# Curriculum and Credit Framework

# For the

# Four Year Under Graduate Programme (FYUGP)

# As per provisions of NEP-2020

# Vinoba Bhave University Hazaribag

Subject: **Chemistry**

To be implemented from the Academic Year **2022-23**

(From session 2022-26)

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## HIGHLIGHTS OF REGULATIONS OF FYUGP

### Credits of courses

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instruction 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 Practical** = 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.

Any semester will have at least 90 working days, i.e., about 15 weeks of teaching. Each week will have 40 working hours spread over 6 days.

## Course Structure for FYUGP "Honours/Research"

### 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 from all the streams (9) | **AEC**; Ability Enhancement Courses (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** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 100-199: Foundation or Introductory courses | **I** | 4 | 4 | | 3 | 2 | 3 | 4 | | | | **20** |
| | **II** | 4+4 | | 4 | 3 | 2 | 3 | | | | | **20** |
| | **Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 credits)** | | | | | | | | | | | |
| 200-299: Intermediate-level courses | **III** | 4+4 | 4 | | 3 | 2 | 3 | | | | | **20** |
| | **IV** | 4+4+4 | | 4 | | 2 | | 2 | | | | **20** |
| | **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** |
| | **VI** | 4+4+4+4 | | 4 | | | | | | | | **20** |
| | **Exit Point: Bachelor's Degree** | | | | | | | | | | | |
| 400-499: Advanced courses | **VII** | 4+4+4+4 | 4 | | | | | | | | | **20** |
| | **VIII** | 4 | | 4 | | | | | | 12 | 4+4+4 | **20** |
| | **Exit Point: Bachelor's Degree with Hons. /Hons. with Research** | | | | | | | | | | | **160** |

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

## Semester wise Course Code and Credit Points

| Semester | Major, Minor subject related, Minor Vocational, Skill Enhancement, Value added, Ability enhancement & Internship Courses | | |
|---|---|---|---|
| | **Code** | **Papers** | **Credits** |
| **I** | AEC-1 | Language and Communication Skills (English or Hindi) | 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 (English) | 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 (MIL-2; 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 (MIL-2/ English-2) | 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/<br><br>AMJ-1<br>AMJ-2<br>AMJ-3 | Research Internship/Field Work/Dissertation<br>OR<br>Advanced Major paper-1 (Disciplinary/Interdisciplinary Major)<br>Advanced Major paper-2 (Disciplinary/Interdisciplinary Major)<br>Advanced Major paper-3 (Disciplinary/Interdisciplinary Major) | 12/<br><br>4<br>4<br>4 |
| | | **Total Credit** | **160** |

**Number of Credits by types of Courses**

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).

**Overall Course Credit Points**

| **Courses** | **Nature of Courses** | **3-Y UG Credits** | **4-Y UG Credits** |
|---|---|---|---|
| Major | Core courses | 60 | 80 |
| Minor | i. Discipline/ Interdisciplinary courses and<br>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, Health & wellness, Community outreach activities, Environmental Studies, 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** |

**Abbreviations:**

| | |
|---|---|
| AEC | Ability Enhancement Courses |
| SEC | Skill Enhancement Courses |
| IAP | Internship/Apprenticeship/ Project |
| MDC | Multidisciplinary Courses |
| MJ | 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 aim of Bachelor's Degree Programme in Chemistry is intended to provide:

1. Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles, and theories.
2. To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.
3. 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.
4. 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.
5. 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.
6. To mold a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
7. To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

## Programme Learning outcomes

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 Course Structure and Examination Structure for Chemistry Major**

| 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 | Inorganic Chemistry-I | 4 | 25 | 75 | --- |
| II | MJ-2 | Organic Chemistry-I | 4 | 25 | 75 | --- |
| | MJ-3 | **Practical-I (Organic)** | 4 | --- | --- | 100 |
| III | MJ-4 | Physical Chemistry - I | 4 | 25 | 75 | --- |

| | | | | | | |
|---|---|---|---|---|---|---|
| | MJ-5 | **Practical-II (Physical)** | 4 | --- | --- | 100 |
| **IV** | MJ-6 | Organic Chemistry-II | 4 | 25 | 75 | --- |
| | MJ-7 | Physical Chemistry - II | 4 | 25 | 75 | --- |
| | MJ-8 | **Practical-III (Inorganic)** | 4 | --- | --- | 100 |
| **V** | MJ-9 | Inorganic Chemistry- II | 4 | 25 | 75 | --- |
| | MJ-10 | Organic Chemistry -III | 4 | 25 | 75 | --- |
| | MJ-11 | **Practical-IV (Organic)** | 4 | --- | --- | 100 |
| **VI** | MJ-12 | Inorganic Chemistry-III | 4 | 25 | 75 | --- |
| | MJ-13 | Organic Chemistry - IV | 4 | 25 | 75 | --- |
| | MJ-14 | Physical Chemistry - III | 4 | 25 | 75 | --- |
| | MJ-15 | **Practical-V (Physical)** | 4 | --- | --- | 100 |
| **VII** | MJ-16 | Inorganic Chemistry - IV | 4 | 25 | 75 | --- |
| | MJ-17 | Organic Chemistry - V | 4 | 25 | 75 | --- |
| | MJ-18 | Physical Chemistry - IV | 4 | 25 | 75 | --- |
| | MJ-19 | **Practical-VI (Inorganic)** | 4 | --- | --- | 100 |
| **VIII** | MJ-20 | Physical Chemistry - V | 4 | 25 | 75 | --- |
| | AMJ-1 | Organic Chemistry -VI | 4 | 25 | 75 | --- |
| | AMJ-2 | General Chemistry | 4 | 25 | 75 | --- |
| | AMJ-3 | **Practical-VII (General Chemistry)** | 4 | --- | --- | 100 |
| | or RC-1 | Research Methodology | 4 | 25 | 75 | --- |
| | RC-2 | Project Dissertation/ Research Internship/ Field work | 8 | --- | --- | 200 |
| | | **Total Credit** | **92** | | | |

## *Instruction to Question Setter*

**Semester Internal Examination (SIE):**

There will be **Only One Semester Internal Examination (SIE) in Major, Minor and Research Courses**, which will be organized at college/institution level. However, only one End Semester Examination (ESE) in other courses will be conducted either at College/ Institution or University level depending upon the nature of course in the curriculum.

**A. <u>(SIE 10+5=15 marks):</u>**

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

**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.

**<u>Group A</u>**

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

**<u>Group B</u>**

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

**Note:** There may be subdivisions in the questions of Group B.

**B. <u>(SIE 20+5=25 marks):</u>**

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

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. Class Attendance Score (CAS) includes the behaviour of the student towards teachers and other students of the College.

**Subject/ Code**

**F.M.** =20 **Time**=1Hr. 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. ..... [5]
3. ..... [5]
4. ..... [5]
5. ..... [5]
6. ..... [5]

**Note:** There may be subdivisions in the questions of Group B.

## END SEMESTER UNIVERSITY EXAMINATION (ESE):

### A. (ESE 60 marks):

There will be two group of questions **A** and **B**. **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 be answered.

**Subject/ Code**

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

Exam Year

**General Instructions:**

i. **Group A** carries very short /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 the questions of Group B.

**B. (ESE 75 marks):**

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

**Subject/ Code**

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

**General Instructions:**

i. **Group A** carries very short / short answer type **compulsory** questions.
ii. **Answer 4 out of 7** 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]
10. ..... [15]

**Note:** There may be subdivisions in the questions of Group B.

**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 seven questions of twenty marks each, out of which any four are to be answered.

**Subject/ Code**

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

**General Instructions:**

i. **Group A** carries very short/short answer type **compulsory** questions.
ii. **Answer 4 out of 7** 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.

| | | | |
|---|---|---|---|
| i. | ……. | vi……. | |
| ii. | ……. | vii…… | |
| iii. | ……. | viii……... | |
| iv. | …….. | ix…….. | |
| v. | …….. | x……... | [10] |

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

**Group B**

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]
10. …… [20]

**Note:** There may be subdivisions in the questions of Group B.

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# SEMESTER I

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## MAJOR COURSE MJ-1 (Theory)
## INORGANIC CHEMISTRY -I

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## INORGANIC CHEMISTRY-I **Theory: 60 Lectures**

**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. Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form different atoms.
7. Defining isotopes, isobars and isotones.
8. Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
9. Characterize bonding between atoms, molecules, interaction, and energetics
10. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond-distances and energies.
11. Valence bond theory, concept of hybridization, predicting geometry of molecules.
12. Importance of hydrogen bonding and metallic bonding.

**Course Learning Outcomes:**

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

1. Electronic configuration of various elements in periodic table
2. Periodicity
3. Predicting structure of molecules
4. Effect of hydrogen bonding
5. Inorganic polymers

**Course Outlines:**

Atomic Structure, Periodicity elements, Chemical Bonding: lonic bond, Covalent bond, Metallic Bond, Weak Chemical Forces, , Inorganic Polymers

**Course Content:**

**1. Atomic Structure:**

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 $\psi$ and $\psi^2$. 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. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

**(12 Lectures)**

**2. Periodicity of Elements:**

The long form of periodic table, *s*, *p*, *d* and *f* - block elements, Detailed discussion of the following
properties of the elements, with reference to *s* & *p*-block.

a. Effective nuclear charge, shielding 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
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 and Allred Rochow scales, electronegativity and polarisation of bonds.

**(12 Lectures)**

**3. Chemical Bonding:**

(i) *lonic bond:*

Ionic bond- general characteristics of ionic compounds, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation, expression for lattice energy, Madelung's constant, Born-Haber cycle and its applications, Solvation energy.

**(4 Lectures)**

(ii) *Covalent bond:*

Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions, 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, Bent's 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- polarizing power and polarizability, Fajan rules, Ionic character in covalent compounds: Bond moment and dipole moment, Ionic character from dipole moment and electronegativities.

**(12 Lectures)**

(iii) *Metallic Bond:*

Qualitative idea of free electron model, Molecular orbital theory/Band theory and explanation of Conductors, Semiconductors & Insulators with examples.

**(6 Lectures)**

(iv) *Weak Chemical Forces:*

van der Waals forces, ion-dipole, dipole-dipole & dipole - induced dipole interactions, Lenard-Jones potential, hydrogen bonding and its effects on melting point, boiling point and solubility of compounds.

**(6 Lectures)**

**4. Inorganic Polymers:**

Introduction, Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of Silicones and Siloxanes, Borazines, Phosphazenes and Silicates.

**(8 Lectures)**

**Reference Books:**


1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, $5^{th}$ $Ed^{n}$.
2. Indrajit Kumar, Undergraduate Chemistry, Major-1 Pragati Prakashan Meerut, 2023.
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. Rodger, G. E. *Inorganic and Solid-State Chemistry*, Cengage Learning, 2002.
6. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*, John Wiley Sons, N.Y., 1994.
7. Rodger, G.E. *Inorganic and Solid-State Chemistry*, Cengage Learning India Edition, 2002.
8. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010
9. Dr. S. K. Agrawal and Dr. Keemti Lal, Advanced Inorganic Chemistry, Pragati Prakashan Meerut, 2020

# SEMESTER II

## MAJOR COURSE MJ-2 (Theory)
## ORGANIC CHEMISTRY -I

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

### ORGANIC CHEMISTRY-I **Theory: 60 Lectures**

**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. Predict mechanism of organic reactions.
3. Lab/ Instrumentation techniques used for analysing reaction mechanisms.

**Course Content:**

1. **Basics of Organic Chemistry:**
   Organic Compounds: Classification and Nomenclature, Hybridization, shape of molecules, influence of hybridization on bond properties. Electron Displacement Effects: inductive, electromeric, resonance and mesomeric effects, 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, Nucleophilicity and basicity, Types, shape and relative stability of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

   **(12 Lectures)**

2. **Stereochemistry:**
   Concept of asymmetry, Fischer Projection, Newman 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, Diastereoisomers, Meso structures, Racemic mixtures, Resolution of racemic mixture, Relative and absolute configuration: D/L and R/S configurations.

   **(12 Lectures)**

3. **Chemistry of Aliphatic Hydrocarbons:**
   a. **Alkanes:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Corey-House synthesis, Free radical substitutions: Halogenation - relative reactivity and selectivity.

      **(4 Lectures)**

   b. **Alkenes & Alkynes:** Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1CB reactions. Saytzeff's and Hofmann's 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.

      **(12 Lectures)**

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

      **(6 Lectures)**

4. **Aromatic Hydrocarbons:**
   Aromaticity: Huckel's rule, 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.

**(8 Lectures)**

5. **Polynuclear Aromatic Hydrocarbons:**

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

**(6 Lectures)**

**Reference Books:**


1. R. N. Morrison & R. N. Boyd, Organic Chemistry, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. S. H. Pine, 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).
6. Indrajit Kumar, Undergraduate Chemistry Major, Pragati Prakashan Meerut, 2023
7. P. Sykes, A guidebook to mechanism in organic chemistry, Pearson Education

## MAJOR COURSE MJ-3 (Practical)
## ORGANIC CHEMISTRY PRACTICAL -I

| Marks: 0 ( SIE) + 100 (ESE: 3Hrs) = 100 | Pass Marks: 40 |
|---|---|

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

***Instruction to Question Setter for***

2 Practical = 2 x 40 = 80 Marks
Viva-voce = 15 Marks
Note-book = 5 Marks

**Two Practicals are to be performed.**

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
    a) Water
    b) Alcohol
    c) Alcohol-Water
3. Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting point apparatus).
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
    a) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.
    b) Separation of a mixture of two sugars by ascending paper chromatography.
    c) Separation of a mixture of *o*-and *p*-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

### 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. and Gulati A., Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).

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# SEMESTER III

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## MAJOR COURSE MJ-4 (Theory)
## PHYSICAL CHEMISTRY -I

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

### PHYSICAL CHEMISTRY-I **Theory: 60 Lectures**

**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. Electrolytes and electrolytic dissociation, salt hydrolysis and acid-base equilibria.
5. Understanding Kinetic model of gas and its properties.
6. Maxwell distribution, mean-free path, kinetic energies.
7. Behaviour of real gases, its deviation from ideal behaviour, equation of state, isotherm, and law of corresponding states.
8. Liquid state and its physical properties related to temperature and pressure variation.
9. Properties of liquid as solvent for various household and commercial use.
10. Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
11. 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 and finding out reference from JCPDI file.
3. Numerical related to salt hydrolysis, ionic equilibria.

**Course Content:**

1. **Gaseous State:**

   **Behaviour of real gases**: Deviations 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; van der Waals equation expressed in virial form, Boyle 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, including 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.

   **(25 Lectures)**

2. **Liquid State:**

   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. Structure of water.

   **(8 Lectures)**

3. **Solid State:**

   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.

   **(12 Lectures)**

4. **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; dissociation constants of mono-, di- and tri-protic acids. Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts. Buffer solutions; Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product, Brönsted-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) Application of HSAB principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.

**(15 Lectures)**

**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)

## MAJOR COURSE MJ-5 (Practical)
## PHYSICAL CHEMISTRY PRACTICAL - I

| Marks: 0 ( SIE) + 100 (ESE: 3Hrs) = 100 | Pass Marks: 40 |
|---|---|

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

***Instruction to Question Setter for***

2 Practical = 2 x 40 = 80 Marks
Viva-voce = 15 Marks
Note-book = 5 Marks

**Two experiments are to be performed.**

1. **Surface tension measurements:**
    a) Determination of Surface tension by drop number method.
    b) Study of variation of surface tension of detergent solutions with concentration.
2. **Viscosity measurements using Ostwald's viscometer:**
    i. Determination of viscosity of aqueous solutions of
        a) Polymer
        b) Ethanol
        c) Sugar at room temperature
    ii. Determination of viscosity of sucrose solution with different concentrations.
3. **Thermochemistry:**
    **a)** Determination of heat capacity of the Calorimeter and enthalpy of neutralisation of hydrochloric acid with sodium hydroxide.
    **b)** Calculation of enthalpy of ionisation of ethanoic acid.
    **c)** Determination of enthalpy of hydration of copper sulphate.
    **d)** Study of the solubility of benzoic acid in water and determination of its enthalpy of solution.

**Reference Books:**


1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & Mc Bane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).
4. Athawale V. D. and Mathur P. Experimental Physical Chemistry, New Age International (2001).

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# SEMESTER IV

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## MAJOR COURSE MJ-6 (Theory)
## ORGANIC CHEMISTRY-II

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## ORGANIC CHEMISTRY-II **Theory: 60 Lectures**

**Course Objectives:**

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

1. Familiarization about classes of organic compounds and their methods of preparation.
2. Basic uses of reaction mechanisms.
3. Name reactions, uses of various reagents and the mechanism of their action.
4. Preparation and uses of various classes of organic compounds.
5. Organometallic compounds and their uses.
6. Organic chemistry reactions and reaction mechanisms.
7. Use of reagents in various organic transformation 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. Difference in reactivity of different carbonyl compounds.
4. Functional derivatives of carbonyl compounds and their relative reactivities.
5. Different modes of reactions of carbonyl compounds and functional derivatives of carboxylic acids.

**Course Content:**

1. **Chemistry of Halogenated Hydrocarbons:**
   - **a)** ***Alkyl halides****:* Methods of preparation, nucleophilic substitution reactions – $S_N1$, $S_N2$ and $S_{N'}$ mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.
   - **b)** ***Aryl halides:*** Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
   - **c)** ***Organometallic compounds*** of Mg and Li and their use in synthesis.

   **(12 Lectures)**
2. **Alcohols, Phenols, Ethers and Epoxides:**
   - **a)** ***Alcohols****:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.
   - **b)** ***Phenols:*** Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.
   - **c)** ***Ethers and Epoxides:*** Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$.

   **(12 Lectures)**
3. **Carbonyl compounds:**
   - **a)** Structure, reactivity and preparation
   - **b)** Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of 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, WolffKishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC);
   - **c)** Addition reactions of unsaturated carbonyl compounds: Michael addition.
   - **d)** Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

   **(20 Lectures)**
4. **Carboxylic Acids and their Derivatives:**
   - **a)** Preparation, physical properties and reactions of monocarboxylic acids.
   - **b)** 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
   - **c)** 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.

**(16 Lectures)**

**Reference books:**


1. Solomons, T.W G., Fryhle, B. Craig. *Organic Chemistry,* John Wiley & Sons, Inc (2009).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, Seventh edition Cengage Learning, 2013.
3. P Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman, New Delhi.
4. Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, Seventh edition Cengage Learning, 2013.

## MAJOR COURSE MJ-7 (Theory)

## **PHYSICAL** CHEMISTRY **-II**

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## PHYSICAL CHEMISTRY-II **Theory: 60 Lectures**

**Course Objectives:**

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

1. Laws of thermodynamics and concepts.
2. Partial molar quantities and its attributes.
3. Dilute solution and its properties.
4. The concept of system, variables, heat, work, and laws of thermodynamics.
5. The concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.
6. The concept of entropy; reversible, irreversible processes. Calculation of entropy using 3nd law of thermodynamics.
7. The application of thermodynamics: Joule Thompson effects, partial molar quantities.
8. The theories/thermodynamics of dilute solutions.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Use of thermochemical equations for calculation of energy and related terms.
2. Use of thermodynamics in explaining chemical behaviour of solute/solvent and reactions.
3. Study of calorimeter principle and its use.

**Course Content:**

1. **Introduction to thermodynamics and first law of thermodynamics:**
   Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. *First law:* Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat

capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

**(14 Lectures)**

2. **Thermochemistry:**
   Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.

   **(10 Lectures)**

3. **Second law of thermodynamics:**
   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.

   **(6 Lectures)**

4. **Third law of thermodynamics:**
   Third Law of thermodynamics, Boltzmann entropy equation, Residual entropy, Calculation of absolute entropy of molecules.

   **(5 Lectures)**

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

   **(10 Lectures)**

6. **Partial molar quantities:**
   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.

   **(5 Lectures)**

7. **Dilute solutions:**
   Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties:
   - **a)** Relative lowering of vapour pressure
   - **b)** Elevation of boiling point
   - **c)** Depression of freezing point
   - **d)** Osmotic pressure

   and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

   **(10 Lectures)**

**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. *Commonly Asked Questions in Thermodynamics.* CRC Press, 2011.
7. Levine, I.N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010.
8. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.

## MAJOR COURSE MJ-8 (Practical)
## INORGANIC CHEMISTRY PRACTICAL - I

| **Marks: 0 ( SIE) + 100 (ESE: 3Hrs) = 100** | **Pass Marks: 40** |
|---|---|

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

***Instruction to Question Setter for***

2 Practical = 2 x 40 = 80 Marks
Viva-voce = 15 Marks
Note-book = 5 Marks

**Two experiments are to be performed.**

1. **Titrimetric Analysis**
   - **i.** Calibration and use of apparatus.
   - **ii.** Preparation of solutions of different Molarity/Normality of titrants.
   - **iii.** Use of primary and secondary standard solutions.
2. **Acid-Base Titrations:**
   - **i.** Estimation of carbonate and hydroxide present together in mixture.
   - **ii.** Estimation of carbonate and bicarbonate present together in a mixture.
   - **iii.** Estimation of free alkali present in different soaps/detergents.
3. **Oxidation-Reduction Titrimetry**
   - **i.** Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
   - **ii.** Estimation of oxalic acid and sodium oxalate in a given mixture.
   - **iii.** Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

**Reference Books:**

**1.** Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson, 2009.
**2.** Svehala G. and Sivasankar I. B., Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.
**3.** Khosla, B.D. Garg V. C. and Gulati A., Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).

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# SEMESTER V

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## MAJOR COURSE MJ-9
## INORGANIC CHEMISTRY-II

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## INORGANIC CHEMISTRY-II **Theory: 60 Lectures**

**Course Objectives:**

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

1. Oxidation-Reductions and their use in metallurgy.
2. Acids, Bases and salts and various concepts of acid and base.
3. Chemistry of s and p-block elements.
4. Chemistry of noble gases.
5. Redox reactions in hydrometallurgy processes.
6. Structure, bonding of s and p block materials and their oxides/compounds.
7. Chemistry of boron compounds and their structures.
8. Chemistry of noble gases and their compounds; application of VSEPR theory in explaining structure and bonding.

**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. Use of boron compounds.
4. Applications of acid-base concepts.

**Course Content:**

1. **Acids, Bases and salts:**

Arrhenius concept of acid and base and its limitations, Bronsted-Lowry concept of acid and base and its limitations, Solvated proton, Relative strengths of acids and bases, Levelling effect and levelling solvents, Types of acid-base reactions, Salts and their classifications, Lewis concept of acid and base and its limitations, Classification of Lewis acids and bases into hard and soft categories, Hard and Soft Acid Base (HSAB) principle and its implications, Theoretical basis of hardness and softness, Electronegativity and hardness and softness, Acid -base strength and hardness and softness, Lux-Flood concept of acid and bases.

**(15 Lectures)**

2. **Oxidation-Reduction and general principle of metallurgy:**
   Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Latimer diagrams and Frost diagrams and their applications, Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

   **(12 Lectures)**

3. **Chemistry of *s* and *p* Block Elements:**
   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, polyhalide ions, pseudo-halogens, properties of halogens.

   **(25 Lectures)**

4. **Noble gases:**
   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 $XeF_2$), Shapes of noble gas compounds (VSEPR theory).

   **(08 Lectures)**

**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 Chemistry 3rd 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.** 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.
**7.** Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010)**.**

## MAJOR COURSE MJ-10
## ORGANIC CHEMISTRY-III

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*
*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*
*End Semester Examination (ESE 75 marks):*
There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.
***Note:*** *There may be subdivisions in the questions of group B.*

## ORGANIC CHEMISTRY-III **Theory: 60 Lectures**

**Course Objectives:**

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

1. Nitrogen containing functional groups and their reactions.
2. Familiarization with polynuclear hydrocarbons and their reactions.
3. Heterocyclic compounds and their reactions.
4. Alkaloids and Terpenes
5. Understanding reactions and reaction mechanism of nitrogen containing functional groups.
6. Understanding the reactions and mechanisms of diazonium compounds.
7. Understanding the structure and their mechanism of reactions of selected polynuclear hydrocarbons.
8. Understanding the structure, mechanism of reactions of selected heterocyclic compounds.
9. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

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

1. Use of benzene diazonium salt in organic synthesis.
2. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.
3. Nitrogen containing organic compounds/heterocyclic compounds in synthetic chemistry.

**Course Centent**

1. **Nitrogen Containing Functional Groups:**
   Preparation and important reactions of nitro and compounds, nitriles and isonitriles. 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's reagent and nitrous acid. Diazonium salts: Preparation and synthetic applications.

   **(20 Lectures)**
2. **Heterocyclic Compounds:**
   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 Napierlaski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoic acid.

   **(20 Lectures)**
3. **Sulphur containing compounds:**
   Preparation and reactions of thiols, thioethers including 1,3-dithiane and sulphonic acids.

   **( 6 Lectures)**
4. **Alkaloids:**
   Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine and Reserpine.

   **(8 Lectures)**
5. **Terpenes:**
   Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.

   **(6 Lectures)**

**Reference Books:**


1. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
2. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
3. Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
4. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
5. Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press Inc., New York (2001).
7. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).
8. Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, Third Edition (1999).
9. Clayden J., Greeves N., Warren S., Organic Chemistry, (2nd Ed)., (2012), Oxford University Press.


## MAJOR COURSE MJ-11 (Practical)
## ORGANIC CHEMISTRY PRACTICAL -II

| **Marks: 0 ( SIE) + 100 (ESE: 3Hrs) = 100** | **Pass Marks: 40** |
|---|---|

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

***Instruction to Question Setter for***

2 Practical = 2 x 40 = 80 Marks
Viva-voce = 15 Marks
Note-book = 5 Marks

**Two experiments are to be performed.**

1. Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.
2. Organic preparations:
   - **i.** Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (Using conventional method and Using green chemistry approach).
   - **ii.** Benzolyation of one of the amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.
   - **iii.** Oxidation of ethanol/ isopropanol (Iodoform reaction).
   - **iv.** Bromination (any one)
     - **a)** Acetanilide by conventional methods.

**b)** Acetanilide using green approach (Bromate-bromide method)

**v.** Nitration: (any one)
- **a)** Acetanilide/nitrobenzene by conventional method.
- **b)** Salicylic acid by green approach (using ceric ammonium nitrate).

**vi.** Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.

**vii.** Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

**viii.** Hydrolysis of amides and esters.

**ix.** Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone,
cyclohexanone, benzaldehyde.

**x.** *S*-Benzylisothiouronium salt of one each of water soluble/ insoluble acids (benzoic acid, oxalic
acid, phenyl acetic acid and phthalic acid).

**xi.** Aldol condensation with either conventional or green method.

**xii.** Benzil-Benzilic acid rearrangement.
Collected solid samples may be used for recrystallization, melting point and TLC.

**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. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and*
   *Quantitative Analysis,* University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).


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# SEMESTER VI

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## MAJOR COURSE MJ-12 (Theory)
## INORGANIC CHEMISTRY-III

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the*

*behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## INORGANIC CHEMISTRY-III

**Theory: 60 Lectures**

**Course Objectives:**

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

1. Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
2. Transition metals, its stability, colour, oxidation states and complexes.
3. Lanthanides, Actinides – separation, colour, spectra and magnetic behaviour.
4. The nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
5. The transition metals stability in reactions, origin of colour and magnetic properties.
6. The separation of Lanthanoids and Actinoids, its colour, spectra and magnetic behaviour.
7. The non-aqueous solvents and their role in chemical reaction.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Transition elements and their difference with non-transition elements.
2. Coordination compounds and prediction of their structure on the basis of various theories.
3. Colour & magnetic properties of coordination compounds.
4. Lanthanoids and actinoids and their characteristic features.
5. Various types of non-aqueous solvents and different types of chemical reactions taking place in them.

**Course Content:**

1. **d-Block elements: transition elements**

   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 & Frost 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).

   **(15 Lectures)**

2. **Coordination compounds:**

   Werner's theory, EAN rule, piano-stool compounds, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, 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, Qualitative aspect of Ligand field theory, MO diagrams of representative coronation complexes, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect.

**(20 Lectures)**

3. **f-Block elements: Lanthanoids and Actinoids:**
   Electronic configuration, oxidation states, colour, spectra and magnetic behaviour, lanthanide contraction, separation of lanthanides (ion-exchange method only).

   **(10 Lectures)**

4. **Non-aqueous solvents:**
   Solvents and their role during chemical reactions, Classification of solvents on the basis of various criteria, General properties of ionising solvents, Different types of chemical reactions taking place in a solvent, Different types of chemical reactions taking place in liquid $NH_3$ and their comparison to those taking place in aqueous medium , liquid $SO_2$ as a solvent, liquid HF as a solvent, liquid $N_2O_4$ as a solvent and glacial acetic acid as a solvent.

   **(10 Lectures)**

**Reference Books:**


1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
2. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999.
5. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.


## MAJOR COURSE MJ-13 (Theory)
## ORGANIC CHEMISTRY-IV

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal*

*Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## ORGANIC CHEMISTRY-IV

**Theory: 60 Lectures**

**Course Objectives:**

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

**Course Objectives:**

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

1. Nature of amino acids, peptides and proteins and their biological significance.
2. Enzymes and their importance.
3. Nucleic acids and their biological role.
4. Structure of pharmaceutical compounds and their biological activity.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Elucidating reaction mechanisms for organic reactions.
2. Nucleic acids and heredity
3. Lipids and their health implications
4. Enzymes and their applications.
5. Pharmaceutical compounds and their applications.

**Course Content:**

1. **Amino acids, peptides and proteins:**
   a) **Amino acids:** Classification of Amino Acids, α-Amino acids- synthesis, ionic properties and reactions, Zwitterion structure, $pK_a$ -values, isoelectric point and electrophoresis.
   b) **Study of peptides:** Determination of primary structure by end group analysis, Synthesis of peptides by using N-protecting, C-protecting and C-activating groups, Merrifield solid phase peptide synthesis.
   **c) Proteins:** General characteristics, Classification of proteins, Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

   **(20 Lectures)**
2. **Enzymes:**
   General characteristics, Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of

enzyme action (including stereospecificity).

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

**(10 Lectures)**

3. **Lipids:**

   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).

   **(10 Lectures)**

4. **Nucleic acids:**

   Definition and general characteristics, Components of nucleic acids, nucleosides and nucleotides, Structure of nucleic acids, The chemical basis of heredity- Replication of DNA, Synthesis of adenine, guanine, cytosine, uracil and thymine.

   **(10 Lectures)**

5. **Pharmaceutical compounds-structure and importance:**

   Definition, Classification, Structure and Therapeutic use of

   a) Antipyretics: Paracetamol (with synthesis)
   b) Analgesics: Ibuprofen (with synthesis)
   c) Antimalarials: Chloroquine (with synthesis)
   d) Antibiotics: Chloramphenicol (with synthesis)

   **(10 Lectures)**

**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 reactions 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. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
14. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
15. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
16. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
17. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
19. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.

## MAJOR COURSE MJ-14 (Theory)

## PHYSICAL CHEMISTRY-III

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## PHYSICAL CHEMISTRY-III **Theory: 60 Lectures**

**Course Objectives:**

On completion of this course, the students will 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. Adsorption isotherms.
5. Understanding phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
6. Understanding 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.

7. Catalyst – mechanism of catalytic action, enzyme catalysis.
8. 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 phase diagram.
2. Study of reaction kinetics, Fast reactions.
3. Heterogeneous catalysis used in industry and its mechanism of action.
4. Application of adsorption isotherms in metal adsorption, significance.

**Course Content:**

1. **Phase equilibria:**

   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 nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

   **(20 Lectures)**

2. **Chemical Kinetics:**

   Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for zero, first, second and fractional order reactions, kinetics of heterogeneous 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 theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

   **(20 Lectures)**

3. **Catalysis:**

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

   **(10 Lectures)**

4. **Surface Chemistry:**

   Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin,

Derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

**(10 Lectures)**

**Reference Books:**


1. Atkins P. W. and De Paula J., *Physical Chemistry, (*tenth edition) Oxford University Press, 2014.
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa , 2004.
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books, 2004.
4. Engel, T. & Reid, P. *Physical Chemistry* Third Edition*,* Prentice-Hall,2012.
5. Zundhal, S.S*. Chemistry concepts and applications* Cengage India, 2011.
6. Ball, D. W. *Physical Chemistry* Cengage India, 2012.
7. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
8. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.
9. Metz, C. R*. Physical Chemistry 2nd Ed.,* Tata McGraw-Hill, 2009.


## MAJOR COURSE MJ-15 (Practical)
## PHYSICAL CHEMISTRY PRACTICAL -II

| **Marks: 0 ( SIE)) + 100 (ESE: 3Hrs) = 100** | **Pass Marks: 40** |
|---|---|

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

***Instruction to Question Setter for***

2 Practical = 2 x 40 = 80 Marks
Viva-voce = 15 Marks
Note-book = 5 Marks

Two experiments are to be performed.

1. Distribution of acetic acid /benzoic acid between water & cyclohexane.
2. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
3. Study of equilibrium of at least one of the following reactions by the distribution method:
   a) $I_2$ (aq) + $I^- \rightarrow I_3^-$ (aq)
   b) $Cu^{++}$(aq) + $n\ NH_3 \rightarrow [Cu(NH_3)_n]^{2+}$
4. **Study of Kinetics of reaction of:**
   a) Acid hydrolysis of methyl acetate with HCl.
   b) Saponification of ethyl acetate.
5. **Conductometric titrations:**
   a) Strong acid vs. strong base
   b) Strong acid vs. weak base
   c) Weak acid vs. strong base

d) Mixture of strong acid & weak acid vs. strong base to calculate the strength of base

6. **Potentiometric titrations:**
   a) Strong acid vs. strong base
   b) Weak acid vs. strong base
   c) Dibasic acid vs. strong base
   d) Potassium dichromate vs. Mohr's salt.

**Reference Books:**


1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand, New Delhi, 2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry,* Eighth Edition, McGraw-Hill (2003).
3. Halpern, A. M. and McBane, G. C. *Experimental Physical Chemistry,* Third Edition, W, H. Freeman (2003).


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# SEMESTER VII

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## MAJOR COURSE MJ-16 (Theory)
## INORGANIC CHEMISTRY-IV

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## INORGANIC CHEMISTRY-IV **Theory: 60 Lectures**

**Course Objectives:**

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

**Course Objectives:**

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

1. Characteristics of important compounds of 3d metals.
2. 18-electron rule and its applications.
3. Organometallic compounds and their applications in organic synthesis and industries.
4. Bioinorganic chemistry – metal ions in biological system, its toxicity.
5. Understanding the bioinorganic chemistry of metals in biological systems.
6. Haemoglobin and its importance in biological systems

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Reactions of $KMnO_4$ and $K_2Cr_2O_7$ as oxidising agent.
2. Action of organometallic compounds in accelerating rate of chemical reactions.
3. Role of $Mg^{2+}$ during photosynthesis by green plants.
4. Toxicity of various metals and mechanism of metal-biological system interaction.
5. Transport and storage of $O_2$ in human beings.

**Course Content:**

1. **Chemistry of 3d metals:**
   Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of chromium, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

   **(10 Lectures)**

2. **Organometallic Compounds:**
   a) Definition and applications of organometallic compounds , Classification of organometallic compounds on the basis of bond type, Concept of hapticity of organic ligands, classification of ligands on the basis of hapticity.

   **(3 Lectures)**

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

   **(15 Lectures)**

   c) **Zeise's salt**: Preparation, structure& bonding of Zeise's salt, Evidences of synergic effect and comparison of synergic effect with that in carbonyls.

   **(4 Lectures)**

   d) **Metal Alkyls:** 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 Grignard reagent and their structures, Schlenk equilibrium.

**(4 Lectures)**

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

**(5 Lectures)**

f) **Organometallic compounds of Mg and Li** – Preparation, Structure & bonding and uses in synthesis of organic compounds.

**(4 Lectures)**

3. **Bioinorganic compounds:**

A brief introduction to bio-inorganic chemistry, Geochemical effect on distribution of metals, Metal ions present in biological systems, Classification of elements according to their action in biological system, 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, Role of $Ca^{2+}$ in blood clotting, stabilization of protein structures and structural role (bones), Carbonic anhydrase and carboxypeptidase, Carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals, Toxicity of metal ions (Hg, Pb, Cd and As), Chelating agents in medicine. Iron and its application in biosystems, Haemoglobin, Storage and transfer of iron.

**(15 Lectures)**

**Reference Books:**


1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
2. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company1994.
4. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999.
5. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
7. Kumar, Indrajit, Organometallic compounds, Pragati Prakashan Meerut, 2022.


## MAJOR COURSE MJ-17 (Theory)

## ORGANIC CHEMISTRY-V

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## ORGANIC CHEMISTRY-V

**Theory: 60 Lectures**

**Course Objectives:**

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

1. Understanding structure of molecules on the basis of spectroscopic techniques.
2. Understanding the significance and structure of carbohydrates.
3. Understanding the structure, mechanism of action of selected dyes.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Use of spectroscopic techniques in the elucidation of structure of
2. Structures of monosaccharides, disaccharides and polysaccharides.
3. Synthesis of dyes and their applications to fibres.

**Course content:**

1. **Organic spectroscopy:**

   General principles and introduction to absorption and emission spectroscopy.

   a) **UV-VIS spectroscopy:** Basic principle, Absorption laws, Types of electronic transitions, $\lambda_{max}$ , Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption bands- Hyperchromic and Hypochromic shifts, Effect of solvent on electronic spectra, Woodward-Fieser rules and their applications in the calculation of $\lambda_{max}$ of

      i. α, β-unsaturated aldehydes, ketones, carboxylic acids and esters
      ii. Conjugated dienes

      with or without extended conjugation.

      Distinction between *cis*- and *trans*- isomers

   b) **IR Spectroscopy:** Basic principle, Molecular vibrations, Fingerprint region and its significance, Group frequency region and its importance, Infrared absorption frequencies of organic molecules with functional groups containing O, N and S (such as ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, thiols, thioethers, etc.); Effect of H-bonding, resonance/conjugation and ring-size on IR absorptions.

   c) **NMR Spectroscopy:** Basic principle, Reference in proton magnetic resonance spectroscopy and Chemical shift, Chemical shifts of H atoms bonded to carbon atoms (aliphatic, olefinic aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides, mercapto), Spin-spin coupling, Chemical exchange, effect of deuteration.

   d) **Mass Spectrometry:** Basic principle and various terms involved, Application of fragmentation rules in characterization of organic compounds.

e) **Problems:** Solving problems for the elucidation of molecular structure with the help of mixed spectral data.

2. **Carbohydrates:**

Occurrence, classification and their biological importance.

a) **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.

b) **Disaccharides:** Structure elucidation of maltose, lactose and sucrose.

c) **Polysaccharides:** Elementary treatment of starch, cellulose and glycogen excluding their structure elucidation.

3. **Dyes:**

Classification, Colour and constitution, Mordant and Vat Dyes, Chemistry of dyeing, Synthesis and applications of

a) **Azo dyes:** Methyl Orange and Congo Red (mechanism of Diazo Coupling)

b) **Triphenyl Methane Dyes:** Malachite Green, Rosaniline and Crystal Violet

c) **Phthalein Dyes:** Phenolphthalein and Fluorescein, Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin, Edible Dyes with examples.

**Reference Books:**


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

16. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.

## MAJOR COURSE MJ-18 (Theory)
## PHYSICAL CHEMISTRY-IV

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

### PHYSICAL CHEMISTRY-IV **Theory: 60 Lectures**

**Course Objectives:**

On completion of this course, the students will 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 their applications.
5. Basic ideas about polymers.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Electrolyte and non-electrolyte.
2. Passage of electric current through the aqueous solution or molten state of electrolyte.
3. Non-spontaneous chemical reactions taking place at electrodes during electrolysis.
4. Mechanism of production of electric current due to spontaneous chemical reactions.
5. Classification and applications of polymers.

**Course content:**

1. **Conductance:**
   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-Hückel-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:

a) degree of dissociation of weak electrolytes
b) ionic product of water
c) solubility and solubility product of sparingly soluble salts
d) conductometric titrations and
e) hydrolysis constants of salts.

**(20 Lectures)**

2. **Electrochemistry:**

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. 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 to different kinds of half-cells. 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).

**(20 Lectures)**

3. **Polymers:**

**a) Introduction:** Polymers**,** Monomers, Polymerisation processes (addition polymerisation & Condensation polymerisation) and their mechanism, Classification of polymers (elastomers, thermoplastics, thermosetting plastics & fibres; natural, synthetic & semi-synthetic; organic & inorganic; homo polymers & copolymers, isotactic, atactic & syndiotactic), Structure of polymers ( linear, branched, cross-linked & network polymers).

**b) Properties of polymers:** Polydispersity index, crystallinity in polymer, Density, Melting temperature & glass transition temperature, Co-efficient of linear thermal expansion & volumetric thermal expansion.

c) **Molecular weight of polymers:** Number average molecular weight, Weight average molecular weight, Determination of molecular weight of polymers by light scattering, osmometry, end-group analysis & viscosity measurements.

**(13 Lectures)**

4. **Electrical and magnetic properties of atoms and molecules:**

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.

**(7 Lectures)**

**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).
8. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
9. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
10. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987.
11. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
12. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
13. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
14. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962)


## MAJOR COURSE MJ-3 (Practical)
## INORGANIC CHEMISTRY Practical -II

| **Marks: 0 ( SIE) + 100 (ESE: 3Hrs) = 100** | **Pass Marks: 40** |
|---|---|

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

***Instruction to Question Setter for***

2 Practical = 2 x 40 = 80 Marks
Viva-voce = 15 Marks
Note-book = 5 Marks

**Two experiments are to be performed.**

1. Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions. Following radicals may be analyzed:
    a) Carbonate, nitrate, nitrite, sulphide, sulphate, sulphite, acetate, fluoride, chloride, bromide, iodide.
    b) borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium, bismuth, tin, iron, aluminium, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium.
    c) Mixtures containing one interfering anion, or insoluble component ($BaSO_4$,

$SrSO_4$, $PbSO_4$, $CaF_2$ or $Al_2O_3$) **or** combination of anions e.g. $CO_3^{2-}$ and $SO_3^{2-}$, $NO_2^-$ and $NO_3^-$,$Cl^-$ and $Br^-$, $Cl^-$ and $I^-$, Brand $I^-$, $NO_3^-$ and $Br^-$, $NO_3^-$ and $I^-$. Spot analysis/tests should be done whenever possible.

2. **Iodo / Iodimetric Titrations**
   i. Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
   ii. Estimation of (i) arsenite and (ii) antimony iodimetrically.
   iii. Estimation of available chlorine in bleaching powder iodometrically.
3. **Inorganic preparations**
   i. Preparation of Cuprous Chloride, $Cu_2Cl_2$
   ii. Preparation of Aluminium potassium sulphate (Potash alum) or Chrome alum.
   iii. Preparation of Chrome alum.
   iv. Preparation of ammine complexes of Cu(II) and Ni(II).
   v. Controlled synthesis of cis- and trans-chromium oxalate hydrate complexes, $K[Cr(C_2O_4)_2(H_2O)_2]$ : kinetic vs. thermodynamic control.
   vi. Preparation of potassium trioxalatoferrate(III).
   vii. Preparation of potassium trioxalatochromate(III).

**Recommended books/references:**


1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* Sixth Edition Pearson, 2009.
2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.
3. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.


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# SEMESTER VIII

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## MAJOR COURSE MJ-20 (Theory)

## PHYSICAL CHEMISTRY-V

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## PHYSICAL CHEMISTRY-V

**Theory: 60 Lectures**

**Course Objectives:**

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

1. The wave-particle duality.
2. Schrodinger's wave equation and its application to hydrogen atom.
3. Rotational spectra and its applications.
4. Vibrational spectra and its applications.
5. Raman spectra and their superiority over IR spectra.
6. Electronic spectra and effect of rotations and vibrations.
7. Photochemical reactions and their kinetics.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Wave like character of extremely small fast-moving particles.
2. Postulates of quantum mechanics and their applications in dealing with small moving particles.
3. Rotational, vibrational, Raman and electronic spectra and their applications in determining molecular parameters.
4. Photochemical reactions and their quantum yields.

**Course Content:**

1. **Quantum Chemistry:**
   Introduction to black-body radiation and distribution of energy, photo-electric effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), The uncertainty principle, The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance, Postulates of quantum mechanics, Basic idea about operators, eigen function and values, Schrodinger equation and application to free-particle and particle in a box, boundary conditions, wave functions and energies, degeneracy, application of Schrodinger's wave equation to hydrogen atom, Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics, representations of hydrogenic orbitals.

   **(20 Lectures)**

2. **Molecular Spectroscopy:**
   Quantisation of molecular energies, Boltzmann distribution, Interaction of electromagnetic radiation with molecules and various types of spectra, Born-Oppenheimer approximation.
   a) **Rotation spectroscopy:** The rotation of molecules and classification of molecules on the basis of principal moments of inertia, Rotational spectra of

rigid diatomic molecules, Selection rules, Intensities of spectral lines, Determination of bond lengths of diatomic and linear triatomic molecules, Effect of isotopic substitution on rotational spectra, Centrifugal distortion and rotational spectra of non-rigid rotor.

b) **Vibrational spectroscopy:** Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies, Breakdown of Born-Oppenheimer approximation – interaction between rotations and vibrations of molecules, Vibration-rotation spectroscopy, diatomic vibrating rotator, P, Q, R branches.

**c) Raman spectroscopy:** Introduction**,** Raman effect**,** Classical and quantum theories of Raman effect, Rotational Raman spectra, Effect of nuclear spin on rotational Raman spectra, Vibrational Raman spectra, Stokes & anti-Stokes lines and their intensity difference, Rule of mutual exclusion.

**d) Electronic Spectroscopy:** Franck-Condon principle, Electronic transitions, Selection rules for electronic transitions, Electronic spectra of diatomic molecules, Vibrational coarse structure of electronic spectra, Rotational coarse structure of electronic spectra, Singlet & triplet states of molecules and their characteristics, Fluorescence and phosphorescence, Dissociation and predissociation, Electronic spectra of polyatomic molecules.

**(30 Lectures)**

**3. Photochemistry:**

Laws of photochemistry, Quantum yield, Jablonski diagrams, Franck-Condon principle, Law of photochemical equivalence, Quantum efficiency, Low and high quantum efficiency, Kinetics of photochemical reactions ($H_2 + Br_2 = HBr$, $2HI = H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

**(10 Lectures)**

**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,* University Science Books, 1998.
4. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
5. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
6. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999.
7. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).
8. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).


## ADVANCED MAJOR COURSE AMJ-1 (Theory)

## ORGANIC CHEMISTRY-VI

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## ORGANIC CHEMISTRY-VI **Theory: 60 Lectures**

**Course Objectives:**

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

1. How to propose mechanism of organic reactions
2. Effect of structure on the reactivity of organic molecules.
3. Different types of organic reactions and their synthetic applications.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. To correlate the reactivity of various organic compounds to their structure.
2. The use of various name reactions in the synthesis of organic compounds.
3.

On successful completion of this course the student should know:

**Course content:**

1. **Structure and Reactivity:**
   - **a)** 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.
   - **b)** Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.
   - **c)** 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.
   - **d)** Various types 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.

2. **Electrophilic Substitution reactions:**
    a) **Aliphatic Electrophilic Substitution:** Bimolecular mechanism-SE2 and SE1. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effects of substrates, leaving group and the solvent polarity on the reactivity.
    b) **Aromatic Electrophilic Substitution:** 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.
3. **Addition reactions:**
    a) **Addition to Carbon-Carbon Multiple Bonds:** Mechanistic and stereo chemical 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, hydrogenation of aromatic rings, Hydroboration. Michael reaction.
    b) **Addition to Carbon-Hetero Multiple Bonds:** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids esters and nitriles. Addition of Grignard reagents, organo- zinc and organo-lithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.
4. **Nucleophilic Substitution:**
    a) **(a) Aliphatic Nucleophilic Substitution:** The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighbouring group-mechanism: neighbouring group participations by σ and π bonds, anchimeric assistance, Classical and nonclassical carbocations, norbornyl system, common carbocation rearrangements. The SN1 mechanism: Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity: The effects of substrate structure, attacking nucleophile, Leaving group and Reaction medium; ambident nucleophile, regioselectivity.
    b) **Aromatic Nucleophilic Substitution:** The SNAr, SN1, benzyne and SRN1 mechanism. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von-Richter, Sommelet- Hauser and Smiles rearrangements.
5. **Elimination Reactions:**
   The E2, E1 and E1CB mechanisms and their spectrum. Orientation of the double bond . Reactivity effects of substrate structures. Attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination. Claisen and Cope rearrangements. Fluxional tautomerism.

6. **Rearrangement reactions:**
   General mechanistic approach to molecular rearrangement reactions, Carbocation rearrangement, Migratory aptitude and memory effects, comparison of rearrangements of carbocations, carbanions and carbon radicals, Mechanism of the following: Pinacol-Pinacolone, Favorskii, Bayer-Villiger oxidations, Arndt-Eistert synthesis, Beckman, Hoffman, Curtius, Fries and Claisen rearrangement, Claisen and Cope rearrangements, Ene reactions.

7. **Free radical Reactions:**
   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.

**Reference Books:**


1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wi1ey.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H. 0. House, Benjamin.
7. Principles of Organic Synthesis, R. 0. C. Norman and J. M. Coxon, Blackle Academic & Professional.
8. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds, D. Nasipuri, New Age international.
11. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
12. Organic Chemistry, Clayden, et.al, oxford university press
13. Basic Stereochemistry of Organic Molecules, S. Sengupta, Book, Syndicate Pvt. Ltd. Kolkata, 1987.

## ADVANCED MAJOR COURSE AMJ-2 (Theory)
## INORGANIC CHEMISTRY-V

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 20+5=25 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 75 marks):*

There will be two group of questions **A** and **B**. **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 seven questions of fifteen marks each, out of which any four are to be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

### General Chemistry **Theory: 60 Lectures**

**Course Objectives:**

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

1. Isotopes and their classifications.
2. Nuclear stability and nuclear reactions.
3. Use of nuclear energy in constructive work.
4. Applications of radioactive isotopes.
5. Nature, synthesis, characteristics and applications of nanomaterials.

**Course Learning Outcomes:**

On successful completion of this course the student should know:

1. Radioactivity and its measurement.
2. Calculation of energy derived from mass defect.
3. Radiocarbon dating and its use in the determination of age of old biological samples.
4. Determination of age of rocks by radioisotope uranium and thorium.
5. Neutron activation analysis and its used in the determination of composition in a non-destructive way.

**Course Content:**

1. **Nuclear Chemistry**
    a) **Introduction:** Nucleus and its classification, nuclear forces, nuclear stability, mass defect, nuclear binding energy, nuclear models. Radioactive decay (Radioactive elements, general characteristics of radioactive decay, decay

kinetics - decay constant, half-life, mean life period), units of radioactivity, Transient and secular equilibria.

b) **Nuclear reactions**: Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions, Type of nuclear reactions, Nuclear fission, Nuclear fusion, Nuclear reactor: classification of reactors, the natural uranium reactor, breeder reactor. Nuclear fusion and stellar energy.

c) **Measurement of radioactivity**: Idea about accelerator and detector, van de Graaff and linear accelerators, synchrotrons, Geiger-Muller detector, Scintillation detectors.

d) **Radioactive isotopes and their applications**: Tracer technique, Radioisotope dating, Isotopic dilution analysis, Neutron activation analysis, disposal of nuclear waste, nuclear disaster and its management.

**(30 Lectures)**

2. **Nanomaterial fundamentals:**

a) **Introduction:** Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot); Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.

b) **Synthesis:** 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.

c) **Size dependent properties of nanomaterials** (basic idea with few examples only): Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colours (Blue shift & Red shift), Magnetic, thermal and catalytic properties.

d) **Nanomaterials Characterization and applications:** Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed).

**(30 Lectures)**

**Reference Books:**

1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley Interscience

**2.** Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall, Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
**3.** A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
**4.** Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
**5.** Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern,
**6.** Zhen Guo and Li Tan, *Fundamentals and Applications of Nanomaterials*.2009, Artech House, London Publication.
**7.** Physical methods for chemistry: R. S. Drago, 1992, Saunders college publication.
**8.** Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International (P) Ltd., 2015.
**9.** C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
**10.** G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London, 2004.
**11.** R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley& Sons, England, 2005.
**12.** Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley Interscience, 2003.
**13.** Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

## ADVANCED MAJOR COURSE AMJ-3 (Practical)
## GENERAL CHEMISTRY PRACTICAL

| **Marks: 0 (5 SIE) + 100 (ESE: 3Hrs) = 100** | **Pass Marks: 40** |
|---|---|

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

***Instruction to Question Setter for***

| | |
|---|---|
| 2 Practical | = 2 x 40 = 80 Marks |
| Viva-voce | = 15 Marks |
| Note-book | = 5 Marks |

**Two experiments are to be performed.**

1. Verify Lambert-Beer's law.
2. Determine the concentration of $CuSO_4$/ $KMnO_4$/ $K_2Cr_2O_7$ in a solution of unknown concentration.
3. Determine the concentration of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
4. Saponification value of oil or fat
5. Determination of Iodine value of oil or fat
6. Identification an organic compound.
7. Synthesis of ZnO nanoparticles.
8. Preparation of Silver nanoparticles.
9. Verification of Beer-Lambert law using nano-particles (above prepared nano-particles may be used for the study).

# Chemistry Minor

Chemistry may be opted as Minor-1 by the students having Major subject from

a) Natural & Physical Sciences (other than Chemistry) and
b) Mathematics, Statistics & Computer application streams.

It is intended to support the Major subject. There will be four papers of Chemistry minor of 4 credits each with following description:

i. Theory: 3 credits of 75 marks with pass marks 30.
ii. Practical: 1 credit of 25 marks with pass marks 10.

The chemistry Minor can be opted in odd semesters as follows:

| Semester | Minor paper | No. of Credits | |
|---|---|---|---|
| | | Theory | Practical |
| I | MN-1A (CHE) | 3 Credits (75 Marks) (SIE=10+5, ESE =60) | 1 Credit (25 Credits) (SIE= 0, ESE =25) |
| III | MN-1B (CHE) | 3 Credits (75 Marks) (SIE=10+5, ESE =60) | 1 Credit (25 Credits) (SIE= 0, ESE =25) |
| V | MN-1C (CHE) | 3 Credits (75 Marks) (SIE=10+5, ESE =60) | 1 Credit (25 Credits) (SIE= 0, ESE =25) |
| VII | MN-1D (CHE) | 3 Credits (75 Marks) (SIE=10+5, ESE =60) | 1 Credit (25 Credits) (SIE= 0, ESE =25) |

## MN-1A (Theory): Inorganic and Organic Chemistry

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

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

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 10+5=15 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 10 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 60 marks):*

There will be two group of questions **A** and **B**. **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 be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## Section A: Inorganic Chemistry-1

1. **Atomic Structure:** Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle, Hydrogen atom structure, Need of a new approach to Atomic structure. Significance of quantum numbers: Orbital angular momentum quantum numbers $m_l$, 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.

**(10 Lectures)**

2. **Chemical Bonding and Molecular Structure**

*Ionic Bounding:* 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. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, 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.

Concept of resonance and resonation structure in various inorganic and inorganic and organic molecules/ions.

**(10 Lectures)**

## Section B: Organic Chemistry-1

1. **Fundamentals of Organic Chemistry:**
   a) **Electronic Displacements:** Inductive Effect, electronic Effect, Resonance and Hyperconjugation, Cleavage of Bonds: Homolysis and Heterolysis. Structure, Shape and reactivity of organic molecules, Nucleophiles and electrophiles.
   b) **Reactive intermediates:** Carbocations, Carbanions and free radicals.
   c) **Strength of organic acids and bases:** Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

**(8 Lectures)**

2. **Stereochemistry**

Conformations with respect to ethane, butane and cyclohexane, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representation, Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism;

Enantiomers, Diastereomers and Meso compounds. Threo- and erythro- D and L-cis–trans nomenclature; CIP Rules; R/S (for up to 2 chiral carbon atoms) and E/Z Nomenclature (for up to two C=C systems).

**(7 Lectures)**

**3. Aliphatic hydrocarbons**

Fundamental group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

a) **Alkanes:** (up to 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: halogenation.

b) **Alkenes:** (up to 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, Ozonolysis, oxymercuration-demercuration, hydroboration-oxidation.

c) **Alkynes:** (up to 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 alkaline $KMnO_4$

**(20 Lectures)**

**Reference Books:**


1. J. D. Lee: A new Concise Inorganic chemistry, E. L. B. S.
2. F.A. Cotton & G. Wilknson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, john Wiely.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T.W. Graham Solomon: Organic Chemistry, John Wiely and Sons.
6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E.L.Eliel: Stereochemistry of Carbon Compounds, tata McGraw Hill.
8. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: Organic Chemistry. Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.

## MN-1A (Practical): Inorganic and Organic Chemistry

| Marks:0 (SIE) + 25 (ESE: 3Hrs) = 25 | Pass Marks: = 10 |
|---|---|

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

***Instruction to Question Setter for***

1 Practical = 20 Marks

Viva-voce + Note-book = 5 Marks

## Section A: Inorganic Chemistry-volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of Water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically $Na_2S_2O_3$.

## Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements).

## Reference Books:


1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Qualitative Chemical Analysis, A. I. Vogel, Prentice Hall, 6th edition.
3. Textbook of Practical Organic Chemistry, A. I. Vogel, Prentice Hall, 5th Edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.


## MN-1B (Theory): Physical and Organic Chemistry

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

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

***Instruction to Question Setter***

*Semester Internal Examination (SIE 10+5=15 marks):*

*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 10 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*

*End Semester Examination (ESE 60 marks):*

There will be two group of questions **A** and **B**. **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 be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## Section A: Physical Chemistry-1

1. **Chemical Energetics:**

   Review of thermodynamics and the Laws of Thermodynamics, Important principles and limitations of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature-Kirchhoff's equation.

   **(8 Lectures)**

2. **Chemical Equilibrium:**

   Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and $G^0$, Le Chatelier's principle. Relationships between $K_p$, $K_C$ and $K_x$ for reactions involving ideal gases.

   **(5 Lectures)**

3. **Ionic Equilibria:**

   Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant ionic product to water, lionization of weak acids and bases, $_P$H for different types of salts solutions and buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

   **(7 Lectures)**

## Section B: Organic Chemistry-2

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

1. **Aromatic hydrocarbons**

   *Preparation* (case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
   *Reactions:* (Case benzene): electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzene (up to 4 carbons on benzene).

   **(8 Lectures)**

2. **Alkyl and Aryl Halides**

a) **Alkyl Halides** (up to 5 Carbons) Types of nucleophile 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.

b) **Aryl Halides:** *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 $NaNH_2/NH_3$).

**(8 Lectures)**

3. **Alcohols and Phenols** (up to 5 Carbons)
   a) **Alcohols:** *Preparation:* Preparation of $1^0$, $2^0$,and $3^0$ 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) oxidation of diols(up to 6 Carbons), Pinacol-Pinacolone rearrangement.

   b) **Phenols:** (Phenol case) 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.

**(9 Lectures)**

**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. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
7. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
8. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
9. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

## MN-1B (Practical): Physical and Organic Chemistry

| Marks:0 (SIE) + 25 (ESE: 3Hrs) = 25 | Pass Marks: = 10 |
|---|---|

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

***Instruction to Question Setter***

1 Practical = 20 Marks

Viva-voce + Note-book = 5 Marks

**Section A: Physical Chemistry**

**Thermochemistry**

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

**Ionic equilibria**

a) 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.
b) Preparation of buffer solutions:
   I. Sodium acetate-acetic acid
   II. Ammonium chloride-ammonium hydroxide.

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

**Section B: 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. Preparation:
   Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   a) Bromination of Phenol/Aniline.
   b) Benzoylation of amines/phenols.
   c) Oxime and 2.4 - dinitrophenylhydrazone of aldehyde/ketone.

**Reference Books:**

1. I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice Hall.

2. F. G. Mann& B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B. D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

## MN-1C (Theory): Physical and Organic Chemistry

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

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

***Instruction to Question Setter***

*Semester Internal Examination (SIE 10+5=15 marks):*
*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 10 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*
*End Semester Examination (ESE 60 marks):*
There will be two group of questions **A** and **B**. **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 be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## Section A: Physical Chemistry-2 (20 Lectures)

1. **Solutions:**

   Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law-non-ideal solutions. Vapour pressure-composition and temperature-composition curves and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

   Partial miscibility of Iiquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids-Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

2. **Phase Equilibrium**

   Phase, components and degree of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagram of one-component system (water and sulphur).

3. **Conductance**

   Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Conductometric titrations (only acid-base).

4. **Electrochemistry**

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamics properties: G. H. and S from EMF data.

**Section B: Organic Chemistry-3 ( 25 Lectures)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

1. **Carboxylic acids and their derivatives**

   Carboxylic acids (aliphatic and aromatic).
   *Preparation*: Acidic and Alkaline hydrolysis esters.
   *Reactions:* Hell-Vohlard- Zelinsky Reaction.

2. **Carboxylic acid derivatives (aliphatic):** (up to 5 carbons)

   *Preparation*: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.

   *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

3. **Amines and Diazonium Salts**

   Amines (Aliphatic Aromatic): (up to 5 carbons)
   *Preparation*: From alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.
   *Reactions:* Hofmann vs Saytzeff's elimination, Carbylamine test, Hinsberg's test, with $HNO_2$. Schotten – Baumann Reaction, Electrophilic substitution (case aniline): nitration, bromination, sulphonation.
   **Diazonium salts:** Preparation: from aromatic amines.
   *Reactions: Conversion to benzene, phenol, dyes.*

4. **Amino Acids, Peptides and Proteins:**

   *Preparation of amino acids*: Strecker synthesis using Gabriel's Phthalimide synthesis. Zwitterion, Isoelectric point and electrophoresis.
   *Reactions of amino Acids:* ester of –COOH group, acetylation of $–NH_2$ group, complexation with $Cu^{2+}$ ions, ninhydrin test.
   Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

5. **Carbohydrates:** Classification**,** General properties, Glucose and fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and fructose, mutarotation, ascending and descending in monosaccharides, Structure of disaccharides (sucrose, cellobiose, maltose, lactose).

**Reference Books:**

1. G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).

2. J. C. Kotz, P. M. Treichel, J.R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd. New Delhi (2009).
3. B. H. Mahan: University Chemistry, 3rd Ed. Narosa (1988).
4. R. H. Petrucci, General Chemistry, 5th Ed., Macmillan Publishing Co. New York (1985).
5. Morrisin, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson education).
6. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson education).
7. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
8. Berg, J. M. Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.

## MN-1C (Practical): Physical and Organic Chemistry

| **Marks:0 (SIE) + 25 (ESE: 3Hrs) = 25** | **Pass Marks: = 10** |
|---|---|

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

***Instruction to Question Setter***

1 Practical = 20 Marks
Viva-voce + Note-book = 5 Marks

## Section A: Physical Chemistry

**Distribution Law**

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

a) $I_2(aq)+I^- + (aq) \rightleftharpoons I_3^-(aq)$
b) $Cu^{2+}(aq) + xNH_3 \rightleftharpoons [Cu(NH_3)_x]^{2+}$

**Conductance**

a) Determination of Cell constant.
b) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
c) Perform the following conductometric titrations:
   i. Strong acid vs. Strong base
   ii. Weak acid vs. Strong base
   iii. Weak acid vs. Strong base

**Section B: Organic Chemistry**

Systematic Qualitative organic analysis of organic compounds possessing mono-functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines and preparation of one derivative.

**Reference Books:**

1. I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Ed.

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. Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

## MN-1D (Theory): Inorganic and Physical Chemistry

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

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

***Instruction to Question Setter***

*Semester Internal Examination (SIE 10+5=15 marks):*
*The Semester Internal Examination shall have two components. (a) One Semester Internal Examination Written Test (SIE) of 10 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.*
*End Semester Examination (ESE 60 marks):*
There will be two group of questions **A** and **B**. **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 be answered.

***Note:*** *There may be subdivisions in the questions of group B.*

## Section A: Inorganic Chemistry-2 (20 Lectures)

1. **General Principles of Metallurgy:**

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

2. **s- and p- Block Elements:**

   Periodicity in s- and p- Block Elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Allred-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.

3. **Compounds of s-and p- Block Elements**

   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 ($NH_3$, $N_2H_4$, $N_3H$, $NH_2OH$)

**Section B: Physical Chemistry-3 (25 Lectures)**

1. **Kinetic Theory of Gases**

   Postulates of kinetic theory of Gases and derivation of the kinetic gas equation. 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. Andrew's isotherms of $CO_2$.

2. **Solids:**

   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.

3. **Chemical Kinetics**

   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. Concepts of activation energy and its calculation from Arrhenius equations.

   Theories of Reactions Rates: Collision theory and activated complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

**Reference Books:**


1. G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
2. J. C. Kotz, P. M. Treichel, J.R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd. New Delhi (2009).
3. B. H. Mahan: University Chemistry, 3rd Ed. Narosa (1988).
4. R. H. Petrucci, General Chemistry, 5th Ed., Macmillan Publishing Co. New York (1985).
5. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
6. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Willey.
7. D. F. Shriver & P.W. Atkins: Inorganic Chemistry, Oxford University Press.
8. Gary Wulfsberg: inorganic Chemistry, Viva Books Pvt. Ltd.

## MN-1D (Practical): Inorganic and Physical Chemistry

| Marks:0 (SIE) + 25 (ESE: 3Hrs) = 25 | Pass Marks: = 10 |
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(Credits: Practical-01) **30 Hours**

***Instruction to Question Setter***

1 Practical = 20 Marks

Viva-voce + Note-book = 5 Marks

**Section A: Inorganic Chemistry**

Semi-micro qualitative analysis using $H_2S$ of mixtures-not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

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

b) Anions: $CO_3^{2-}$, $S^{2-}$, $SO_3^{2-}$, $S_2O_3^{2-}$, $NO_3^-$, $CH_3COO^-$, $Cl^-$, $Br^-$, $I^-$, $NO_3^-$, $SO_4^{2-}$, $PO_4^{3-}$, $BO_3^{3-}$, $C_2O_4^{2-}$, $F^-$.

(Spot tests should be carried out wherever feasible)

**Section B: Physical Chemistry**

1. 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.
2. 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.

**Reference Books:**


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