Schrodinger equation for hydrogen atom-separation of variables-energy levels-radial factors of the hydrogen atom wave functions .

Unit – IV: Applications of Quantum Chemistry - II

Covalent bonding – Born-Oppenheimer approximation-Hydrogen molecule ion, LCAO – MO and VB treatments of the hydrogen molecule. Antisymmetry and Pauli's exclusion principle. Slater determinantal wave function, term symbols and spectroscopic states – Russell-Saunders coupling.

Unit – V: Applications of Quantum Chemistry - III

The variation Theorem, linear variation principle, perturbation theory (first order and non degenerate). Applications of variation method and perturbation theory to the helium atom. Hybridization-determination of bond angles of sp, sp^2 and sp^3 hybridizations. Huckel pi-electron (HMO) theory and its applications to ethylene, butadiene and benzene. HMO orbital construction, calculation of properties –delocalization energy, electron density and bond order. A brief idea of self consistent field theory.

Unit - VI (Not For Final Examination)

Computer Applications in Chemistry Introduction to computers and computing - Block diagram of a PC and the functions of the various units of computer - High and low level languages - Introduction to net working - LAN, WAN, Internet and Intranet - WorldWideWeb - ChemWeb - E-journals - search engines for chemistry. Introduction to C language - Structure of C program - Control statements.

Examples of simple chemistry Programmes. 01. Conversion of Celsius temperature to Kelvin temperature 02. Applications of Beer-Lambert Law. 03. Linear least square - Fit log k vs I/T plot to get Arrhenius parameters. 04. Determination of Anharmonicity constant and dissociation energy calculation.

Textbooks:

1. P. Atkins, J. D. Paula, Physical Chemistry, Oxford University Press, 2013.
2. K. J. Laidler, Chemical Kinetics, Tata Mc Graw Hill, 2014.

3. R. K. Prasad, Quantum Chemistry, New Age International, 2017
4. Puri, Sharma, Pathania, Principle of Physical Chemistry, Vishal Publishing, 2017

Supplementary Reading

5. K. B. K. Sen, Quantum Chemistry, Tata McGraw Hill, 1992.
6. A. K. Chandra, Introduction to Quantum Chemistry, Tata McGraw Hill, 1997.
7. W. Levine, Quantum Chemistry, PHI Learning, 2014.
8. G.L. Agrawal, Basic Chemical Kinetics, Tata McGraw Hill, 1990.

Course outcomes:

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

CO1 Understand the theoretical basis underlying the kinetics of different chemical reactions

CO2 Appreciate the theories of molecular dynamics

CO3 Comprehend the quantum mechanics of simple systems

CO4 Evaluate the applications of quantum chemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√

SEMESTER - VIII **Credits: 3**
Hours: 5

19ICHP84: Organic Chemistry Practical – II

Learning Objectives:

To undertake separation and analysis of organic mixtures using two compound system.

Qualitative Analysis: Analysis of two component mixture. Separation and systematic analysis of the separated two individual components.

Textbook

1. J. Mohan, Organic Analytical Chemistry, Theory and Practice, Narosa, 2003.
2. V.K. Ahluwalia, P. Bhagat, R. Aggarwal, Laboratory Techniques in Organic Chemistry, I.K. International, 2005.
3. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, 2005.

Supplementary reading

4. N.S. Gnanaprakasam, G. Ramamurthy, Organic Chemistry Lab Manual, S.V. Printers, 2000.

Course outcomes:

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

CO1 acquire the necessary practical skills to independently analyse organic compounds.

CO2 gain expertise in the separation of two component mixtures of organic compounds.

CO3 systematically evaluate organic compounds

CO4 apply the knowledge in industries.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√												√			
CO2	√		√									√	√			√	√
CO3	√			√										√			
CO4	√	√				√	√	√				√	√			√	√

SEMESTER - VIII **Credits: 3**
Hours: 5

19ICHP85: Inorganic Chemistry Practical – I

Learning Objective:

To get the skill in the identification of cations including rare earth metals and to develop the skill in the estimation of metal ions by complexometric titrations

Semi Micro Qualitative Analysis

Mixture containing two common cations and two of the following less familiar cations.

Se, Te, W, Mo, Be, Ti, Ce, Th, Zr, U, V, Tl and Li.

Text Books:

1. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, National Pubs. 1988.
2. A.I. Vogel, Text Book of Quantitative Inorganic Analysis, 5th Ed., Longman, 1989

Course outcomes:

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

CO1 acquire the necessary practical skills to independently analyse Inorganic compounds.

CO2 gain expertise in the systematic analysis if inorganic compounds.

CO3 apply the knowledge in industries

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			

SEMESTER - IX **Credits: 4**
Hours: 4

19ICHT91: SYNTHETIC ORGANIC CHEMISTRY

Learning Objectives:

To learn the new techniques in planning an organic synthesis and to acquire knowledge about polymers and its industrial importance.

Unit – I: Planning Organic Synthesis

An introduction to retrosynthesis - Synthon, Synthetic equivalent, Target molecule, Functional group interconversion - Disconnection approach - One group disconnection - Disconnection of alcohols, olefins and ketones - Logical and illogical disconnections. Two group disconnection - 1,2-, 1,3-, 1,4-, 1,5- and 1,6-dioxygenated skeletons and dicarbonyls. Retro Diels - Alder reaction - Pericyclic reactions – Retrosynthesis of some heterocycles containing two nitrogen atoms. Retrosynthetic analysis of Camphor, Longifiline and Reserpine.

Unit – II: Reagents in Organic Chemistry:

Uses of the following reagents in organic synthesis and functional group transformations. Sodium borohydride, Lithium aluminium hydride, tri-n-butyltin hydride, Lithium dimethyl cuprate, Lithium diisopropyl amide, Trimethylsilyl iodide, dicyclohexylcarbodiimide, OsO_4, DDQ, SeO_2, PCC. Phase Transfer Catalysts - Benzyltriethylammonium halides - Crown ethers.

Oxidation and reduction:

Oxidation - Swern and Dess-Martin oxidations, Corey-Kim oxidation, PCC and $KMnO_4$ oxidations. **Reduction** using hydride reagents, $LiAlH_4$, $NaBH_4$ and other organoboranes: chemo- and stereoselectivity, catalytic hydrogenation (homogenous and heterogeneous catalysts).

Unit – III: Organic Reactions and Advanced Mechanisms

Formation of C-C single bond: Aldol condensation, Claisen ester reaction, Stobbe condensation, Knoevenagel reaction, Michael addition, Dieckmann condensation - Stork enamine reaction - Mannich reaction. **Formation of C=C double bond:** Wittig reaction, Claisen-Schmidt condensation and Peterson's synthesis.

Cannizaro and cross Cannizaro reactions, Benzoin condensation, Wolff-Kishner reduction, Clemmenson reduction, Birch reduction and Chichibabin reaction.

General methods of investigation of organic reaction mechanisms - kinetic and non-kinetic methods - Baldwin rules - cross over experiments - isotopic labeling primary and secondary kinetic isotopic effects - solvent kinetic isotopic effects. SN1', SN2' and SNi' mechanisms - Neighbouring group participation - non-classical carbocation and memory effect - structure and solvent effect on nucleophilic substitution reactions.

Unit – IV: Selective Synthetic Methods

Need for protection of functional groups during chemical reactions - protection of hydroxyl, mercapto, amino, carbonyl and carboxylic groups.

Asymmetric synthesis with chiral substrate: Nucleophilic addition to α-chiral carbonyl compounds, Electrophilic addition to α-chiral olefins - epoxidation, cyclopropanation, hydroboration. Asymmetric synthesis using chiral reagents and catalysts: Chiral organo boranes - application in hydroboration, reduction and allylation reactions, epoxidation catalyst,

semicorin catalyst, Jacobson catalyst - Uses of Camphor derived auxiliaries and menthol derived auxiliaries in asymmetric synthesis.

Unit – V: Polymers

Chemistry of polymerisation, Kinetics of polymerisation, Chemical and geometrical structure of polymer molecules, Glass transition temperature, Crystallinity in polymers - Copolymerisation. Polymer stereochemistry.

Industrial polymers - Synthesis, structure and applications of industrially important polymers like PVC, nylon 6,6, buna-S rubber and Polytetrafluoroethylene (*Teflon*). Conducting polymers - Synthesis and applications of polyacetylenes, polyanilines, polypyrroles and polythiophines.

Polymers as aids in organic synthesis - Polymeric reagents, catalysts and substrates. Polymers in Optical lithography - Drug delivery - Drug carriers.

Unit – VI (Not for final examination)

Uses of following reagents in organic synthesis and functional group transformation. Synthesis and uses of drugs- anxiolytics, neuroleptics, hypnotics, sedatives, local anaesthetics, anti-coagulants, hypoglycaemic agents, antihistaminic agents, antimalarials, analgesics, antipyretics and anti-inflammatory.

Textbooks:

1. M. B. Smith, March's Advanced Organic Chemistry, John Wiley & Sons, 7th Ed, **2016.**
2. I. L. Finar, Organic Chemistry Vol 1 and 2, Pearson, 7th Ed., **2009.**
3. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, **2003.**
4. P. S. Kalsi. Organic Reactions: Stereochemistry and Mechanism through solved problems, New Age International (P) Ltd, 4th Ed, **2007.**
5. E. L. Eliel, Stereochemistry of Organic Compounds, Wiley India 42nd Ed., **2011.**

Supplementary reading:

1. Michael B. Smith, Organic Synthesis, Elsevier, 4th Ed., **2010**.
2. C.K. Charles, Organic Synthesis, Narosa, 1st Ed., **2012**.
3. V.K. Ahluwalia, Renu Aggarwal, Organic Synthesis, Narosa, 2nd Ed., **2006**.
4. V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International, 2nd Ed., **2017.**

Course outcomes:

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

CO1 understand the concepts of retrosynthetic analysis
CO2 learn about various organic reagents used in synthetic organic chemistry
CO3 evaluate the various organic reactions and its mechanisms
CO4 understand about selective synthetic methods
CO5 gain knowledge about polymers

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√					√	√	√	√	√
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - IX **Credits: 4**
Hours: 4

19ICHT92: GREEN CHEMISTRY, COMPUTATIONAL CHEMISTRY, DRUG DESIGN AND SPECTROSCOPY

Learning Objective:

To understand the basic aspects of Green Chemistry and spectroscopy of organic compounds.

Unit – I: Green Chemistry

Introduction and principle of green chemistry - Environmental friendly green techniques - solvent supported catalysts and reagents, heterogeneous reactions, Examples of organic reactions involving green chemistry techniques.

Techniques in Organic Synthesis - Use of microwave, ultrasound, ionic liquids, supercritical fluid extraction in organic synthesis – Heterogenized reactions

Unit – II: Computational Chemistry

An introduction to concepts of potential energy surface, Basic principles of molecular mechanics, Ab initio method, Semiempirical calculations (SE) and Density functional theory (DFT) software.

Drug Design and Synthesis

Development of new drugs - Procedures followed in drug design. Physicochemical parameters: Lipophilicity, partition coefficient, electronic ionization constants - Concepts of drug receptors and Drug receptor interactions. Structure-Activity Relationship and Quantitative Structure-Activity Relationship. Free Wilson and Hansch analysis - Case study using morphine and penicillins.

Synthesis of Benzodiazepene, Sulfonyl urea and Diclofenac drugs.

Unit – III: Mass Spectrometry

Principles – measurement techniques – (EI, CI, FD, FAB, SIMS) – presentation of spectral data – molecular ions – isotope ions – simple and multicentre fragmentation – fragment ions of odd and even electron types – factors affecting cleavage patterns – rearrangement ions – McLafferty rearrangement – Retro Diels–Alder fragmentation. Mass spectra of hydrocarbons, alcohols, phenols, aldehydes, ketones, carboxylic acids, amines and their derivatives - MALDI-TOF and its applications.

Unit – IV: NMR Spectroscopy

Nuclear spin and magnetic moment of a nucleus – nuclear energy levels in the presence of magnetic field - basic principles of NMR experiments – CW and FT NMR – ^{1}H NMR chemical shift - factors influencing proton chemical shifts - coupling constants – factors influencing coupling constants – ^{1}H NMR spectra of simple organic molecules such as: CH_3CH_2Cl, CH_3CHO, etc., AX, AB and AMX spin system – spin decoupling – nuclear overhauser effect – chemical exchange.

Introduction to ^{13}C NMR - chemical shifts – additivity principle – factors affecting ^{13}C NMR chemical shifts - proton decoupled, off-resonance, INEPT and DEPT ^{13}C NMR spectra – ^{13}C NMR spectra of simple organic molecules.

Unit – V: Multidimensional NMR Spectroscopy:

Basic principles of 2D NMR spectroscopy – HOMOCOSY, HSQC, HMBC, TOCSY and NOESY spectra and their applications.

Introduction of 3D NMR experiment, HCCH-TOCSY, HNCA experiment, HNCO experiment, HN(CA)CO experiment, Backbone assignments and Side-chain assignments - Spectroscopic identification of Organic Compounds - Identification of organic compounds using data of UV, IR and NMR spectroscopy and mass spectrometry.

Unit – VI (Not for final examination)

Techniques in organic synthesis – use – Neat reaction, Grinding techniques. Synthesis of Phenothiazines, Piperidinediones, Aminobenzoic acid and its derivatives, 1,3- Indanedione derivatives, Ethylenediamine derivatives, Aminoquinolines, Paracetamol and Phenylbutazone.

Textbooks:

1. Rashmi Sanghi, Srivastava, Green Chemistry, Narosa Publishing House, 5th Ed., **2012**
2. Albert S. Matlack, Introduction to Green Chemistry, CRC Press, 2nd Ed., **2010**.
3. Ashutosh Kar, Medicinal Chemistry, 6th Ed., **2015.**
4. Errol Lewars, Computational Chemistry, Springer, 3rd Ed., **2015.**
5. G. K. Patrick, Medicinal Chemistry, Garland Science, 1st Ed., **2015.**
6. R. M. Silverstein, F. X. Webster, D. J. Kiemle & D. L. Bryce, Spectrometric Identification of Organic compounds, John Wiley, 8th Ed., **2016.**
7. Jagmohan, Organic Spectroscopy, Narosa, 2nd Ed., (15), **2016.**
8. R. S. Macomber, A Complete Introduction to NMR Spectroscopy, Wiley, **1998.**
9. Jag Mohan, Organic Spectroscopy, Principles & Applications, Narosa , 2nd Ed., **2016.**

Supplementary Reading

10. Sameuel Delvin, Green Chemistry, IVY Publishing House 1st Ed., **2006**
11. M.M. Srivastava, Rashmi Sanghi, Chemistry for Green Environment, Narosa, 1st Ed., **2005**
12. V. K. Ahluwalia, Medicinal Chemistry, 2nd Edition, Ane Books P Ltd., **2012.**
13. William Kemp, Organic Spectroscopy, Macmillan Education UK, 3rd Ed., **2008**.
14. P.S. Kalsi, Spectroscopy of Organic Compounds, New Age International Publishers, 6th Ed, Reprint, **2005.**

Course outcomes:

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

CO1 correlate the UV absorption and molecular structure

CO2 understand IR stretching frequencies of organic compounds with their functional groups.

CO3 interpret the ^{1}H and ^{13}C NMR spectra of organic compounds

CO4 learn the principles of multidimensional NMR

CO5 analyze the unknown compounds by spectroscopy.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									√
CO2	√		√						√						√	√	
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - IX **Credits: 4**
Hours: 4

19ICHT93: Spectral and Analytical Techniques

Learning Objectives

To study the electronic and magnetic properties of complexes, applications of diffraction methods and to know the characterization of inorganic compounds using ESR, NQR and Mossbauer spectroscopies.

Unit-I: Spectral and Magnetic Properties of Complexes

Ground state Terms for d^1-d^9 ions- Derivation of terms for p^2 and d^1 configurations. Characteristics of d-d transitions. Energy level diagrams – Orgel diagrams of d^1-d^9 - Tanabe-Sugano diagram of d^6. Effect of Jahn Teller distortion, Nephelauxetic effect, Selected examples of d-d spectra – $[Ti(H_2O)_6]^{3+}$, trans – $[Cr(en)_2F_2]^+$, $[Ni(en)_3]^{2+}$, $[CoF_6]^{3-}$, $[Co(ox)_3]^{3-}$, $[Cu(H_2O)_6]^{2+}$.

Magnetism: dia, para, ferro and antiferro – magnetism – quenching of orbital angular momentum, Temp independent paramagnetism – Effect of spin orbit coupling on spectral and magnetic properties.

Unit – II: Photoelectron and ESR Spectroscopies

Valence and core binding energies – Measurement technique – Koopman's theorem – Chemical shifts in X-ray photoelectron spectroscopy – Auger spectroscopy – Applications of ESCA in chemistry.

Electron spin Resonance Spectroscopy – Origin of the spectrum – method of recording - hyperfine splitting – **g** value and hyperfine splitting constant - ESR spectra of simple organic radicals - application of ESR spectra to transition metal complexes

Unit - III: NQR and Mossbauer Spectroscopies

NQR spectroscopy – Theory of NQR – instrumentation – Nuclear quadrupole coupling constants – Applications.

Mossbauer spectroscopy – principle – source and absorber – isomer shift – quadrupole splitting – magnetic interactions – applications to Fe and Sn compounds.

Unit-IV: Diffraction Methods

Crystal systems and lattice types. Miller indices and Bravais lattices. Unit cells and its identification from systematic absence - the concept of reciprocal lattice – Structure factor and its relation with electron density –Analysis by powder X-ray diffraction and single crystal photography and its applications.

Electron and neutron diffraction – Elementary treatment – Wierl equation – Scattering of neutron by solids and liquids – comparison with X-ray diffraction – Magnetic scattering – measurement techniques – Elucidation of structure of a simple gas phase molecule.

Unit – V: Chromatography and ORD

Principles of gas – liquid and gas – solid chromatography – Instrumentation - Applications – Principles and Applications of HPLC – supercritical fluids chromatography – Properties of supercritical fluids – Instrumentation and applications.

Theories of Optical Rotatory Dispersion and Circular Dichroism – correlation between structure and optical rotation – axial haloketone rule – Cotton effect – Octant rule – Deduction of absolute configuration of organic molecules and inorganic complexes.

Unit – VI (Not for final examination)

^1H, ^{13}C, ^{19}F, ^{17}O, ^{31}P and ^{119}Sn NMR spectra of coordination compounds – IR and Mass spectra of complexes – Hirshfeld surface analysis.

Textbooks

1. Huheey, J.E., Inorganic chemistry, E. L. Keiter, R. L. Keiter, O. K. Medhi, Pearson Press, 5th edition, 2011
2. Lee, J.D., Concise inorganic chemistry, Wiley India, 5th edition, 2012
3. S. F. A. Kettle, Coordination Compounds, Publisher Thomas Nelson, 1969.

4. R. A. Day, A. L. Underwood, Quantitative Analysis, PHI Learning Pvt. Ltd.,6th edition, 2009.
5. R.S. Drago, Physical Methods in Chemistry, East West Press, 2nd edition, 2015
6. E. A. V. Ebsworth, D.W.H. Rankine, S. Craddock, Structural Methods in Inorganic Chemistry, ELBS, 1991.
7. J.H.D.Eland, Butterworth, Photoelectron Spectroscopy, 2nd Edition, Elsevier, 1983.
8. E.L. Eliel, Stereochemistry of Carbon Compounds, 42nd Ed. Tata McGraw Hill, 2011.

Course Outcomes:

After completion of this course, students are able to

CO1 evaluate the spectral and magnetic properties of complexes.

CO2 analyse the spectral techniques like PES and ESR

CO3 understand the theory of NQR

CO4 appreciate the diffraction methods

CO5 gain knowledge on ORD and CD

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√										√	√			√	√
CO5	√			√						√		√		√		√	

SEMESTER - IX **Credits: 4**
Hours: 4

19ICHT94: Electrochemistry and Spectroscopy

Learning Objectives:

To learn the theories electrochemistry and to learn the fundamental concepts of molecular, UV and IR spectroscopy.

Unit – I: Electrochemistry - Theories of Strong Electrolytes and Electrochemical Cells

Debye-Huckel-Onsager equation and its verification, conductance at high field and high frequency, Debye-Huckel limiting law.

Electrochemical cell reactions, Nernst equation – electrochemical series. electrode-electrolyte interface, electrical double layer- Helmholtz-Perrin, Gouy-Chapmann and Stern theories – electro kinetic phenomena- Lipmann equation, corrosion and passivity –Pourbaix and Evans diagrams-methods of protection of metals from corrosion

Unit – II: Electrochemistry- Electrode Reactions, Battery and Fuel Cell

Ion-solvent interactions – Born Model, Enthalpy, free energy and entropy of ion-solvent interactions. Primary and secondary solvations (salting in and salting out). Electrode kinetics – Butler-Volmer equation, Tafel equation, polarization and over voltage –mechanism of hydrogen evolution and oxygen evolution reactions. Batteries-Lead –acid battery, Lithium-Iron and Nickel-Cadmium battery. Fuel cell-hydrogen-oxygen and hydrocarbon-oxygen fuel cell.

Unit – III: Electroanalytical Methods

Principle and applications of electrogravimetry, coulometry – amperometry – potentiometry – conductometry – polarography – voltammetry – cyclic voltammetry – anodic stripping voltammetry.

Unit – IV: Molecular Spectroscopy

Vibrational spectra – harmonic and anharmonic oscillators – fundamental vibrations and overtones – hot bands. Vibrational-rotational spectra – P, Q, R branches. Electronic spectra of diatomic molecule – Potential energy curves – Franck-Condon Principle.

Raman spectra – theory – Selection Rules – Rotational Raman Spectra and Vibrational Raman Spectra. Mutual exclusion principle.

Comparison of Raman and IR spectra – structural determination from Raman and IR spectroscopy, rule of mutual exclusion.

Unit-V: UV – Visible and IR -Spectroscopy

Ultraviolet – Visible spectroscopy – types of electronic transitions – chromophores and auxochromes - factors influencing positions and intensity of absorption bands – absorption spectra of dienes, polyenes and α, β - unsaturated carbonyl compounds – Woodward – Fieser rules.

IR Spectroscopy – vibrational frequencies and factors affecting them – identification of functional groups – intra and inter molecular hydrogen bonding – finger print region – Far IR region – metal ligand stretching vibrations.

Unit – VI (Not For Final Examination)

Advanced Spectral Techniques

Raman Micro spectrometry applied to the Study of Electrode Materials-(Coherent Anti Stokes Raman spectroscopy (CARS), Resonance Raman, Time Resolved Raman Spectroscopy and Surface enhanced Raman spectroscopy and its applications. 2D IR Spectroscopy and Single photon Fluorescence spectroscopy and its applications - Single molecule spectroscopy and its applications.

Text Books:

1. S. Glasstone, Introduction to Electrochemistry, East West Pvt., Ltd., 2008.
2. O'M Bockris and A. K. N. Reddy, Modern Electrochemistry; Vol. 1 and 2, 2nd Ed., Plenum Press, New York, 2014.
3. C.N.Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill, 1993.
4. William Kemp, Organic Spectroscopy, 2011.
5. P. Atkins, J. D. Paula, Physical Chemistry, Oxford University Press, 2013.

6. John R Dyer, Application of absorption spectroscopy of organic compounds, Prentice-Hall of India Pvt. Ltd, 2005

Supplementary Reading

7. L. Antropov, Theoretical Electrochemistry; University Press of the Pacific, USA, 2001.
8. R. G. Compton, Electrode Kinetics: Reactions; Elsevier Science Press, Chennai, 1987

Course outcomes:

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

CO1 understand the theories of strong electrolytes.

CO2 acquire the knowledge about various electro analytical techniques

CO3 solve the numerical and analytical problems related to electrochemistry and surface chemistry.

CO4 appreciate the theories of molecular spectroscopies like UV and IR.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√

SEMESTER - IX

Credits: 3
Hours: 5

19ICHP95: Inorganic Chemistry Practical – II

Learning Objectives:

To develop skills in the determination of a metal ion in presence of another by appropriate techniques.

Quantitative analysis

1) Determination of Ba^{2+} and Ca^{2+} ions
2) Determination of Cu^{2+} and Ni^{2+} ions
3) Determination of Cu^{2+} and Zn^{2+} ions
4) Determination of Cu^{2+} and SO_4^{2-} ions
5) Determination of Ca^{2+} and Mg^{2+} ions
6) Analysis of pyrolusite

Text Book:

1. A. I. Vogel's, Quantitative Inorganic Analysis, 5th Ed., Prentice Hall, 2015.

Course outcomes:

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

CO1 acquire the necessary practical skills to independently determine inorganic ions.

CO2 gain expertise in the systematic analysis of inorganic compounds.

CO3 apply the knowledge in industries.

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			

SEMESTER - IX **Credits: 3**
Hours: 5

19ICHP96: Physical Chemistry Practical – II

Learning Objectives:

To learn the principles and verification of basic electrochemistry and Kinetics

I. Potentiometry Experiments

1) Single electrode potentials
2) Solubility of sparingly soluble salt
3) Redox titrations
   a) Ferrous iron (II) **vs** dichromate (Fe^{2+} vs $Cr_2O_7^{2-}$)
   b) Iodide ion (I^-) **vs** $KMnO_4$
   c) Ferrous iron (II) **vs** Cerium (IV) ion (Fe^{2+} vs Ce^{4+})
4) Precipitation titrations
   a) Chloride Vs Silver ion
   b) Iodide Vs Silver ion
   c) Mixture of chloride and iodide ions Vs Silver ion
5) Potentiometric titrations (by quinhydrone electrode)
   a) Strong acid **vs** Strong base
   b) Mixture of acids (HCl + weak acid) **vs** NaOH

II. Chemical Kinetics

1) Acid catalysed hydrolysis of an ester.
2) Comparison of acid strengths.
3) Persulphate – iodide kinetics – clock reaction – Primary salt effects
4) Saponification of an ester
5) Iodination of acetone

Text Books:

1. B.P. Levitt, Ed., Findlay`s Practical Physical Chemistry, 9th Ed., Longman, 1985.
2. J.N. Gurtu, R. Kapoor, Advanced Experimental Chemistry, Vol.I, S.Chand & Co., 1987.

Course outcomes:

After the completion of this course, students will be able to

CO1 understand the necessary practical skills in instrumental analysis.

CO2 gain expertise in systematic calculations and graphical representation.

CO3 apply the knowledge in industries

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			

SEMESTER - X **Credits: 4**
Hours: 4

19ICHT101: Nuclear, Bioinorganic and Materials Chemistry

Learning Objectives:

To understand theory of radioactivity and applications of radioisotopes, bioinorganics and materials.

Unit-I: Nuclear Chemistry

Radioactive decay and equilibrium, Nuclear Q – value and nuclear cross sections, different types of nuclear reactions, fission and fusion. Theories of fission. Fissile and Fertile isotopes.-Nuclear fusion – stellar energy, Theories of α- and β- decay, orbital electron capture, nuclear isomerism, internal conversion. Hot atom chemistry. Radio isotopes and their Applications: Activation analysis, Isotopic dilution technique-radiometric titration- tracer technique. Counting techniques such as G. M. counter and proportional counter. Applications of nuclear science in industry, agriculture and biology.

Unit-II: Chemistry of Lanthanides and actinides

Correlation of electronic structures, occurrence and isolation, separation - Chemistry of separation of Np, Pu & Am from U & fission products. Oxidation states and general properties – Comparison with 'd' block elements, Lanthanide contraction and its significance, Coordination compounds of lanthanides - Spectral and magnetic characteristics of lanthanides and actinides - Position in the periodic table. Similarities between the actinides and lanthanides.

Unit-III: Bioinorganic Chemistry-I

Role of alkali and alkaline earth metals in biological systems– Mechanism of ion transport across membranes, Sodium – potassium pump - Ionophores – Metalloporphyrins – cytochromes – iron-sulfur proteins: rubredoxin and ferredoxins. Oxygen carriers: hemerythrin and hemocyanin- structural features and function of myoglobin and haemoglobin – .Photosynthesis - PS-I and PS-II.

Unit-IV: Bioinorganic Chemistry-II

Enzymes-Inhibition and poisoning, Vitamin B_{12} and B_{12} coenzymes, metallothionine. Metalloenzymes-Carbonic anhydrase and Carboxy peptidase. -Nitrogen fixation- in vitro and in vivo. Transition metal-nucleic acid interaction. Anticancer activity of Pt-complexes-different types of active platinum complexes- Mechanism of anticancer activity of *cis*-platin. Nonactivity of trans-platin - Lithium therapy in psychiatric mind disorder.

Unit-V: Preparative techniques of inorganic materials

Principle of solid state reactions with reference to MgO and Al_2O_3 - Reaction conditions – Structural considerations – reaction rates – Wagner mechanism – nucleation and diffusion – surface structure and reactivity. Synthesis of $MgAl_2O_4$ (a spinel) – experimental procedure. Synthesis of a Zeolite - $(Na_x(AlO_2)_x(SiO_2)_y)mH_2O$ - Preparation of thin films – cathode sputtering – Preparation of metastable phase by sol-gel technique – Hydrothermal technique – Zone melting – Melts – vapour phase transport methods.

Unit – VI (Not for final examination)

Uses of nuclear radiations: Radiation sterilization – Radiation energy for chemical synthesis – Radioisotopes as a source of electricity.

Biological role of some trace non-metals: boron, silicon, sulphur, selenium, arsenic, fluorine, chlorine, bromine, iodine – role of metal complexes in conventional drug resistant to malaria.

Text Books:

1. E. L. Keiter, R. L. Keiter, O. K. Medhi, Pearson Press, 5th edition, 2011
2. H. J. Arnikar, Essential of Nuclear Chemistry, New Age International, 1995.
3. S. Glasstone, Source Book of Atomic Energy, Affiliated East West Press, 1967.
4. Huheey, J.E., Inorganic chemistry, Addison Wesley, 2011.
5. Anthony R. West, Solid state chemistry and its applications, John Wiley, New Delhi,2007

6. M. Arumugam, Material Science, Anuradha Agencies, Kumbakonam second Edition,2003

Course outcomes:

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

CO1 understand about radioactivity and its application for peaceful purposes

CO2 get familiarise with chemical reactions in physiological systems

CO3 understand lanthanides and actinides

CO4 appreciate bioinorganic chemistry

CO5 learn preparative techniques in inorganic chemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - X **Credits: 4**
Hours: 4

19ICHT102: Nano Materials, Macromolecular and Surface Chemistry

Learning Objectives:

To learn about the synthesis and characterization techniques of nanomaterials and to learn the principle of various adsorption isotherms.

Unit - I: Synthesis and Applications of Nanomaterials

Preparation of nanomaterials – sol-gel synthesis, Chemical Vapour Deposition (CVD), electrodeposition, ball milling, plasma arcing, uses of natural nanoparticles. Synthesis and applications of carbon nanotubes.

Self assembled monolayers – monolayers on gold – preparation – structure – growth process – patterning monolayers – mixed monolayers.

Core-Shell nanoparticles – introduction – types of systems – characterization – properties. Monolayer–protected metal nanoparticles – characterization – functionalization – Application. Semiconductor quantum dots – synthesis – electronic structure & spectral properties

Sensors – Classification, Types of sensors, properties, chemical sensor, electrochemical sensors, optical sensors, biosensors, nanosensors, nanobiosensors, Applications of Nanosensors.

Unit - II: Characterization of Nanomaterials

Electron microscopes – scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning Transmission Electron Microscopy (STEM), Scanning Probe Microscopy (SPM) – scanning tunneling microscopy (STM) – Atomic manipulations, Focused Ion beam (FIB) technique – Atomic force microscopy (AFM) – scanning probe Lithography (SPL), Dip pen nanolithography (DPN) - Optical microscopies for nanoscience and Technology – Confocal microscopy – scanning near-field optical microscopy – particle size analysis.

Unit - III Material Science

Band theory - insulators, semiconductors and conductors and their applications - superconductors and their applications – A study of conducting polymers, liquid crystals, NLO, LCD, LED and photochromic materials and their applications. Principle, properties and applications of ferroelectric, piezoelectric and pyroelectric materials.

Unit IV: Properties of Polymers

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

Polymer structure and physical properties –crystalline melting point T_m. Determination of T_g. Relationship between T_m and T_g.

Biopolymers – biomaterials. Polymers in medical field - High temperature and fire – resistant polymers.

Unit – V: Surface Chemistry

Langmuir and BET isotherms, Adsorption from solutions – Gibbs adsorption isotherm, surface area determination – Applications of adsorption – adsorption indicators. Study of surface film, surface tension, surface free energy: Pressure across an interface –Laplace and Kelvin equations. Surfactant-classification of surfactants, hydrophobic interaction, micellization of surfactant, critical micelle concentration, factors affecting the critical micelle concentration, thermodynamics of micellization.

Unit – VI (Not For Final Examination)

Nanostructures Carbon clusters: Discovery of C60 - alkali doped C60 - superconductivity in C60 - larger and smaller fullerenes. Carbon nanotubes: Synthesis- single walled carbon nanotubes – structure and characterization - Mechanism of formation - chemically modified carbon nanotubes – doping - Functionalizing nanotubes - Application of carbon nanotubes. Nanowires: Synthetic strategies - Gas phase and solution phase growth - Growth control - Properties.

Text Books

1. T. Pradeep, Nano-The Essentials, Tata McGraw Hill, 2007.
2. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Nanotechnology, Overseas Press, 2005
3. Billmeyer .W., Text Book of polymer Science, Johnwiley&Sons ,Newyork,1984.
4. M. Arumugam, Materials Science, Anuradha Agencies, 3rd Edition, 2016.
5. W. D. Callister, Materials Science and Engineering, An Introduction.
6. Peter Atkins, Julio de Paula, Physical Chemistry, Oxford press, 2013.

Supplementary Reading

7. Journals like Chemistry of Materials, Journal of Materials Chemistry, Advanced Materials etc.. Web resource: http://chemistry.uohyd.ernet.in/~cy551/
8. C. N. R. Rao, A. Muller and A. K. Cheetham (Eds), The Chemistry of Nanomaterials: Vol. 1 and 2; Wiley-VCH; Germany, Weinheim, 2004.
9. V. R. Gowrikar, Polymer Science, New Age International, 2015
10. P. Atkins, J. D. Paula, Physical Chemistry, Oxford University Press, 2013.

Course outcomes:

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

CO1 know various methods of preparations of nanomaterial and its characterization using various microscopic techniques.

CO2 evaluate the principle and applications of industrially important materials

CO3 understand concepts of polymers, mechanism, kinetics and applications

CO4 understand about polymer chemistry

CO5 understand the basic surface chemistry

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - X **Credits: 2**
Hours: 4

19ICHP103: Organic Chemistry Practical – III

Learning Objectives:

To understand the basic aspects of quantitative experiments in Organic Chemistry and to estimate the organic compounds.

Quantitative analysis and Estimation of phenol, aniline, methyl ketone and glucose by volumetric analysis.

Text Books:

1. J. Mohan, Organic Analytical Chemistry, Theory and Practice, Narosa, 2003.
2. V.K. Ahluwalia, P. Bhagat, R. Aggarwal, Laboratory Techniques in Organic Chemistry, I.K. Int. 2005.
3. N.S. Gnanaprakasam, G. Ramamurthy, Organic Chemistry Lab Manual, S.V. Printers, 2000.
4. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall, 1996.

Course outcomes:

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

CO1 examine quantitative analysis of organic compounds

CO2 understand the quantitative methods

CO3 perform the estimation of phenol

CO4 analyse glucose and ketones

CO5 apply the knowledge in industries

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - X **Credits: 2**
Hours: 4

19ICHP104: Inorganic Chemistry Practical – III

Learning Objectives:

To know the colorimetric estimation of metal ions and to understand the complexometric titrations.

Colorimetric analysis:

Colorimetric estimations of copper, nickel, iron and chromium using photoelectric colorimeter.

Complexometric Titrations:

a) Standardization of EDTA.

b) Determination of Mg^{2+}, Zn^{2+}, Ni^{2+} and Ca^{2+}

Water analysis:

a) Estimation of total alkalinity of water

b) Estimation of dissolved oxygen in waste water

c) Estimation of chloride content in water

d) Estimation of hardness in water by EDTA

e) Chemical oxygen demand (COD)

Preparation of the followings:

1) Tris (thiourea) copper(I) chloride
2) Potassium trioxalatoferrate
3) Tetraammine copper(II) sulphate
4) Microcosmic salt
5) Chrome alum
6) Trans-Diaquadioxalatochromate(III)

Text Books:

1. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, National Pubs. 1988.
2. A.I. Vogel, Text Book of Quantitative Inorganic Analysis, 5th Ed., Longman, 1989

Course outcomes:

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

CO1 understand the colorimetric estimations of metal ions

CO2 gain knowledge on the preparation of complexes

CO3 evaluate the water quality that will be useful in environmental aspect

CO4 understand the complexometric titrations

CO5 calculate the hardness of water

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√
CO5	√			√		√				√		√		√		√	

SEMESTER - X **Credits: 2**
Hours: 4

19ICHP105: Physical Chemistry Practical – III

Learning Objectives:

To learn the principles and verification of Kinetics, electrochemistry and Phase diagrams.

Electrochemistry:

1. Kinetics of saponification of ester by conductometric method.
2. Determination of activity, activity coefficient of ions
3. Determination of pH of a Buffer solution (potentiometer)
4. Determination of dissociation constant of weak acid by Potentiometer.

pH Metry:

5. Dissociation constant of monobasic acid
6. Dissociation constant of dibasic acid
7. Dissociation constant of tribasic acid
8. Study the influence of cu^{2+} and Fe^{2+} on the reaction between persulfate and iodide ions.
9. Study of adsorption of acetic acid/oxalic acid on charcoal

Phase Rule:

10. Two component system-simple Eutectic
11. Three component system.

Kinetics:

12. Determination of energy of activation (Ea) for acid catalyzed hydrolysis of an ester

Text Books:

1. B.P. Levitt, Ed., Findlay`s practical Physical Chemistry, 9th Ed., Longman, 1985.
2. J.N. Gurtu, R. Kapoor, Advanced Experimental Chemistry, Vol.I, S.Chand& Co., 1987

Course outcome:

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

CO1 acquire the necessary practical skills to perform physical chemistry practicals.

CO2 gain expertise in the instrumental analysis.

CO3 evaluate calculations involving in physical chemistry

CO4 apply the gained knowledge in industries

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√									
CO2	√		√						√								
CO3	√			√						√				√			
CO4	√	√				√	√	√				√	√			√	√

SEMESTER - X

Credits: 6
Hours: 10

19ICHPJ106: Project Work / Inplant training

Learning Objectives:

To learn the basics of research work by carrying out selective academic and applied projects.

Course outcomes:

At the end of the course, the students will

CO1 acquire the practical knowledge of understanding research problems.

CO2 gain knowledge basic principles of various components of research

CO3 apply the principles of chemistry in various fields

PO and PSO/Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√	√						√				√	√	√	√	√	
CO2	√		√						√			√	√	√	√	√	
CO3	√			√						√				√			