FYUGP

CHEMISTRY HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER RANCHI UNIVERSITY

Upgraded & Implemented from 3rd Semester of Academic Session 2022-26
& From 1st Semester of Session 2023-27 Onwards

UNIVERSITY DEPARTMENT OF CHEMISTRY

Ranchi University, Ranchi-834008 (Jharkhand)

Ref No. :..... *Date :.....*

Members of Board of Studies of NEP FYUGP Syllabus
to be Implemented from 3rd Semester of Academic session 2022-26 & Onwards

1. **Chairman:**
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   Associate Professor & Head, University Department Chemistry,
   Ranchi University, Ranchi

2. **External Member:**
   i. **Prof (Dr.) Sanjoy Misra**
   Professor (Rtd.) & Ex-H.O.D.
   University Department Chemistry, R.U., Ranchi

   ii. **Dr. Khurshid Akhtar**
   Associate Professor & H.O.D., Dr. Shyama Prasad Mukherjee University, Ranchi

3. **Internal Members:**
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   Assistant Professor, University Department of Chemistry, R.U., Ranchi

   ii. **Dr. Smriti Singh**
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   iii. **Dr. Guru Charan Sahu**
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   viii. **Sri Subhankar Aich**
   Assistant Professor, Department of Chemistry, Marwari College, R.U., Ranchi

   ix. **Dr. Anil Kumar Pandey**
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   xi. **Dr. Reena Bhadani**
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DIRECTOR
IQAC, RANCHI UNIVERSITY
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HEAD/CHAIRMAN
Department of Chemistry
Ranchi University, Ranchi

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Students are Instructed to

Refer Syllabus of Allied/ Opted Subjects from R.U. Website

HIGHLIGHTS OF REGULATIONS OF FYUGP

PROGRAMME DURATION

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from **1st of July**.

ELIGIBILITY

- The selection for admission will be primarily based on availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if Marks of the Major subject is not available. Reservation norms of The Government of Jharkhand must be followed as amended in times.
- UG Degree Programmes with Double Major shall be provided only to those students who secure a minimum of overall 75% marks (7.5 CGPA) or higher.
- Other eligibility criteria including those for multiple entry will be in light of the UGC Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions.

ADMISSION PROCEDURE

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the University for FYUGP.

VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for maximum for Seven years from the date of registration.

ACADEMIC CALENDAR

- An Academic Calendar will be prepared by the university to maintain uniformity in the CBCS of the UG Honours Programmes, UG Programmes, semesters and courses in the college run under the university (Constituent/Affiliated).
- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
- **Semester:** The Odd Semester is scheduled from **July to December** and the Even Semester is from **January to June**. Each week has a minimum of 40 working hours spread over 6 days.
- Each semester will include – Admission, course work, conduct of examination and declaration of results including semester break.
- In order to undergo 8 weeks' summer internship/ apprenticeship during the summer camp, the Academic Calendar may be scheduled for academic activities as below:
  a) Odd Semester: **From first Monday of August to third Saturday of December**
  b) Even Semester: **From first Monday of January to third Saturday of May**
- An academic year comprising 180 working days in the least is divided into two semesters, each semester having at least 90 working days. With six working days in a week, this would mean that each semester will have 90/ 6 = 15 teaching/ working weeks. Each working week will have 40 hours of instructional time.
- Each year the University shall draw out a calendar of academic and associated activities, which shall be

strictly adhered to. The same is non-negotiable. Further, the Department will make all reasonable endeavors to deliver the programmes of study and other educational services as mentioned in its Information Brochure and website. However, circumstances may change prompting the Department to reserve the right to change the content and delivery of courses, discontinue or combine courses and introduce or withdraw areas of specialization.

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:
  - UG Certificate after completing 1 year (2 semesters) of study in the chosen fields of study provided they complete one vocational course of 4 credits during the summer vacation of the first year or internship/ Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.,
  - UG Diploma after 2 years (4 semesters) of study diploma provided they complete one vocational course of 4 credits or internship/ Apprenticeship/ skill based vocational courses offered during first year or second year summer term in addition to 9 credits from skill-based courses earned during first, second, and third semester,
  - Bachelor's Degree after a 3-year (6 semesters) programme of study,
  - Bachelor's Degree (Honours) after a 4-year (8 semesters) programme of study.
  - Bachelor Degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking 12 credit Research component in fourth year of FYUGP.

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over the duration of a semester (minimum 15 weeks).

a) One hour of teaching/ lecture or two hours of laboratory /practical work will be assigned per class/interaction.
   One credit for Theory = 15 Hours of Teaching i.e., 15 Credit Hours
   One credit for Practicum = 30 Hours of Practical work i.e., 30 Credit Hours

b) For credit determination, instruction is divided into three major components:
   Hours (L) – Classroom Hours of one-hour duration.
   Tutorials (T) – Special, elaborate instructions on specific topics of one-hour duration
   Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of two-hour duration.

CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

- Student's final marks and the result will be based on the marks obtained in Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

PROMOTION CRITERIA

First degree programme with single major:

i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
ii. No student will be detained in odd Semesters (I, III, V & VII).
iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of Courses in an academic year, a student has to pass in minimum 9 papers out of the total 12 papers.
iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 18 papers out of the total 24 papers.
v. To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum 26 papers out of the total 34 papers.
vi. However, it will be necessary to procure pass marks in each of the paper before completion of the course.

First degree programme with dual major:

vii. Above criterions are applicable as well on the students pursuing dual degree programmes however first degree programme will remain independent of the performance of the student in dual major courses.
viii. To get eligible for taking ESE, a student will be required to pass in at least 75% of Courses in an academic year, a student has to pass in minimum 3 papers out of the total 4 papers.
ix. It will be a necessity to clear all papers of second major programme in second attempt in succeeding session, failing which the provision of dual major will be withdrawn and the student will be entitled for single first degree programme.

PUBLICATION OF RESULT

- The result of the examination shall be notified by the Controller of Examinations of the University in different newspapers and also on University website.
- If a student is found indulged in any kind of malpractice/ unfair means during examination, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of next coming session and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.
- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination for clearing the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.

Regulation related with any concern not mentioned above shall be guided by the Regulations of the University for FYUGP.

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COURSE STUCTURE FOR FYUGP **'HONOURS/ RESEARCH'**

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 160]

Level of Courses	**Semester**	**MJ**; Discipline Specific Courses – Core or Major (80)	**MN**; Minor from discipline (16)	**MN**; Minor from vocational (16)	**MDC**; Multidisciplinary Courses [Life sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9)	**AEC**; Ability Enhancement Courses (Modern Indian Language and English) (8)	**SEC**; Skill Enhancement Courses (9)	**VAC**; Value Added Courses (6)	**IAP**; Internship/ Dissertation (4)	**RC**; Research Courses (12)	**AMJ**; Advanced Courses in lieu of Research (12)	**Credits**	**Double Major (DMJ)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	**I**	4	4		3	2	3	4				**20**	4+4
	II	4+4		4	3	2	3					**20**	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 credits)												
200-299: Intermediate-level courses	**III**	4+4	4		3	2	3					**20**	4+4
	IV	4+4+4		4		2		2				**20**	4+4
	Exit Point: Undergraduate Diploma provided with Summer Internship in 1st or 2nd year/ Project (4 credits)												
300-399: Higher-level courses	**V**	4+4+4	4						4			**20**	4+4
	VI	4+4+4+4		4								**20**	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	**VII**	4+4+4+4	4									**20**	4+4
	VIII	4		4						12	4+4+4	**20**	4+4
	Exit Point: Bachelor's Degree with Hons. /Hons. with Research											**160**	**224**

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation.

Upgraded & Implemented from 3rd Sem. of Session 2022-26 & 1st Sem. of Session 2023-27 Onwards

Table 2: Semester wise Course Code and Credit Points for Single Major:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	**Papers**	**Credits**
I	AEC-1	Language and Communication Skills (MIL 1 - Hindi/ English)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (MIL 2 - English/ Hindi)	2
	SEC-2	Skill Enhancement Course-2	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (Language Elective 1 - Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (Language Elective - Modern Indian language including TRL)	2
	VAC-2	Value Added Course-2	2

	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	4
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	4
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	4
	MJ-11	Major paper 11 (Disciplinary/Interdisciplinary Major)	4
	IAP	Internship/Apprenticeship/Field Work/Dissertation/Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	4
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	4
	MJ-14	Major paper 14 (Disciplinary/Interdisciplinary Major)	4
	MJ-15	Major paper 15 (Disciplinary/Interdisciplinary Major)	4
VII	MN-1D	Minor from Discipline-1	4
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4
	MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)	4
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4
VIII	MN-2D	Minor from Vocational Studies/Discipline-2	4
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/ AMJ-1 AMJ-2 AMJ-3	Research Internship/Field Work/Dissertation OR Advanced Major paper-1 (Disciplinary/Interdisciplinary Major) Advanced Major paper-2 (Disciplinary/Interdisciplinary Major) Advanced Major paper-3 (Disciplinary/Interdisciplinary Major)	12/ 4 4 4
		Total Credit	**160**

NUMBER OF CREDITS BY TYPE OF COURSE

The hallmark of the new curriculum framework is the flexibility for the students to learn courses of their choice across various branches of undergraduate programmes. This requires that all departments prescribe a certain specified number of credits for each course and common instruction hours (slot time).

Table 3: Overall Course Credit Points for Single Major

Courses	Nature of Courses	3 yr UG Credits	4 yr UG Credits
Major	Core courses	60	80
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	24	32
Multidisciplinary	3 Courses	9	9
AEC	Language courses	8	8
SEC	**Courses to be developed by the University**	9	9
Value Added Courses	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6	6
Internship (In any summer vacation for Exit points or in Semester-V)		4	4
Research/ Dissertation/ Advanced Major Courses	Research Institutions/ 3 Courses		12
	Total Credits =	**120**	**160**

Table 4: Overall Course Code and Additional Credit Points for Double Major

Courses	Nature of Courses	3 yr UG Credits	4 yr UG Credits
Major 1	Core courses	60	80
Major 2	Core courses	48	64
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	24	32
Multidisciplinary	3 Courses	9	9
AEC	Language courses	8	8
SEC	**Courses to be developed by the University**	9	9
Value Added Courses	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6	6
Internship (In any summer vacation for Exit points or in Semester-V)		4	4
Research/ Dissertation/ Advanced Major Courses	Research Institutions/ 3 Courses		12
	Total Credits =	**168**	**224**

Table 5: Semester wise Course Code and Additional Credit Points for Double Major:

Semester	Double Major Courses		
	Code	Papers	Credits
I	DMJ-1	Double Major paper-1 (Disciplinary/Interdisciplinary Major)	4
	DMJ-2	Double Major paper-2 (Disciplinary/Interdisciplinary Major)	4
II	DMJ-3	Double Major paper-3 (Disciplinary/Interdisciplinary Major)	4
	DMJ-4	Double Major paper-4 (Disciplinary/Interdisciplinary Major)	4
III	DMJ-5	Double Major paper-5 (Disciplinary/Interdisciplinary Major)	4
	DMJ-6	Double Major paper-6 (Disciplinary/Interdisciplinary Major)	4
IV	DMJ-7	Double Major paper-7 (Disciplinary/Interdisciplinary Major)	4
	DMJ-8	Double Major paper-8 (Disciplinary/Interdisciplinary Major)	4
V	DMJ-9	Double Major paper-9 (Disciplinary/Interdisciplinary Major)	4
	DMJ-10	Double Major paper-10 (Disciplinary/Interdisciplinary Major)	4
VI	DMJ-11	Double Major paper-11 (Disciplinary/Interdisciplinary Major)	4
	DMJ-12	Double Major paper-12 (Disciplinary/Interdisciplinary Major)	4
VII	DMJ-13	Double Major paper-13 (Disciplinary/Interdisciplinary Major)	4
	DMJ-14	Double Major paper-14 (Disciplinary/Interdisciplinary Major)	4
VIII	DMJ-15	Double Major paper-15 (Disciplinary/Interdisciplinary Major)	4
	DMJ-16	Double Major paper-16 (Disciplinary/Interdisciplinary Major)	4
		Total Credit	**64**

Abbreviations:

AEC	Ability Enhancement Courses
SEC	Skill Enhancement Courses
IAP	Internship/Apprenticeship/ Project
MDC	Multidisciplinary Courses
MJ	Major Disciplinary/Interdisciplinary Courses
DMJ	Double Major Disciplinary/Interdisciplinary Courses
MN	Minor Disciplinary/Interdisciplinary Courses
AMJ	Advanced Major Disciplinary/Interdisciplinary Courses
RC	Research Courses

AIMS OF BACHELOR'S DEGREE PROGRAMME IN CHEMISTRY

The broad aims of bachelor's degree programme in Chemistry are:

The aim of bachelor's degree programme in chemistry is intended to provide:

(i) Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles, and theories.

(ii) To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.

(iii) To provide knowledge and skill to the students' thus enabling them to undertake further studies in chemistry in related areas or multidisciplinary areas that can be helpful for self-employment/entrepreneurship.

(iv) To provide an environment that ensures cognitive development of students in a holistic manner. A complete dialogue about chemistry, chemical equations and its significance is fostered in this framework, rather than mere theoretical aspects

(v) To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A chemistry graduates as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.

(vi) To mold a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.

(vii) To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

PROGRAM LEARNING OUTCOMES

The broad aims of bachelor's degree programme in Chemistry are:

The student graduating with the Degree B.Sc. (Honours/Research) in Chemistry should be able to understand:

(i) **Core competency:** Students will acquire core competency in the subject Chemistry, and in allied subject areas.

(ii) Systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, and all other related allied chemistry subjects.

(iii) Students will be able to understand use the evidence based comparative chemistry approach to explain the chemical synthesis and analysis.

(iv) The students will be able to understand the characterization of materials.

(v) Students will be able to understand the basic principle of equipment, instruments used in the chemistry laboratory.

(vi) Students will be able to understand demonstrate the experimental techniques and methods of their area of specialization in Chemistry.

(vii) **Disciplinary knowledge and skill:** A graduate student are expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest like Analytical Chemistry, Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Material Chemistry, etc. Further, the student will be capable of using of advanced instruments and related soft-wares for in-depth characterization of materials/chemical analysis and separation technology.

(viii) **Skilled communicator:** The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

(ix) **Critical thinker and problem solver:** The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.

(x) Sense of inquiry: It is expected that the course curriculum will develop an inquisitive characteristic among the students through appropriate questions, planning and reporting experimental investigation.

(xi) **Team player:** The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field-based situation and industry.

(xii) **Skilled project manager:** The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

(xiii) **Digitally literate:** The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, and use of chemical simulation software and related computational work.

(xiv) **Ethical awareness/reasoning:** A graduate student requires to understand and develop ethical awareness/reasoning which the course curriculum adequately provide.

(xv) **Lifelong learner:** The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

SEMESTER WISE COURSES IN CHEMISTRY MAJOR-1 FOR FYUGP **2022 onwards**

Table 7: Semester wise Examination Structure in Discipline Courses:

Semester	Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Atomic Structure, Chemical Bonding & Redox Reactions	4	25	75	---
II	MJ-2	Organic Basics and Hydrocarbons	4	25	75	---
	MJ-3	**Practical-I**	4	---	---	100
III	MJ-4	States of Matter & Concept of Equilibria	4	25	75	---
	MJ-5	**Practical-II**	4	---	---	100
IV	MJ-6	Functional Groups Containing X, O, S & N	4	25	75	---
	MJ-7	s, p, d, f-block Elements & Coordination Chemistry	4	25	75	---
	MJ-8	**Practical-III**	4	---	---	100
V	MJ-9	Chemical Thermodynamics & Applications	4	25	75	---
	MJ-10	Reaction Mechanisms in Organic Chemistry	4	25	75	---
	MJ-11	**Practical-IV**	4	---	---	100
VI	MJ-12	Analytical Chemistry	4	25	75	---
	MJ-13	Phase Equilibria, Chemical Kinetics & Surface Chemistry	4	25	75	---
	MJ-14	Organometallic and Bioinorganic Chemistry	4	25	75	---
	MJ-15	**Practical-V**	4	---	---	100
VII	MJ-16	Electrochemistry	4	25	75	---
	MJ-17	Polymer & Materials Chemistry	4	25	75	---
	MJ-18	Reaction Mechanisms & Electronic Spectra in Inorganic Chemistry	4	25	75	---
	MJ-19	**Practical-VI**	4	---	---	100
VIII	MJ-20	Molecular Spectroscopy & Photochemistry	4	25	75	---
	AMJ-1	Quantum & Nanochemistry	4	25	75	---
	AMJ-2	Heterocyclics & Biomolecules	4	25	75	---
	AMJ-3	**Practical-VII**	4	---	---	100
	or RC-1	Research Methodology	4	25	75	---
	RC-2	Project Dissertation/ Research Internship/ Field Work	8	---	---	200
		Total Credit	**92**			

Table 8: Semester wise Course Code and Credit Points for Skill Enhancement Courses:

Semester	Skill Enhancement Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	SEC-1	Fuel & Pharmaceutical Chemistry	3	---	75	---
II	SEC-2	Green Chemistry	3	---	75	---
III	SEC-3	Elementary Computer Application Softwares	3	---	75	---
		Total Credit	**9**			

Table 9: Semester wise Course Code and Credit Points for Minor Courses:

Semester	Minor Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MN-1A	Introductory Chemistry	4	15	60	25
III	MN-1B	Chemical Equilibria & Functional Groups	4	15	60	25
V	MN-1C	Chemistry of s- & p-Block Elements and States of Matter	4	15	60	25
VII	MN-1D	Chemistry of d- & f-Block Elements & Molecules of Life	4	15	60	25
		Total Credit	**16**			

INSTRUCTION TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE):

There will be Only One Semester Internal Examination in Major, Minor and Research Courses, which will be organized at college/institution level. However, Only One End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

A. (SIE 10+5=15 marks):

There will be two group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks.

B. (SIE 20+5=25 marks):

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESE):

A. (ESE 60 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

B. (ESE 75 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to answer.

C. (ESE 100 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of twenty marks each, out of which any four are to answer.

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATION

Question format for **10 Marks**:

Subject/ Code

F.M. =10 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [5]
3. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATION

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks**:

Subject/ Code

F.M. =60 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **75 Marks**:

Subject/ Code

F.M. = 75 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **100 Marks**:

Subject/ Code

F.M. = 100 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.

SEMESTER I

I. MAJOR COURSE –MJ 1:
ATOMIC STRUCTURE, CHEMICAL BONDING & REDOX REACTIONS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

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

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table, physical and chemical characteristics, periodicity.
4. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
5. Atomic theory of matter, composition of atom.
6. Defining isotopes, isobar and isotone.
7. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
8. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules
3. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication

Course Content:

UNIT 1: Atomic Structure: (10 classes each of 60 minutes duration)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.

UNIT II: Periodicity of Elements: (10 classes each of 60 minutes duration)

s, *p*, *d*, *f* -block elements, the Long form of Periodic Table. Detailed discussion of the following properties of the elements.

a. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
b. Atomic radii (van der Waals)
c. Ionic and crystal radii.
d. Covalent radii (octahedral and tetrahedral)
e. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
f. Electron gain enthalpy, trends of electron gain enthalpy.
g. Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity.

UNIT III: Chemical Bonding:

(i) *Ionic bond:* **(5 classes each of 60 minutes duration)**

General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation, Madelung constant, expression for lattice energy, Kapustinskii equation. Born-Haber cycle and its application, Solvation energy.

(ii) *Covalent bond:* **(12 classes each of 60 minutes duration)**
Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone and bond pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules: N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions. Covalent character in ionic compounds; polarization, polarizing power and polarizability. Fajan rules. Ionic character in covalent compounds: Bond moment and dipole moment, ionic character from dipole moment and electronegativities.

(iii) *Metallic Bond:* **(6 classes each of 60 minutes duration)**
Qualitative idea of free electron model, Semiconductors, Insulators.

(iv) *Weak Chemical Forces:* **(2 classes each of 60 minutes duration)**
Van der Waals, ion-dipole, dipole-dipole, induced dipole, dipole-induced dipole interactions, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.

UNIT IV: Oxidation-Reduction and general principle of metallurgy: (15 classes each of 60 minutes duration)
Redox equations, Balancing by Ion electron method & Oxidation number method. Disproportionation Reaction. Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Pyrometallurgy, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel de Boer process and Mond's process, Zone refining.

Reference Books:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.
2. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry,(Third Edition)* John Wiley & Sons,1999.
3. Atkins, P. W. and De Paula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press,2014.
4. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.
5. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*, John Wiley Sons, N.Y. 1994.
6. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.6 Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010

II. SKILL ENHANCEMENT COURSE- SEC 1:
FUEL & PHARMACEUTICAL CHEMISTRY

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

(Credits: Theory-03) **45 Hours**

Course Objectives:

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

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table, physical and chemical characteristics, periodicity.
4. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
5. To understand atomic theory of matter, composition of atom.
6. Defining isotopes, isobar and isotone.
7. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
8. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules
3. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication

Course Content:

UNIT I: Energy Resources & Fuel: (25 classes each of 60 minutes duration)

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of
Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.
Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking),
Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting)
Solid and semisolid lubricants, synthetic lubricants.
Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

UNIT II: Pharmaceuticals: (20 classes each of 60 minutes duration)

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach.

Synthesis of the representative drugs of the following classes:

Analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen);
Antibiotics (Chloramphenicol);
Antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim);
Antiviral agents (Acyclovir),
Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate),
Antilaprosy (Dapsone),
HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation.

Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics: Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry,* Goel Publishing House, Meerut.
4. G.L. Patrick: *Introduction to Medicinal Chemistry*, Oxford University Press, UK.65
5. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
6. William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

SEMESTER II

I. MAJOR COURSE- MJ 2:
ORGANIC BASICS AND HYDROCARBONS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

On successful completion of this course the student should be able to understand:

1. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
2. Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and their nomenclature.
3. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
4. Reactivity, stability of organic molecules, structure, stereochemistry.
5. Mechanism of organic reactions (effect of nucleophile/ leaving group, solvent),substitution *vs*. elimination.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Design and syntheses of organic molecules.
2. Correlation of Reactivity, stability of organic molecules, structure, stereochemistry.

Course Content:

UNIT I: Basics of Organic Chemistry: (16 classes each of 60 minutes duration)

Organic Compounds: Classification and Nomenclature, Hybridization, shape of molecules, influence of hybridization on bond properties. Electron Displacement Effects: inductive, electromeric, resonance and mesomeric effects. Tautomerism, hyperconjugation and their applications. Dipole moment, Organic acids and bases, their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges, Electrophiles and Nucleophiles, Nucleophlicity and basicity, Types, shape and relative stability of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, annulenes, anti-aromaticity, Y-aromaticity, homo-aromaticity, bonding in fullerenes, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes. Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

UNIT II: Stereochemistry: (12 classes each of 60 minutes duration)

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions, Geometrical isomerism: cis–trans & syn-anti isomerism and E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Diastereomers, Meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S configurations. Threo & Erythreo isomers.

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

UNIT III: Chemistry of Aliphatic Hydrocarbons:

A. Alkanes: (6 classes each of 60 minutes duration)

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Corey House Synthesis, Kolbe's Synthesis, Free radical substitutions: Halogenation - relative reactivity and selectivity. Lengthening and shortening of carbon chain in alkanes.

B. Alkenes & Alkynes: (10 classes each of 60 minutes duration)

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cB reactions. Saytzeff and Hofmann eliminations, Pyrolytic eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration- demercuration, hydroboration-

oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels- Alder reaction, Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Conversions involving π-bonds.

C. Aromatic Hydrocarbons (10 classes each of 60 minutes duration)
Aromaticity: Aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups.

D. Polynuclear Hydrocarbons: (6 classes each of 60 minutes duration)
Reactions of naphthalene and anthracene: Structure, preparation and important derivatives of naphthalene and anthracene.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
2. Pine S. H. *Organic Chemistry*, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, *Organic Chemistry*, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, *Organic Chemistry*, 2nd Ed., (2012), Oxford University Press.
5. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry*, *Part A: Structure and mechanism*, Kluwer Academic Publisher, (2000).

II. MAJOR COURSE- MJ 3:
PRACTICALS-I

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:
Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals: Learning about the hazards of materials, equipment, and procedures used in chemical laboratories is a part of the educational objective of this subject.

I. Acquaintance with Chemistry Laboratory

1. Common Laboratory Apparatus
   Test tube, Beakers, Erlenmeyer flask, Volumetric flask, graduated cylinder, Pipette, Graduated pipette, Burette, Burette clamp. Funnel, Test tube holder, Bunsen burner, Glass rod, Utility clamp, Spot test plate, Tripod for Bunsen burner, Wash bottle, Spatula, Round-bottom flasks, Glass Condenser, Filter paper, Separatory funnel, Chemical balance, Furnaces etc.

2. Common Symbols of Laboratory Concerns
   Biohazard, Highly Flammable, Oxidizing, Corrosive, Harmful/Irritant, Radioactive, Explosive, Toxic, Dangerous for the Environment etc.

3. Common Laboratory Reagents
   Common Acids, Common Bases, Common Inorganic/Organic Salts, Organic Compounds, Common Solvents, Difference between Dilute/Concentrated/Fuming liquids.

4. Chemistry Laboratory Techniques
   Cutting, Bending & Rounding edge of glass tube & glass rods, fitting glassware's, fitting equipment for Fractional distillation, drawing liquids through pipette, burette & measuring cylinders, Diluting a solution to a known strength, Safe storage of chemicals.

II. Common Procedures

1. Heating/Boiling with and without condenser, Filtration techniques, Separation techniques, Crystallization techniques.

2. Purification of organic compounds
   (say naphthalene & others) by crystallization using the following solvents:
   a. Water b. Alcohol c. Alcohol-Water d. Acetone e. Hexane f. Toluene

3. Determination of the melting points
   a. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
   b. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
   c. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method).

III. Volumetric Analysis

1. Acid-Base Titrations
   a. Estimation of oxalic acid present in the supplied sample.
   b. Estimation of sodium hydroxide present in given sample.
   c. Estimation of amount of acetic acid in vinegar solution.
   d. Estimation of carbonate and hydroxide present together in mixture.

e. Estimation of carbonate and bicarbonate present together in a mixture.
f. Estimation of free alkali present in different soaps/detergents.

2. Oxidation-Reduction Titrimetry
   a. Estimation of Fe(II) in supplied solution using standardized $KMnO_4$ solution.
   b. Estimation of oxalic acid using standardized $KMnO_4$ solution.
   c. Estimation of percentage of Fe(II) in Iron fillings with standard $K_2Cr_2O_7$

Note:

- You must wear **Safety goggles & Lab Apron** in the laboratory at all times.
- Only CO_2 and dry-chemical fire extinguishers should be used on chemical or electrical fires.
- Water faucets at sinks may be used to wash skin exposed to corrosive chemicals.
- Most importantly, make any **Emergency inform** as soon as possible to a Teacher or staff member.

Reference Books

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: N.Delhi (2011).
4. Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).

III. SKILL ENHANCEMENT COURSE- SEC 2: GREEN CHEMISTRY

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

(Credits: Theory-03) **45 Hours**

Course Objectives:

On completion of this course, the students will be able to understand

1. The importance of green synthesis and its need.
2. The methods involving green synthesis and economy associated with it.
3. The importance of green solvents
4. The scope of green chemistry.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Goals and outcomes of green chemistry
2. The innovative methods for organic synthesis.
3. The alternative sources of starting materials for green synthesis.

Course Content:

UNIT I: Introduction to Green Chemistry (4 classes each of 60 minutes duration)

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.
Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

UNIT II: Principles of Green Chemistry and Designing a Chemical synthesis (15 classes each of 60 minutes duration)

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids.

Energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

UNIT III: Examples of Green Synthesis/ Reactions (18 classes each of 60 minutes duration)

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.

2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzoic acid), Oxidation (of toluene, alcohols).
Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

3. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

4. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

UNIT IV: Future Trends in Green Chemistry (8 classes each of 60 minutes duration)
Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions ss; Green chemistry in sustainable development.

Books Suggested:

1. V.K. Ahluwalia & M.R. Kidwai: *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
2. P.T. Anastas & J.K. Warner: *Oxford Green Chemistry- Theory and Practical*, University Press (1998).
3. A.S. Matlack: *Introduction to Green Chemistry*, Marcel Dekker (2001).
4. M.C. Cann & M.E. Connely: *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

SEMESTER III

I. MAJOR COURSE- MJ 4:
STATES OF MATTER & CONCEPT OF EQUILIBRIA

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:
On completion of this course, the students will be able to understand:

1. Familiarization with various states of matter.
2. Physical properties of each state of matter and laws related to describe the states.
3. Calculation of lattice parameters.
4. Understanding Kinetic model of gas and its properties.
5. Maxwell distribution, mean-free path, kinetic energies.
6. Liquid state and its physical properties related to temperature and pressure variation.
7. Properties of liquid as solvent for various household and commercial use.
8. Solids, lattice parameters – its calculation, application of symmetry, solid characteristicsof simple salts.
9. Ionic equilibria – electrolyte, ionization, dissociation.

Course Learning Outcomes:
On successful completion of this course the student shall know:

1. Determination of lattice parameters of given salt.
2. Study of X-Ray diffraction pattern.
3. Numerical related to salt hydrolysis, ionic equilibria.

Course Content:

UNIT I: Behaviour of real gases: (20 classes each of 60 minutes duration)
Deviation from ideal gas behaviour, compressibility factor and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour. Boyle's temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation, collision frequency, collision diameter, mean free path and viscosity of gases, their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η, variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

UNIT II: Liquid state: (5 classes each of 60 minutes duration)
Structure and physical properties of liquids, vapour pressure, surface tension, viscosity, and their dependence on temperature. Effect of addition of various solutes on surface tension, cleansing action of detergents.

UNIT III: Solid state: (15 classes each of 60 minutes duration)
Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices, X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method.Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.

UNIT IV: Equilibria-I: (20 classes each of 60 minutes duration)
Concept of Equilibrium. Le Chatelier's principle and its applications. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases (Kinetic derivation). Equilibrium between ideal gases and a pure condensed

phase.

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, dissociation constants of mono-, di- and tri-protic acids.
Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH of different salt solutions. Buffer solutions, Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product.

Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) and applications of HSAB principle.
Qualitative treatment of acid–base titration curves (calculation of pH at various stages). Theories of indicators, selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press(2006).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)
5. Roy, B. N. *Fundamentals of Classical and Statistical Thermodynamics* Wiley, 2001*6 Commonly Asked Questions in Thermodynamics.* CRC Press, 2011.

II. MAJOR COURSE- MJ 5:
PRACTICALS-II

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:
Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

I. Measuring Physical parameters

1. **Surface tension measurements.**
   a. Determine the surface tension of supplied liquid solution.
   b. Study the variation of surface tension of detergent/ supplied solutions with concentration.
2. **Viscosity measurement using Ostwald's viscometer**.
   a. Determination of coefficient of viscosity of supplied solutions
   b. Study the variation of coefficient of viscosity of sucrose solution with the change in concentration of solute.

II. Gravimetric Analysis:

a. Estimation of nickel (II) using Dimethylglyoxime (DMG).
b. Estimation of barium as $BaSO_4$
c. Estimation of magnesium in pyrolusite
d. Estimation of iron in Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

III. Ionic equilibria & pH measurements

1. Preparation of buffer solutions of different pH
   i. Sodium acetate-acetic acid
   ii. Ammonium chloride-ammonium hydroxide
2. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
3. Determination of dissociation constant of a weak acid.
4. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

Reference Books

1. Vogel, A.I. *A text book of Quantitative Analysis*, ELBS 1986.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry,5th Ed.,* Pearson (2012)

III. SKILL ENHANCEMENT COURSE- SEC 3:
ELEMENTARY COMPUTER APPLICATION SOFTWARES

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

A Common Syllabus for FYUGP (Credits: Theory-03) **45 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
*There will be **objective type test** consisting of **Seventy-five questions of 1 mark each**. Students are required to mark their answer on **OMR Sheet** provided by the University.*

Course Objectives:

The objective of the course is to generate qualified manpower in the area of Information Technology (IT) and Graphic designing which will enable such person to work seamlessly at any Offices, whether Govt. or Private or for future entrepreneurs in the field of IT.

1. INTRODUCTION TO COMPUTER SYSTEM

1. Basic Concept of Computer: What is Computer, Applications of Computer, Types of computer, Components of Computer System, Central Processing Unit (CPU) **(3 Hours)**

2. Concepts of Hardware: Input Devices, Output Devices, Computer Memory, Types of Memory, processing Concept of Computer **(4 Hours)**

3. Operating system: What is an Operating System, Operating System Examples, Functions of Operating System(Basic), Introduction to Windows 11, Working on Windows 11 environment, Installation of Application Software, My Computer, Control Panel, searching techniques in windows environment, Basic of setting **(6 Hours)**

4. Concept of Software: What is Software, Types of Software, Computer Software- Relationship between Hardware and Software, System Software, Application Software, some high level languages **(4 Hours)**

5. Internet & its uses: Basic of Computer networks; LAN, WAN, MAN, Concept of Internet, Applications of Internet; connecting to internet, what is ISP, World Wide Web, Web Browsing software's, Search Engines, URL, Domain name, IP Address, using e-governance website, Basics of electronic mail, getting an email account, Sending and receiving emails. **(6 Hours)**

2. MICROSOFT OFFICE 2016 AND LATEST VERSIONS

6. Microsoft Word: Word processing concepts, Creation of Documents, Formatting of Documents, Formatting of Text, Different tabs of word 2016 environment, Formatting Page, Navigation of Page, Table handling, Header and footer, Page Numbering, Page Setup, Find and Replace, Printing the documents **(7 Hours)**

7. Microsoft Excel (Spreadsheet): Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Work Sheets, Formatting worksheet, Excel Formula, Concept of charts and Applications, Pivot table, goal seek, Data filter, data sorting and scenario manager, printing the spreadsheet **(6 Hours)**

8. Microsoft Power Point (Presentation Package): Concept and Uses of presentation package, Creating, Opening and Saving Presentations, working in different views in Power point, Animation, slide show, Master Slides, Creating photo album, Rehearse timing and record narration **(5 Hours)**

9. Digital Education: What is digital education, Advantages of digital Education, Concept of e-learning, Technologies used in e learning **(4 Hours)**

Reference Books

1. Nishit Mathur, *Fundamentals of Computer*, APH publishing corporation (2010)
2. Neeraj Singh, *Computer Fundamentals (Basic Computer),* T Balaji, (2021)
3. Joan Preppernau, *Microsoft Power Point 2016 step by step*, Microsoft press (2015)
4. Douglas E Corner, *The Internet Book* 4th Edition, prentice –Hall (2009)
5. Steven Welkler, *Office 2016 for beginners*, Create Space Independent Publishing Platform (2016)
6. Wallace Wang, *Microsoft Office 2019*, Wiley (January 2018)
7. Noble Powell, *Windows 11 User Guide For Beginners and Seniors*, ASIN, (October 2021)

SEMESTER IV

I. MAJOR COURSE- MJ 6:
FUNCTIONAL GROUPS CONTAINING X, O, S & N

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Familiarization about classes of organic compounds and their methods of preparation.
2. Name reactions, uses of various reagents and the mechanism of their action.
3. Use of reagents in various organic transformation reactions.
4. Nitrogen containing functional groups and their reactions..

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Elucidating reaction mechanisms for organic reactions.
2. Organometallic compounds and their uses.
3. Use of benzene diazonium salt in organic synthesis.

Course Content:

UNIT I: Chemistry of Halogenated Hydrocarbons: (10 classes each of 60 minutes duration)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc. Nucleophilic substitution vs. elimination.
Aryl halides: Preparation from diazonium salts. nucleophilic aromatic substitution, S_NAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li and their use in synthesis.

UNIT II: Alcohols, Phenols, Ethers and Epoxides: (10 classes each of 60 minutes duration)

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3°- alcohols, Bouveault-Blanc Reduction, Preparation and properties of glycols and glycerol. Pinacol-Pinacolone rearrangement.
Phenols: Preparation and properties, Acidic nature and factors affecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.
Ethers and Epoxides: Preparation and reaction with acids. Reaction of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

UNIT III: Carbonyl Compounds: (16 classes each of 60 minutes duration)

Structure, reactivity and preparation of Carbonyl compounds. Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism. Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC),
Addition reactions of unsaturated carbonyl compounds: Michael addition.

UNIT IV: Carboxylic Acids and their Derivatives: (8 classes each of 60 minutes duration)

Preparation, physical properties and reactions of monocarboxylic acids, Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids, Preparation and reactions of acid chlorides, anhydrides, esters and amides, Comparative study of nucleophilic substitution at acyl group, Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.

UNIT V: Chemistry of Active methylene groups: (4 classes each of 60 minutes duration)

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT VI: Sulphur containing compounds: (4 classes each of 60 minutes duration)
Preparation and reactions of thiols, thioethers and sulphonic acids.

UNIT VII: Nitrogen Containing Functional Groups (8 classes each of 60 minutes duration).
Preparation and important reactions of aliphatic and aromatic compounds of nitro, nitrile and isonitrile groups. Amines: Effect of substituent and solvent on basicity, Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction, Distinction between 1°, 2° and 3°- amines with Hinsberg reagent and nitrous acid. Diazonium salts: Preparation and synthetic applications.

Reference Books:

1. P Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., *Organic Chemistry*, 7th Edn., Pearson.
3. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons(1976).
4. Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.
6. Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
7. Clayden, J., Greeves, N., Warren, S., Wothers, P., *Organic Chemistry,* Oxford University PressInc., New York (2001).

II. MAJOR COURSE- MJ 7:

s, p, d, f-block ELEMENTS & COORDINATION CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Chemistry of s and p-block elements.
2. Chemistry of noble gases.
3. Structure, bonding of s and p block materials and their oxides/compounds.
4. Chemistry of boron compounds and their structures.
5. Chemistry of noble gases and their compounds, application of VSEPR theory inexplaining structure and bonding.
6. Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
7. Lanthanides, Actinides – separation, colour, spectra and magnetic behaviour
8. The nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
9. The transition metals stability in reactions, origin of colour and magnetic properties.
10. The separation of Lanthanoids and Actinoids, its colour, spectra and magnetic behaviour.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Extraction of metals through metallurgical operations and their uses.
2. Bonding of various s and p block elements.
3. Chemistry of inorganic polymers and their uses.
4. IUPAC nomenclature of coordination compounds/complexes.
5. Prediction of structure of complexes using various theories, colour and magnetic properties of different complexes. Use of lanthanide/actinide compounds in industries.

Course Content:

UNIT I: Chemistry of *s* and *p* Block Elements: (20 classes each of 60 minutes duration)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements. Hydrides and their classification: ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens.

UNIT II: Noble Gases: (8 classes each of 60 minutes duration)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6, Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2), Shape of noble gas compounds (VSEPR theory).

UNIT III: Transition Elements: (12 classes each of 60 minutes duration)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bosworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excluding their metallurgy)

UNIT IV: Coordination Chemistry: (15 classes each of 60 minutes duration)

Werner's theory, EAN rule, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect. Valence bond theory (inner and outer orbital complexes), Crystal field theory (CFT), d-orbital splitting in weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d-orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series, Introduction to Ligand field theory (LFT) & Molecular Orbital Theory (MOT).

UNIT V: Lanthanides and Actinides: (5 classes each of 60 minutes duration)
Electronic configuration, oxidation states, colour, spectra and magnetic behaviour of lanthanides and actinides. Lanthanide contraction, separation of lanthanides (ion-exchange method only).

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.* John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010
6. Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press(2010).
7. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
8. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.

III. MAJOR COURSE- MJ 8:
PRACTICALS-III

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:
Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

I. Organic Chemistry

1. Detection of hetero elements in organic compounds.
2. Functional group test for nitro, amine and amide groups
3. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
4. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)
5. Organic preparations:
   a. Benzolyation of aniline.
   b. Oxidation of Benzaldehyde to benzoic acid.
   c. Hydrolysis of amides and esters.
   d. Preparation of Semicarbazone derivatives of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
   e. Preparation of methyl orange.

II. Spot Analysis

a. Identification of chemicals by Spot tests.
b. Spot analysis of following Acid & Basic Radicals: CO_3^{2-}, Cl^-, NO_3^-, SCN^-, SO_4^{2-}, PO_4^{3-}, NH_4^+, Co^{2+}, Ni^{2+}, Fe^{3+}

III. Qualitative semi micro analysis

Qualitative semi micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

Cations: NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}
Anions: CO_3^{2-}, NO_2^-, CH_3COO^-, Cl^-, Br^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$
(Spot tests should be carried out wherever feasible)

Mixtures should preferably contain:

a. one interfering anion, **or**
b. insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$) **or**

combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-.

Reference Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
3. Khosla, B.D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
4. Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).

SEMESTER V

I. MAJOR COURSE- MJ 9:
CHEMICAL THERMODYNAMICS & APPLICATIONS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. First & second laws of thermodynamics.
2. Concept of enthalpy & resonance energy.
3. Understanding the use of thermochemistry to calculate Bond energy.

Course Learning Outcomes:

On successful completion of this course the student should know the:

1. use of thermochemistry to calculate Bond energy
2. use of quantum chemistry in elucidation of atomic structure.
3. use of thermochemistry to calculate Bond energy.

Course Content:

UNIT I: Introduction & First Law of thermodynamics: (8 classes each of 60 minutes duration)

Intensive and extensive properties, thermodynamic variables, state and path functions, isolated, closed and open systems, reversible, irreversible and cyclic processes. Zeroth law of thermodynamics. *First law of Thermodynamics:* Concept of heat, *q*, work, *w*, internal energy, enthalpy, relation between heat capacities, calculations of *q*, *w*, *U and H* for reversible and irreversible processes. Expression for work done under free expansion of gases for isothermal and adiabatic conditions.

UNIT II: Thermochemistry: (9 classes each of 60 minutes duration)

Heat of reactions: standard states, enthalpy of formation of molecules and ions. Enthalpy of reactions (combustion, neutralization, solution etc) and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

UNIT III: Second & Third Law: (7 classes each of 60 minutes duration)

Concept of entropy, thermodynamic scale of temperature, statement of the second law of thermodynamics, molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

UNIT IV: Free Energy Functions: (6 classes each of 60 minutes duration)

Gibbs and Helmholtz energy, variation of S, G, A with T, V, P, Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters, inversion temperature, Gibbs-Helmholtz equation, Maxwell relations, thermodynamic equations of state.

UNIT V: Partial molar quantities: (8 classes each of 60 minutes duration)

Partial molar quantities, dependence of thermodynamic parameters on composition, Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

UNIT VI: Dilute solutions: (10 classes each of 60 minutes duration)

Dilute solutions, lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Colligative properties of solutions, abnormal colligative properties, Van't Hoffs factor. Thermodynamic derivation using chemical potential to derive relations between the (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution. Azeotropes.

UNIT VII: Equilibria-II (12 classes each of 60 minutes duration)

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx.

Reference Books:

1. Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press (2011).
2. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
3. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
4. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
5. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999
6. Levine I. N., *Physical Chemistry*, Fourth Edition), McGraw-Hill (International), 1995.
7. McQuarrie D. A. and Simon J. D. *Physical Chemistry- A Molecular Approach*, University Science Books, 1998.

II. MAJOR COURSE- MJ 10:
REACTION MECHANISMS IN ORGANIC CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

On completion of this course, the students will be able to understand

1. Reaction Mechanism and factors related with Structure and Reactivity.
2. Different types of substitution reactions.
3. Different types of Addition reactions in organic molecules
4. How Radical reactions are different from ionic reactions.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Factors affecting organic reactions and
2. Difference between reactions of aliphatic and aromatic reactions.

UNIT I: Reaction Mechanism: Structure and Reactivity (10 classes each of 60 minutes duration)

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases.

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

Effect of structure on reactivity, resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates, Steric LFER. Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

UNIT II: Aliphatic Nucleophilic Substitution (12 classes each of 60 minutes duration)

The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms. Structural and electronic effects on S_N1 and S_N2 reactivity. Solvent effects. Kinetic isotope effects. Intramolecular assistance: Electron transfer nature of S_N2 reaction.

The neighbouring group mechanism, neighbouring group participation by R and π-bonds, anchimeric assistance.

Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations.

The S_Ni mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

UNIT III: Aliphatic Electrophilic Substitution (5 classes each of 60 minutes duration)

Elecrophilic reactivity, general mechanism. Bimolecular mechanisms- S_E2 and S_Ei. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Kinetic of S_E2-Ar reaction. Structural effects on rates and selectivity.

UNIT IV: Addition to Carbon-Carbon Multiple Bonds (5 classes each of 60 minutes duration)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenartion of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

UNIT V: Addition to Carbon-Hetero Multiple Bonds (5 classes each of 60 minutes duration)
Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, Organozinc and Organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

UNIT VI: Aromatic Electrophilic Substitution (8 classes each of 60 minutes duration)
The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

UNIT VII: Aromatic Nucleophilic Substitution (5 classes each of 60 minutes duration)
The S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

UNIT VIII: Free Radical Reactions (10 classes each of 60 minutes duration)
Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity.

Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Books Suggested:

1. Jerry March, *Advanced Organic Chemistry-Reactions, Mechanism and Structure*, John Wi1ey.
2. F. A. Carey and R. J. Sundberg, *Advanced Organic Chemistry*, Plenum.
3. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, Longman.
4. C. K. Ingold, *Structure and Mechanism in Organic Chemistry*, Cornell University Press.
5. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, Prentice-Hall.
6. H. 0. House, *Modern Organic Reactions*, Benjamin.
7. R. 0. C. Norman and J. M. Coxon,*Principles of Organic Synthesis*, Blackle Academic & Professional.
8. S. M. Mukherji, *Pericyclic Reactions*, Macmillan, India.
9. S. M. Mukherji and S. P. Singh, *Reaction Mechanism in Organic Chemistry*, Macmillan.
10. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age international.
11. P.S. Kalsi, *Stereochemistry of Organic Compounds*, New Age International.

III. MAJOR COURSE- MJ 11:
PRACTICALS-IV

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

I. Inorganic Preparations:

a. Tetraamminecopper(II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
b. Potassium tris(oxalate)ferrate(III)
c. Preparation of borax/ boric acid.
d. Cuprous Chloride, Cu_2Cl_2
e. Preparation of Aluminium potassium sulphate $K_2SO_4Al_2(SO_4)_3.12H_2O$ (Potash alum)
f. Preparation of Chrome alum.

II. Thermochemistry

1. Determination of heat capacity of a calorimeter.
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of the enthalpy of ionization of ethanoic acid.
4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

III. Equilibria:

Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + KI \rightarrow KI_3\ (aq)$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow [Cu(NH_3)_n]^{2+}$

Any other experiment carried out in the class.

Reference Books

1. J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
2. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
3. A. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
4. S. M. Khopkar, *Environmental Pollution Analysis*: New Age Int. Publisher, New Delhi.
   Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
5. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry,5th Ed.,* Pearson (2012)
6. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
7. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

SEMESTER VI

I. MAJOR COURSE- MJ 12: ANALYTICAL CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand:

1. To expose the students to the basic techniques of Analytical chemistry.
2. To know the application of Instrumentation techniques in analyses
3. To understand the applications of statistics in data analysis.

Course Learning Outcomes:

On successful completion of this course the student should be able to:

1. Decide appropriate methods for different analytical needs.
2. Present data in meaningful form.
3. Interpret instrumental results to a communicative form.

Course Content:

UNIT I: Qualitative and quantitative aspects of analysis (3 classes each of 60 minutes duration)
Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

UNIT II: Statistical methods in chemical analysis: (12 classes each of 60 minutes duration)
Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation,test of significance, the F-test, Q-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).

UNIT III: Separation techniques: (15 classes each of 60 minutes duration)
Solvent extraction: Classification, principle and efficiency of the technique.
Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

UNIT IV: Polarography: (5 classes each of 60 minutes duration)
Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.

UNIT V: Thermal analysis: (5 classes each of 60 minutes duration)
Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC).

UNIT VI: Analysis Samples: (20 classes each of 60 minutes duration)
Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.

b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Analysis of cosmetics: Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Reference Books:

1. Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
2. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
3. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
4. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
5. Ditts, R.V. *Analytical Chemistry, Methods of separation*, van Nostrand, 1974.
6. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
7. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
8. Khopkar, S. M., *Basic Concepts of Analytical Chemistry*, New Age (Second edition) 1998
9. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
10. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood John Wiley 1979.
11. Robinson, J.W. *Undergraduate Instrumental Analysis* 5th Ed., Marcel Dekker, Inc., New York (1995).
12. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
13. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry* 6th Ed., Saunders College Publishing, Fort Worth (1992).
14. Vogel, A. I. Vogel's *Qualitative Inorganic Analysis* 7th Ed., Prentice Hall.
15. Vogel, A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Prentice Hall.
16. Willard, H.H. et al.: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA, 1988.

II. MAJOR COURSE- MJ 13:
PHASE EQUILIBRIA, CHEMICAL KINETICS & SURFACE CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Phases, components, Gibbs phase rule, Phase diagrams and applications.
2. Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation.
3. Catalyst – mechanism, acid base catalysis, enzyme catalysis.
4. Phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
5. The basics of chemical kinetics: determination of order, molecularity, and understanding theories of reaction rates, determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
6. Langmuir, Freundlich – adsorption isotherms, significance, multilayer adsorption – theory and significance.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Application of course objectives stated above.

Course Content:

UNIT I: Phase Equilibria: (28 classes each of 60 minutes duration)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems, Clausius-Clapeyron equation and its applications to solid- liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water- chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its thermodynamic derivation and applications.

UNIT II: Chemical Kinetics: (18 classes each of 60 minutes duration)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudo-unimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates, Arrhenius equation, activation energy. Collision and Activated Complex theories of reaction rates, Unimolecular reaction, qualitative treatment of the theory of absolute reaction rates. Lindemann mechanism.

UNIT III: Surface chemistry: (6 classes each of 60 minutes duration)

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (Excluding derivation), Adsorption in solution. Colloids: Classification, preparation, properties and stability of colloids.

UNIT IV: Catalysis: (8 classes each of 60 minutes duration)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces, effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis- Menten mechanism, acid-base catalysis.

Reference Books:

1. Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.
2. Castellan, G. W. *Physical Chemistry* 4th Ed., Narosa, 2004.
3. Engel, T. and Reid, P. *Physical Chemistry* 3rd Ed., Prentice Hall, 2012.
4. McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics* Viva Books, 2004.
5. Roy, B. N. *Fundamentals of Classical and Statistical Thermodynamics* Wiley, 2001
6. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics*. CRC Press, 2011.
7. Metz, C.R. *2000 Solved Problems in Chemistry*, Schaum Series, 2006.
8. Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 20116 Ball, D. W. *Physical Chemistry* Cengage India, 2012.
9. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
10. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.

III. MAJOR COURSE- MJ 14:
ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand: Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.

1. Transition metals, its stability, colour, oxidation states and complexes.
2. Lanthanides, Actinides – separation, colour, spectra and magnetic behaviour
3. Bioinorganic chemistry – metal ions in biological system, its toxicity, haemoglobin.
4. Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
5. Understanding the transition metals stability in reactions, origin of colour and magnetic properties.
6. Understanding the separation of Lanthanides and Actinides, its colour, spectra and magnetic behaviour.
7. Understanding the bioinorganic chemistry of metals in biological systems.
8. Haemoglobin and its importance in biological systems.

Course Learning Outcomes:

1. Application of course objectives stated above.

Course Content:

UNIT I: Organometallic Compounds: (10 classes each of 60 minutes duration)

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series.

UNIT II: Synergic effects: (14 classes each of 60 minutes duration)

EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)-(MO diagram of CO can be referred to for synergic effect to IR frequencies).

Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures, properties and reactions of organometallic compounds of Mg, Al,Sn and Li – Use in synthesis of organic compounds.

UNIT III: Ferrocene & Zeise's salt: (10 classes each of 60 minutes duration)

Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Preparation & structure of Zeise's salt. Evidences of synergic effect and comparison of synergic effect with that in carbonyls.

UNIT IV: Metal Alkyls: (6 classes each of 60 minutes duration)

Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignardreagent and their structures, Schlenk equilibrium.

UNIT V: Bioinorganic chemistry: (12 classes each of 60 minutes duration)

A brief introduction to bio-inorganic chemistry. Geochemical effect on distribution of metals. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump, Role of Mg^{2+} ions in energy production and chlorophyll. Iron and its application in bio- systems, Haemoglobin, Myoglobin, Storage and transfer of iron. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

UNIT VI: Catalysis by Organometallic Compounds (8 classes each of 60 minutes duration)

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

Reference Books:

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company1994.
2. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
3. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY,1967.
4. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997

IV. MAJOR COURSE- MJ 15:
PRACTICALS-V

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

I. Analysis of water

Determination of water quality parameters in following aspect:

a. Determination of dissolved oxygen in water.
b. Determination of Chemical Oxygen Demand (COD)
c. Determination of Biological Oxygen Demand (BOD)
d. Percentage of available chlorine in bleaching powder.
e. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
f. Measurement of dissolved CO_2.

II. Equilibria:

1. Determination of critical solution temperature (CST) of the phenol-water system.
2. Determination of effect of impurity (NaCl) on CST of phenol-water system.
3. Distribution of acetic/ benzoic acid between water and cyclohexane.
4. Initial rate method: Iodide-persulphate reaction
5. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.

III. Separation Techniques

1. Chromatography:
   a. Separation of mixtures
      (i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.
      (ii) Paper chromatographic separation of Cd^{2+} and Pb^{2+}.
      (iii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
      (iv) Separation of mixture of two amino acids by paper chromatography.

Reference Books:

1. Vogel, A.I. *A text book of Quantitative Analysis*, ELBS 1986.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).
6. Khosla, B. D.; Garg, V. C. & Gulati, *A. Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
7. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* 8th Ed.; McGraw-Hill: New York (2003).
8. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry* 3rd Ed.; W.H. Freeman & Co.: New York (2003).

SEMESTER VII

I. MAJOR COURSE- MJ 16: ELECTROCHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand:

1. Basic principle of electrochemistry, chemical cells and their function, EMF measurement, potentiometric titrations and their applications.

Course Learning Outcomes:

1. Application of course objectives stated above.

Course Content:

UNIT I: Conductance: (16 classes each of 60 minutes duration)

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) hydrolysis constants of salts etc.

UNIT II: Electrochemistry: (12 classes each of 60 minutes duration)

Quantitative aspects of Faraday's law. Applications of electrolysis in metallurgy and industry. Half-cell potential, Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation, Standard electrode (reduction) potential and its application of different kind of half-cells. Electrified interfaces, overpotential, Electrocatalysis- influence of various parameters. Hydrogen electrode.

UNIT III: Application of EMF measurements: (12 classes each of 60 minutes duration)

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential, determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

UNIT IV: Electroanalytical methods: (7 classes each of 60 minutes duration)

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

UNIT V: Electrical & Magnetic Properties of Atoms and Molecules: (8 classes each of 60 minutes duration)

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

UNIT VI: Principles of Corrosion: (5 classes each of 60 minutes duration)

Introduction to corrosion, homogenous theory, electrolytic theory of corrosion, forms of corrosion, special attention to rusting and its influence of economy of the world, corrosion monitoring and prevention methods.

Reference Books:

1. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. *Physical Chemistry* 4th Ed., Narosa (2004).
3. Mortimer, R. G. *Physical Chemistry* 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., *Physical Chemistry* 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. *Physical Chemistry* 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
7. Silbey, R. J., Alberty, R. A. & Bawendi, M. G. *Physical Chemistry* 4th Ed., John Wiley &Sons, Inc. (2005).

II. MAJOR COURSE- MJ 17:
POLYMER & MATERIALS CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand:

1. The mechanism of polymer material formation.
2. Molecular weight and structure property relationship
3. Polymerization procedure and Zigler-Natta catalysis. 4. Characterization of polymers

Course Learning Outcomes:

On successful completion of this course the student should be able to understand:

1. Student will explore various aspects of Polymerisation.

Course Content:

UNIT I: Introduction: (4 classes each of 60 minutes duration)

Introduction and classification of Polymers, Biopolymers, Synthetics polymers. polymerization process, degree of polymerization, condensation and addition polymers, kinetics of addition polymerization process.

UNIT II: Polymeric Structure and Property Relationship: (8 classes each of 60 minutes duration)

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average and weight average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, van der Waals volume, Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

UNIT III. Polymerization Chemistry: (4 classes each of 60 minutes duration)

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

UNIT IV: Characterization of Polymers: (8 classes each of 60 minutes duration)

Molecular Weight Determination by Light scattering, End-group analysis, Viscosity, Applications of FTIR, UV-visible, NMR and Mass Spectroscopy for identification of polymers.

UNIT V: Properties of Polymers: (12 classes each of 60 minutes duration)

(Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol-formaldehyde resins, polyurethanes, silicone polymers, polydienes, Polycarbonates.

UNIT VI: Frontier areas of polymer science and technology: (16 classes each of 60 minutes duration)

Conducting polymers: Basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers.

Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soya protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, polyvinyl alcohol, polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells.

Fibers: Natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.
Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.

UNIT VII: Inorganic Polymers: (8 classes each of 60 minutes duration)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Reference Books:

1. D.W. Van Krevelen and P.J. Hoftyzen, *Properties of Polymer*, 3rd Edition Elsevier Scientific,Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, *Physical Properties of Polymers Hand Book*, Williston, Vt, 1996.
3. S K Gupta and Anil Kumar, *Reaction Engineering of Step Growth Polymerization*, PlenumPress, 1987
4. Odian, George, *Principles of Polymerization*, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, *Text book of polymer science*, 3rd Edn., 2007, Wiley.
6. J.R.Fried, *Polymer Science and Technology*, (2005), PHI publication.
7. Billmeyer Jr., Fred W., *Textbook of Polymer Science*, Wiley- Interscience Publishers, NewYork (1962).
8. R. S. Drago, 1992, *Physical methods for chemistry*: Saunders college publication.
9. P. J. Flory, *Principle of polymer chemistry*, Cornell University Press.
10. P. Ghosh, *Polymer Science and technology, Plastics, Rubber and composites*, Tata McGraw Hill.
11. V. Gowriker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, New Age Int. Publication, 2019.

III. MAJOR COURSE- MJ 18:
REACTION MECHANISMS & ELECTRONIC SPECTRA IN INORGANIC CHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

On completion of this course, the students will be able to understand

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules

Course Content:

UNIT I: Reaction Mechanism of Transition Metal Complexes (15 classes each of 60 minutes duration)

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer- sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions

UNIT II: Metal-Ligand Bonding in complexes (7 classes each of 60 minutes duration)

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.

UNIT III: Electronic Spectra and Magnetic Properties of Transition Metal Complexes (18 classes each of 60 minutes duration)

Spectroscopic ground states, Term symbol, Selection rule, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1- d^9 states), calculations of dq and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

UNIT IV: Metal Clusters (5 classes each of 60 minutes duration)

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

UNIT V: Metal π-Complexes (15 classes each of 60 minutes duration)

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes: tertiary phosphine as ligand.

Books Suggested:

1. F.A. Cotton and Wilkinson, *Advanced Inorganic Chemistry*, John Wiley.
2. J.E. Huhey, Harpes & Row; *Inorganic Chemistry.*
3. N.N. Greenwood and A. Earnshow, *Chemisiry of the Elements*, Pergamon.
4. A. B. P. Leve r, *Inorganic Electron ion Spectroscopy*, Elsevier.
5. R.L. Cariin, *Magnetochemistry*, Springer Vertag,
6. Q. Wilkinson, R.D. Gillars and J.A. Mc Cleverty, *Comprehensive Coordination Chemistry* eds., Pergamon.

IV. MAJOR COURSE- MJ 19:
PRACTICALS-VI

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

I. Polymer synthesis

a. Preparation of nylon 66/6
b. Preparation of Face Cream.
c. Preparation of urea-formaldehyde resin.
d. Preparation of novolac resin.

II. Estimations

a. Determination of temporary hardness in supplied sample of water.
b. Determination of permanent hardness in supplied sample of water.
c. Determination of total hardness of water by Complexometry.
d. Estimation of Magnesium and Calcium in a mixture by Complexometry.
e. Estimation of Copper & Zn in mixture by Gravimetry.
f. Estimation of Cu & Ni in a mixture by Gravimetry.

III. Conductometry

1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations:
    a. Strong acid vs. strong base
    b. Weak acid vs. strong base
    c. Mixture of strong acid and weak acid vs. strong base
    d. Strong acid vs. weak base
    e. Construction of Daniell cell and measurement of EMF.

Reference Books:

1. Vogel, Arthur I: *A Test book of Quantitative Inorganic Analysis* (Rev. by G.H Jeffery and others) 5th Ed. The English Language Book Society of Longman.
2. Willard, Hobert H. et al.: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Ditts, R.V. *Analytical Chemistry – Methods of separation*
4. Malcohm P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed.
5. Harry R. Allcock, Frederick W. Lampe and James E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
6. Fred W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
7. Joel R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
8. Petr Munk and Tejraj M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)
9. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
10. Malcolm P. Stevens, *Polymer Chemistry: An Introduction*, 3rd ed. Oxford University Press (2005)
11. Seymour/ Carraher's *Polymer Chemistry*, 9th ed. by Charles E. Carraher, Jr. (2013).

SEMESTER VIII

I. MAJOR COURSE- MJ 20:
MOLECULAR SPECTROSCOPY & PHOTOCHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

This course is designed:

To expose the students to the basic principles of spectroscopic theory. Application of spectroscopic techniques in organic chemistry. Interaction of electromagnetic radiations and matter. Applications of spectroscopic analysis to elucidate structure of organic compounds.

Course Learning Outcomes:

On successful completion of this course the student should be able to understand:

1. Correlate theory and experimental findings in order to explore structural features of organic compounds.
2. Apply the concept to establish structures of unknown compounds.

Course Content:

UNIT I: Organic Spectroscopy (3 classes each of 60 minutes duration)

General principles: Introduction to absorption and emission spectroscopy. Interaction of electromagnetic radiation with molecules & various types of spectra and Born- Oppenheimer approximation.

UNIT II: *UV Spectroscopy:* (5 classes each of 60 minutes duration)

Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption, Application of Woodward - Fieser rules for calculation of λ_{max} for the following systems: α, β-unsaturated aldehydes, ketones, carboxylic acids and esters, Conjugated dienes: alicyclic, homoannular and heteroannular and extended conjugated systems (aldehydes, ketones and dienes). Distinction between cis and trans isomers.

UNIT III*: IR Spectroscopy:* (10 classes each of 60 minutes duration)

Fundamental and non-fundamental molecular vibrations, Infrared radiation and types of molecular vibrations. IR spectra of alkanes,alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). Effect of H-bonding, conjugation, resonance and ring size on IR absorptions, Fingerprint region and its significance, application in functional group analysis.

UNIT IV: *NMR Spectroscopy:* (10 classes each of 60 minutes duration)

Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it, Spin–Spin coupling and coupling constant, Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.

UNIT V: *Mass Spectroscopy:* (8 classes each of 60 minutes duration)

Basics of fragmentations in organic compounds. Discussion of molecular ion peak, base peak and metastable ions, McLafferty rearrangement. Nitrogen rule, Index of hydrogen deficiency. Application of fragmentation in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data. Applications of IR, UV, NMR and Mass spectra for identification of simple organic molecules.

UNIT VI: *Electronic Spectroscopy:* (8 classes each of 60 minutes duration)

Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

UNIT VII: Atomic spectroscopy (6 classes each of 60 minutes duration)

Atomic absorption spectroscopy, theory and application (with some example).

UNIT VIII: ***Photophysical and photochemical processes:*** **(10 classes each of 60 minutes duration)**
Laws of photochemistry, quantum yield. Jablonski diagrams: Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. kinetics of photochemical reactions ($H_2 + Br_2 \rightarrow 2HBr$, $H_2 + Cl_2 \rightarrow 2HCl$, $2HI \rightarrow H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

Reference Books:

1. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999
2. Levine I. N., *Physical Chemistry,* Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. *Physical Chemistry- A Molecular Approach,* UniversityScience Books, 1998
4. Rohatgi-Mukherjee K. K. *Fundamentals of Photochemistry*, New age (revised secondedition).
5. Banwell C.N. & Mc Cash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. TataMcGraw-Hill: New Delhi (2006).
6. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of OrganicCompounds*, John Wiley & Sons.
7. John R. Dyer, *Applications of absorption spectroscopy of organic compounds*, Prentice Hall India (2012).

II. ADVANCED MAJOR COURSE- AMJ 1: QUANTUM & NANOCHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand:

1. Basic principle of laws of electrochemistry.
2. Understanding about chemical cells and their function
3. Understanding about electrodes, EMF measurement.
4. Understanding about potentiometric titrations and theirapplications.

Course Learning Outcomes:

1. Application of course objectives stated above.

Course Content:

QUANTUM CHEMISTRY

UNIT 1: Introduction to Quantum Chemistry (8 classes each of 60 minutes duration)

Introduction to black-body radiation and distribution of energy, photo-electric effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), Plank's Quantum theory. The uncertainty principle, the wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, eigen function and eigen values.

UNIT II: The Schrodinger wave equation (10 classes each of 60 minutes duration)

Postulates of quantum mechanics, the Schrodinger wave equation. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in one dimensional box, three-dimensional box, the harmonic oscillator, the rigid rotor and the hydrogen atom.

Schrodinger equation in spherical polar coordinates and separation of $R_{(r)}$, $\Theta_{(\theta)}$ & $\Phi_{(\phi)}$ (radial and angular parts), degeneracies, spherical harmonics of the hydrogen atoms.

UNIT III: Approximate Methods for multi electron system (6 classes each of 60 min. duration)

The variation method, Perturbation theory (first order and non-degenerate) and the W.K.B. method. Applications of variation method and perturbation theory to the Helium atom.

UNIT IV: Angular momentum (6 classes each of 60 minutes duration)

Ordinary angular momentum, generalized angular momentum (quantum mechanical approach), communication relation, eigen functions for angular momentum, eigen values of angular momentum. Operators: Ladder operators, raising and lowering operator, addition of angular momenta, spin, antisymmetric and Pauli exclusion principle.

UNIT V: Electronic Structure of Atoms (5 classes each of 60 minutes duration)

Electronic configuration, Russell- Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the p^n configuration, term separation energies for the d^n configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, introduction to the methods of self -consistent field, the virial theorem.

UNIT VI: Chemical bonding (5 classes each of 60 minutes duration)

Valence bond and Molecular orbital approaches, LCAO-MO treatment of H_2, H_2^+, bonding and anti-bonding orbitals, Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Average and most probable distances of electron from nucleus.

UNIT VII: Molecular Orbital Theory (5 classes each of 60 minutes duration)

Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory.

NANOCHEMISTRY

UNIT VIII: Introduction to nanoscience, nanostructure and nanotechnology:
(7 classes each of 60 minutes duration)
Basic idea; Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures, Spheroid, Wire, Rod, Tube, and Quantum Dot. Carbon nanotubes and inorganic nanowires. Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod and disc shapes nanoparticles.

UNIT IX: Size dependent properties of nanomaterials: (3 classes each of 60 minutes duration)
Basic idea with few examples only: Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colours (Blueshift & Red shift), Magnetic, thermal and catalytic properties.

UNIT X: Synthesis of Nanomaterials: (5 classes each of 60 minutes duration)
Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Reference Books:

1. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
2. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
3. Zhen Guo and Li Tan, *Fundamentals and Applications of Nanomaterials*.2009, Artech House,London Publication.
4. C. N. R. Rao, A. Muller, A. K. Cheetam, *The* Chemistry of Nanomaterials*: Synthesis, Properties and Applications*, Willey-VCH Verlag, Germany, 2005.
5. G. Cao, *Nanostructures and Nanomaterials: Synthesis, Properties and Appications*, ImperialCollege Press, London, 2004
6. R. W. Kelsall, I. W. Hameley, M. Geoghegan, *Nanoscale Science and Technology*, JohnWiley & Sons, England, 2005
7. Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley, interscience, 2003.
8. Pradeep, T., *A text of book of nanoscience and nanotechnology*, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

III. ADVANCED MAJOR COURSE- AMJ 2: HETEROCYCLICS & BIOMOLECULES

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

Understanding reactions and reaction mechanism of compounds containing active methylene groups. Understanding the reactions and mechanisms of diazonium compounds. Understanding the structure, mechanism of reactions of selected heterocyclic compounds. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

Course Learning Outcomes:

On successful completion of this course the student should know:

Elucidating reaction mechanisms for organic reactions. Use of active methylene groups in organic mechanism and preparation of new organiccompounds. Use of benzene diazonium salt in organic synthesis. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.

Course Content:

UNIT I: Heterocyclic Compounds: (12 classes each of 60 minutes duration)

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom, Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and Furoic acid.

UNIT II: Chemistry of Carbohydrates: (16 classes each of 60 minutes duration)

Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures, Interconversions of aldoses and ketoses, Killiani- Fischer synthesis and Ruff degradation, Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen excluding their structure elucidation.

UNIT III: Chemistry of Amino Acids, Peptides and Proteins (10 classes each of 60 minutes duration)

Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT IV: Chemistry of Enzymes and correlation with drug action (8 classes)

Mechanism and factors affecting of enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecifity). Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non- competitive inhibition including allosteric inhibition).

UNIT V: Chemistry of Lipids (8 classes each of 60 minutes duration)

Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

UNIT VI: Chemistry of Dyes (6 classes each of 60 minutes duration)

Classification, Colour and chemical constitution, Mordant and Vat Dyes, Chemistry of dyeing, Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling), Triphenylmethane dyes -Malachite Green, Rosaniline and Crystal Violet, Phthalein dyes – Phenolphthalein and Fluorescein, Natural dyes –structure elucidation and synthesis of Alizarin and Indigo, Edible Dyes with examples.

Reference Books:

1. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., *Organic Chemistry*, 7th Edn., Pearson.
3. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons(1976).
4. Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.
6. Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
7. Clayden, J., Greeves, N., Warren, S., Wothers, P., *Organic Chemistry,* Oxford University PressInc., New York (2001).
8. Singh, J., Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).
9. Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, ThirdEdition (1999).
10. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009).
11. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
12. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
13. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
14. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
15. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
16. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
17. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
19. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
20. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.

IV. ADVANCED MAJOR COURSE- AMJ 3: PRACTICALS-VII

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 60 marks*
Practical record notebook	*= 15 marks*
Viva-voce	*= 25 marks*

Practicals:

I. Biomolecules:

1. Saponification value of an oil or a fat.
2. Determination of Iodine number of an oil/ fat.
3. Extraction of caffeine from tea leaves.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctional groups.

II. Estimations

a. Estimation of amino group by brominating method.
b. Estimation of Phenolic group by brominating method.
c. Estimation of glucose by Fehling solution method.
d. Estimation of glucose by Bendicts solution method.
e. Estimation of amino acid.
f. Estimation of Formaldehyde.

III. Separation and identification

a. Separation and identification of organic compounds from the following mixture.
   i. Benzoic acid + β – napthol.
   ii. ρ – toludine + naphthalene.

IV. Green Synthesis: Diels Alder reaction in water

a. Reaction between furan and maleic acid in water at room temperature rather than in benzene which requires refluxing.

Reference Books

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).
7. Pavia, D. L. Lamponan, G. H. &Kriz, G.S. *W B Introduction to organic laboratory*.
8. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
9. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.

COURSES OF STUDY FOR FYUGP IN **"CHEMISTRY" MINOR**

MINOR COURSE-1A (SEM-I)

I. MINOR COURSE- MN 1A: INTRODUCTORY CHEMISTRY

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

(Credits: Theory-03) **45 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand:

1. To expose the students to the basic principles of Chemistry.
2. Exposure of all three major branches of Chemistry.
3. Concept of molecular framework and chemical bonding
4. Representative elements and their chemistry.
5. Atomic theory and its evolution.
6. Learning scientific theory of atoms, concept of wave function.
7. Elements in periodic table, physical and chemical characteristics, periodicity.
8. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
9. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
10. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
11. Stereochemistry of organic molecules – conformation and configuration, asymmetricmolecules and nomenclature.
12. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
13. Reactivity, stability of organic molecules, structure, stereochemistry.
14. Mechanism of organic reactions (effect of nucleophile/leaving group, solvent),substitution *vs*. elimination.

Course Learning Outcomes:

1. Application of course objectives stated above.

Course Content:

Section A: Physical Chemistry

UNIT I: Chemical Energetics: (8 classes each of 60 minutes duration)

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations. Calculation of bond energy, bond dissociation energy from thermochemical data. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

UNIT VII: Chemical Kinetics: (7 classes each of 60 minutes duration)

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Section B: Inorganic Chemistry

UNIT III: Atomic Structure: (5 classes each of 60 minutes duration)

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrodinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT IV: Chemical Bonding and Molecular Structure: (10 classes each of 60 minutes duration)
Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Section C: Organic Chemistry
UNIT V: Fundamentals of Organic Chemistry: (3 classes each of 60 minutes duration)
Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.
Aromaticity: Benzenoids and Hückel's rule.

UNIT VI: Aliphatic hydrocarbons:
Alkanes: (4 classes each of 60 minutes duration) (Upto 5 Carbons)
Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation

Alkenes: (3 classes each of 60 minutes duration) (Upto 5 Carbons)
Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule),
Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (3 classes each of 60 minutes duration) (Upto 5 Carbons)
Preparation: Acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.
Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

UNIT VII: Aromatic hydrocarbons: (5 classes each of 60 minutes duration)
Preparation of benzene: from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions of benzene: Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene)

Reference Books:

1. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009)
2. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.
3. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry,(Third Edition)* John Wiley & Sons,1999.
4. Atkins, P. W. and De Paula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press,2014.
5. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*, John Wiley Sons, N.Y. 1994.
6. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, Longman.
7. C. K. Ingold, *Structure and Mechanism in Organic Chemistry*, Cornell University Press.
8. R. T. Morrison and R. N. Boyd, *Organic Chemistry*, Prentice-Hall.
9. H. 0. House, *Modern Organic Reactions*, Benjamin.
10. R. 0. C. Norman and J. M. Coxon, *Principles of Organic Synthesis*, Blackle Academic & Professional.

II. MINOR COURSE- MN 1A PR:
MINOR PRACTICALS-1A PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practicals:

Section A: Physical

Thermochemistry

1. Determination of heat capacity of calorimeter.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
4. Determination of enthalpy of hydration of copper sulphate.

Section B: Inorganic Chemistry - Volumetric Analysis

1. Acid-Base Titrations
   a. Estimation of oxalic acid present in the supplied sample.
   b. Estimation of sodium hydroxide present in given sample.
   c. Estimation of amount of acetic acid in vinegar solution.
   d. Estimation of carbonate and hydroxide present together in mixture.
   e. Estimation of carbonate and bicarbonate present together in a mixture.
   f. Estimation of free alkali present in different soaps/detergents.

2. Oxidation-Reduction Titrimetry
   a. Estimation of Fe(II) in supplied solution using standardized $KMnO_4$ solution.
   b. Estimation of oxalic acid using standardized $KMnO_4$ solution.
   c. Estimation of percentage of Fe(II) in Iron fillings with standard $K_2Cr_2O_7$

Section C: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   a. Benzoylation of amines/phenols
   b. Oxime and 2,4 dinitrophenyl hydrazone of aldehyde/ketone

Reference Books:

1. Vogel's *Qualitative Inorganic Analysis*, A.I. Vogel, Prentice Hall, 7th Edition.
2. F. G. Mann & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman (1960).
3. B.D. Khosla, *Senior Practical Physical Chemistry*, R. Chand & Co.
4. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

MINOR COURSE-1B (SEM-III)

III. MINOR COURSE- MN 1B:
CHEMICAL EQUILIBRIA & FUNCTIONAL GROUPS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-03) **45 Hours**

Course Objectives:
This course is designed:

1. Chemical aspects of some common health hazards.
2. Chemistry of some common useful materials

Course Learning Outcomes:
On successful completion of this course the student should be able to understand:

1. Explore significance of chemistry in daily life.
2. Explore common chemicals of daily use.
3. Learn about food

Course Content:

Section A: Physical Chemistry
UNIT I: Equilibrium: (15 classes each of 60 minutes duration)
Chemical Equilibria: Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases**.** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o},

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Inorganic Chemistry **(8 classes each of 60 minutes duration)**
MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^{+}. Comparison of VB and MO approaches.

Section C: Organic Chemistry
UNIT II: Alkyl and Aryl Halides
Alkyl Halides (Upto 5 Carbons) **(5 classes each of 60 minutes duration)**
Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.
Preparation: from alkenes *and* alcohols.
Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides (3 classes each of 60 minutes duration)
Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).
Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Alcohols: (4 classes each of 60 minutes duration)
Preparation: Preparation of 1^{o}, 2^{o} and 3^{o} alcohols: using Grignard reagent, Ester hydrolysis, Reduction of

aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (3 classes each of 60 minutes duration)
Preparation: Cumene hydroperoxide method, from diazonium salts.
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): (2 classes each of 60 minutes duration)
Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (5 classes each of 60 minutes duration)
(Formaldehye, acetaldehyde, acetone and benzaldehyde)
Preparation: from acid chlorides and from nitriles.

Reactions– Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books:

1. T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
2. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
3. I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
5. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
6. G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
7. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
10. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

IV. MINOR COURSE- MN 1B PR: MINOR PRACTICALS-1B PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practicals:

Section A: Physical Chemistry

Ionic equilibria pH measurements

1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
2. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
3. Preparation of buffer solutions:
    a. Sodium acetate-acetic acid
    b. Ammonium chloride-ammonium hydroxide

Section B: Organic Chemistry

1. Detection of hetero elements in organic compounds.
2. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
3. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
4. Criteria of Purity: Determination of melting and boiling points.
5. Preparations: Mechanism of various reactions involved to be discussed.
6. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
    a. Oxime of aldehyde/ketone
    b. 2,4 dinitrophenylhydrazone of aldehyde/ketone
7. Analysis of soaps and detergents.
8. Preparation of Nylon-6, Nylon-66
9. Preparation of face cream
10. Vitamin-C preparation.

Reference Books

1. B.D. Khosla, *Senior Practical Physical Chemistry*, R. Chand & Co.
2. A.I. Vogel: *Textbook of Practical Organic Chemistry*, 5th edition, Prentice-Hall.
3. F. G. Mann & B. C. Saunders, *Practical Organic Chemistry*, Orient Longman (1960).
4. Waites M.J. (2008). *Industrial Microbiology: An Introduction*, 7th Edition, Blackwell Science, London, UK.
5. Prescott S.C., Dunn C.G., Reed G. (1982). Prescott & Dunn's Industrial Microbiology, 4th Edition, AVI Pub. Co., USA.
6. Reed G. (2004). *Prescott & Dunn's industrial microbiology*, 4th Edition, AVI Pub. Co., USA.
7. JR Casida L.E. (2015). *Industrial Microbiology*, 3rd Edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001) *Industrial Microbiology: An Introduction*. 1st Edition, Blackwell Science, London, UK.
9. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) *Microbiology*. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

MINOR COURSE-1C (SEM-V)

V. MINOR COURSE- MN 1C:

CHEMISTRY OF s- & p-BLOCK ELEMENTS AND STATES OF MATTER

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-03) **45 Hours**

Course Objectives:

After completion of the course, the learner can be able to understand:

1. Composition of atmosphere
2. Biogeochemical cycles
3. Hydrological cycle
4. Water quality parameters
5. Atmospheric chemical phenomena and environmental pollution
6. Water pollution, parameters of water pollution, treatment of polluted water.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Heat Budget of Earth
2. Quality parameters for water
3. Environmental pollution
4. Water pollution, parameters and treatment of polluted water.

Course Content:

UNIT I: General Principles of Metallurgy: (5 classes each of 60 minutes duration)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

UNIT II: *s*- and *p*-Block Elements: (5 classes each of 60 minutes duration)

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

UNIT III: Compounds of *s*- and *p*-Block Elements: (10 classes each of 60 minutes duration

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.

Concept of multicentre bonding (diborane). Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH)

Oxoacids of P, S and Cl.

Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

Section B: Physical Chemistry

UNIT IV: Kinetic Theory of Gases: (15 classes each of 60 minutes duration)

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Most probable, average and root mean square velocities (no derivation). Collision number, collision frequency, collision diameter and mean free path of molecules. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and

their calculation from van der Waals equation. Andrews isotherms of CO_2. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

UNIT V: Liquids: (4 classes each of 60 minutes duration)
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

UNIT VI: Solids: (6 classes each of 60 minutes duration)
Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Reference Books:

1. G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
5. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
7. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
8. D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.

VI. MINOR COURSE- MN 1C PR: MINOR PRACTICALS-1C PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practicals:

Section A: Inorganic Chemistry

Qualitative semi micro analysis

1. Qualitative semi micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

   Cations: NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}

   Anions: CO_3^{2-}, NO_2^-, CH_3COO^-, Cl^-, Br^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$

   (Spot tests should be carried out wherever feasible)

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded).

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

a. Initial rate method: Iodide-persulphate reaction
b. Integrated rate method:
c. Acid hydrolysis of methyl acetate with hydrochloric acid.
d. Saponification of ethyl acetate.
e. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

Reference Books

1. A.I. Vogel, *Qualitative Inorganic Analysis*, Prentice Hall, 7th Edn.
2. A.I. Vogel, *Quantitative Chemical Analysis*, Prentice Hall, 6th Edn.
3. B.D. Khosla, *Senior Practical Physical Chemistry*, R. Chand & Co.

MINOR COURSE-1D (SEM-VII)

VII. MINOR COURSE- MN 1D:

CHEMISTRY OF d- & f-BLOCK ELEMENTS & MOLECULES OF LIFE

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-03) **45 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Basic human physiology. About the basic of human physiological system and food science
2. To learn about the nutrition and its importance, To learn about the food preservation and its utility.
3. Important component of healthy food, Excess and deficiency of nutrition
4. Food preservatives, Preserved products, Food standards

Course Learning Outcomes:

On successful completion of this course the student should know:

1. To know about the basic of human physiological system and food science
2. To learn about the nutrition and its importance, To learn about the food preservation and its utility.

Course Content:

Section A: Inorganic Chemistry

UNIT I: Transition Elements (3d series) (6 classes each of 60 minutes duration)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states.

UNIT II: Lanthanides and Actinides: (5 classes each of 60 minutes duration)

Electronic configuration, oxidation states, colour, spectra and magnetic behaviour of lanthanides and actinides. Lanthanide contraction, separation of lanthanides (ion-exchange method only).

UNIT III: Coordination Chemistry (5 classes each of 60 minutes duration)

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.
Drawbacks of VBT. IUPAC system of nomenclature.

UNIT IV: Crystal Field Theory (4 classes each of 60 minutes duration)

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes.

Section B: Organic Chemistry

UNIT V: Carbohydrates (8 classes each of 60 minutes duration)

Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

UNIT VI: Amino Acids, Peptides and Proteins (8 classes each of 60 minutes duration)

Classification of Amino Acids, Zwitterion structure and Isoelectric point
Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.
Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).
Synthesis of simple peptides (upto dipeptides) by N-protection (t- butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

UNIT VII: Enzymes and correlation with drug action (6 classes each of 60 minutes duration)

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecifity).

Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non- competitive inhibition including allosteric inhibition).

Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group, -NH_2 group, double bond and aromatic ring,

UNIT VIII: Lipids (3 classes each of 60 minutes duration)

Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Reference Books:

1. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009).
2. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
3. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
4. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
5. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
6. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
7. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.,* W. H. Freeman.
11. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.

VIII. MINOR COURSE- MN 1D PR:
MINOR PRACTICALS-1D PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

Practicals:

Section A: Inorganic Chemistry

1. Estimation of the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oxinate in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.
4. To draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound and estimate the concentration of the same in a given solution.
5. Determination of the composition of the Fe^{3+} salicylic acid complex/ Fe^{2+} phenanthroline complex in solution by Job's method.
6. Determination of concentration of Na+ and K+ using Flame Photometry.

Section B: Organic Chemistry

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. To determine the saponification value of an oil/fat.
5. To determine the iodine value of an oil/fat
6. Differentiate between a reducing/ nonreducing sugar.
7. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

Reference Books

1. Oser B L (1965). *Hawk's Physiological Chemistry*, 14th Ed. McGraw-Hill Book
2. Subalakshmi, G and Udipi, SA (2006) *Food processing and preservation*, 1st Ed. New Age International (P) Ltd.
3. Srilakshmi B (2018): *Food Science*, 7th Colour Ed. New Age International (P) Lt
4. Potter NN and Hotchkiss JH (1999): *Food science*,5th Ed, Spinger.
5. A.I. Vogel, *Qualitative Inorganic Analysis*, Prentice Hall, 7th Edn.
6. A.I. Vogel, *Quantitative Chemical Analysis*, Prentice Hall, 6th Edn.
7. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
8. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.
