SHIVIJI UNIVERSITY, KOLHAPUR

M.Sc. Part I Chemistry Syllabus as per New CBCS PATTERN

Including 1st and 2nd semester Applied and Industrial Chemistry

Revised Implemented from 2019-2020

Applicable for University Departments & Affiliated Colleges Centers
# M.Sc. Programme structure (CBCS PATTERN) (2019-20)

## M.Sc. Part – I

### SEMESTER-I (Duration- Six Month)

<table>
<thead>
<tr>
<th>Sr. No</th>
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### SEMESTER-II (Duration- Six Month)

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<tr>
<td>SEC- Mandatory Non-CGPA compulsory Skill Enhancement Course</td>
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<tr>
<td>Practical Examination is annual.</td>
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<td>Examination for CCPR-205 shall be based on Semester II Practicals.</td>
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<td>Separate passing is mandatory for Theory, Internal and Practical Examination</td>
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### M.Sc. Programme structure (CBCS PATTERN) (2020-21)

#### M.Sc. Part – II

#### SEMESTER-III (Duration- Six Month)

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#### SEMESTER-IV (Duration- Six Month)

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<td>Lectures Hours Credit</td>
<td>Maximum Marks Minimum Marks Exam. Hours</td>
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<td>Total (C+D)</td>
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<td>48 640 -- --</td>
<td>560 -- --</td>
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I. CGPA course:

1. There shall be 14 Core Courses (CC) per program.
2. There shall be 02 Discipline Specific Elective (DSE) courses of 08 credits per program.
3. There shall be 04 Core Course Specialization (CCS) courses of 16 credits per program.
4. Total credits for CGPA courses shall be of 96 credits per program.

II. Mandatory Non-CGPA Courses:

1. There shall be 02 Mandatory Non-CGPA compulsory Ability Enhancement Courses (AEC) of 02 credits each per program.
2. There shall be 01 Mandatory Non-CGPA compulsory Skill Enhancement Course (SEC) of 02 credits per program.
3. There shall be one Elective Course (EC) (SWAYAM / MOOC). The credits of this course shall be as specified on SWAYAM / MOOC portal.

Student contact hours per week: 32 Hours (Min.)

| Student contact hours per week: 32 Hours (Min.) | Total Marks for M.Sc.-II: 1200 |
| Theory and Practical Lectures: 60 Minutes Each | Total Credits for M.Sc.-II (Semester III &IV): 48 |
| CC-Core Course | Practical Examination is annual. |
| CCS-Core Course Specialization | Examination for CCPR-305 shall be based on Semester III Practicals. |
| CCPR-Core Course Practical | Examination for CCPR-405 shall be based on Semester IV Practicals. |
| AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course | *Duration of Practical Examination as per respective BOS guidelines |
| SEC-Mandatory Non-CGPA compulsory Skill Enhancement Course | Separate passing is mandatory for Theory, Internal and Practical Examination |
| EC (SWM MOOC) - Non-CGPA Elective Course | |
| GE-Generic Elective | |

Total Credits for M.Sc. Program: 96

Total Marks for M.Sc. Program: 2400
4. There shall be one Generic Elective (GE) course of 02 credits per program. Each student has to take Generic Elective from the department other than parent department.

5. The total credits for Non-CGPA course shall be of 08 credits + 2 to 4 credits, as specified on the SWAYAM/MOOC portal.

6. The credits assigned to the course and the program shall have no relation with the work-load of the teacher.

### Semester I

<table>
<thead>
<tr>
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<td>CC-102</td>
<td>II</td>
<td>CH.1.2 Organic Chemistry - I</td>
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<td>CC-103</td>
<td>III</td>
<td>CH.1.3 Physical Chemistry - I</td>
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<td>CC-104</td>
<td>IV</td>
<td>CH.1.4 Analytical Chemistry - I</td>
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All courses are compulsory.

### Semester II

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All courses are compulsory.
M. Sc. Part – II (Inorganic Chemistry)

Semester III

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<td>Inorganic Chemical Spectroscopy</td>
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<td>X</td>
<td>Coordination Chemistry - I</td>
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<td>CCS-303</td>
<td>XI</td>
<td>Nuclear Chemistry</td>
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Semester IV

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<td>XIV</td>
<td>Coordination Chemistry II</td>
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<td>CCS-403</td>
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<td>Chemistry of Inorganic Materials</td>
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<td>Energy and Environmental Chemistry</td>
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### M. Sc. Part – II (Organic Chemistry)

#### Semester III

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<td>Advanced Spectroscopic Methods</td>
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<td>Advanced Synthetic Methods</td>
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#### Semester IV

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<td>Stereochemistry</td>
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Non-CGPA:
- AEC-306
- EC(SWMMOOC)-307

Non-CGPA:
- SEC-406
- GE-407
## M. Sc. Part – II (Physical Chemistry)

### Semester III

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<td>Electrochemistry</td>
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<td>CCS-303</td>
<td>XI</td>
<td>Molecular Structure – I</td>
<td>Compulsory course</td>
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<td>Advanced Chemical Kinetics</td>
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### Non-CGPA

- AEC-306
- EC(SWMMOOC)-307

### Semester IV

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<td>XIV</td>
<td>Chemical Kinetics</td>
<td>Compulsory course</td>
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<td>CCS-403</td>
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<td>Molecular Structure - II</td>
<td>Compulsory course</td>
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<td>XVI(A)</td>
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### Non-CGPA

- SEC-406
- GE-407
# M. Sc. Part – II (Analytical Chemistry) Semester III

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<td>Organo Analytical Chemistry</td>
<td>Compulsory course</td>
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<tr>
<td>CCS-303</td>
<td>XI</td>
<td>Electroanalytical Techniques in Chemical Analysis</td>
<td>Compulsory course</td>
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<tr>
<td>DSE-304(A)</td>
<td>XII(A)</td>
<td>Environmental Chemical Analysis and Control</td>
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<tr>
<td>DSE-304(B)</td>
<td>XII(B)</td>
<td>Recent Advances in Analytical Chemistry</td>
<td>Choose any one</td>
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<tr>
<td>CCPR-305</td>
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<td>Practical –III</td>
<td>Compulsory course</td>
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## Non-CGPA

<table>
<thead>
<tr>
<th>Course code</th>
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<tbody>
<tr>
<td>AEC-306</td>
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<td>EC(SWMMOOC)-307</td>
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### Semester IV

<table>
<thead>
<tr>
<th>Course code</th>
<th>Paper No.</th>
<th>Title of course</th>
<th>Course Type</th>
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<tbody>
<tr>
<td>CC-401</td>
<td>XIII</td>
<td>Modern Separation Methods in Analysis</td>
<td>Compulsory course</td>
</tr>
<tr>
<td>CCS-402</td>
<td>XIV</td>
<td>Organic Industrial Analysis</td>
<td>Compulsory course</td>
</tr>
<tr>
<td>CCS-403</td>
<td>XV</td>
<td>Advanced Methods in Chemical Analysis</td>
<td>Compulsory course</td>
</tr>
<tr>
<td>DSE-404(A)</td>
<td>XVI(A)</td>
<td>Industrial Analytical Chemistry</td>
<td>Choose any one</td>
</tr>
<tr>
<td>DSE-404(B)</td>
<td>XVI(B)</td>
<td>Quality Assurance and Accreditation</td>
<td>Choose any one</td>
</tr>
</tbody>
</table>
12. Scheme of teaching and examination

(Applicable to University Department and University affiliated colleges centers)

• The semester examination will be conducted at the end of each term (both theory and practical examination)

• Theory paper will be of 80 marks each and 20 marks for internal evaluation test conducted in the mid of the term. Two practicals will be of 100 marks each.

• Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus.

Standard of Passing

As per rules and regulation of M.Sc. course.

13. Standard of Passing

As per rules and regulation of M.Sc. course.

14. Nature of Question Paper and Scheme of Marking

Nature of question paper and scheme of marking

Theory question paper: Maximum marks -80

Total No. of question – 7

All questions are of equal marks. Out of these seven questions five questions are to be attempted.
Question No.1 is compulsory and objective. Total number of bits is 16 with one mark each.

Total marks – 16 (which cover multiple choices, fill in the blanks, definition, true or false). These questions will be answered along with other questions in the same answer book.

Remaining 6 question are divided into two sections, namely section-I and section – II. Four questions are to be attempted from these two section such that not more than two questions from any of the section. Both sections are to be written in the same answer book.

15. Equivalence in Accordance with titles and contents of the papers

M. Sc. Chemistry Semester I and Semester II

(Chemistry, Applied Chemistry and Industrial Chemistry)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Inorganic Chemistry- I (CH-I)/ General Chemical Technology-I(INDC02)</td>
<td>Inorganic Chemistry- I (CH.1.1)</td>
</tr>
<tr>
<td>Organic Chemistry- I (CH-II)/Selected topics in Organic Chemistry(CNDC03)</td>
<td>Organic Chemistry- I (CH.1.2)</td>
</tr>
<tr>
<td>Physical Chemistry- I (CH-III)/ Introduction to Chemical Engineering-I (INDC01)</td>
<td>Physical Chemistry- I (CH.1.3)</td>
</tr>
<tr>
<td>Analytical Chemistry -I (CH-IV)/ Introduction to Environmental Pollution (INDC04)</td>
<td>Analytical Chemistry - I (CH.1.4)</td>
</tr>
<tr>
<td>Inorganic Chemistry- II (CH-V)/ Selected Topics in Inorganic Chemistry (INDC07)</td>
<td>Inorganic Chemistry- II (CH.2.1)</td>
</tr>
<tr>
<td>Course Title</td>
<td>Course Code</td>
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<td>----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Organic Chemistry- II (CH-VI)/General Chemical Technology-II (INDC06)</td>
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</tr>
<tr>
<td>Physical Chemistry- II (CH-VII)/Introduction to Chemical Engineering-II (INDC05)</td>
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</tr>
<tr>
<td>Analytical Chemistry- II (CH-VIII)/Instrumental Methods of analysis (INDC08)</td>
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</table>

M. Sc. In Inorganic Chemistry Semester III and Semester IV

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td><strong>SEMESTER III</strong></td>
</tr>
<tr>
<td>Paper No. ICH-IX: INORGANIC CHEMICAL SPECTROSCOPY</td>
<td>Paper No. IX, ICH 3.1: INORGANIC CHEMICAL SPECTROSCOPY</td>
</tr>
<tr>
<td><strong>ELECTIVE PAPERS</strong></td>
<td><strong>ELECTIVE PAPERS</strong></td>
</tr>
<tr>
<td>Paper No. - ICH - XIIC: SELECTED TOPICS IN INORGANIC CHEMISTRY</td>
<td>Paper No. –XIIC, ICH 3.4(B) : SELECTED TOPICS IN INORGANIC CHEMISTRY</td>
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<tr>
<td><strong>SEMESTER IV</strong></td>
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<tr>
<td>Paper No. - ICH - XIV : COORDINATION CHEMISTRY-II</td>
<td>Paper No. – XIV, ICH 4.2: COORDINATION CHEMISTRY-II</td>
</tr>
<tr>
<td><strong>ELECTIVE PAPERS</strong></td>
<td><strong>ELECTIVE PAPERS</strong></td>
</tr>
<tr>
<td>Paper No.- ICH - XVI(B): RADIATION CHEMISTRY</td>
<td>Paper No. –XVI(B), ICH 4.4(B): RADIATION CHEMISTRY</td>
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</table>

### SEMESTER III

| Paper No- OCH- XII: Drugs and Heterocycles | Paper No-XII(A), OCH 3.4(A): Drugs and Heterocycles |

### SEMESTER IV

| Paper No. - OCH- XV :Chemistry of Natural Products | Paper No. –XV, OCH 4.3 :Chemistry of Natural Products |

**ELECTIVE PAPERS**

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<th>SEMESTER IV</th>
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<tbody>
<tr>
<td><strong>Old Course (2013)</strong></td>
<td><strong>New Course (2018)</strong></td>
</tr>
<tr>
<td>Paper No - PCH - IX: ADVANCED QUANTUM CHEMISTRY</td>
<td>Paper No-IX, PCH 3.1 : ADVANCED QUANTUM CHEMISTRY</td>
</tr>
<tr>
<td>Paper No - PCH - XII: SOLID STATE CHEMISTRY</td>
<td>Paper No-XII(A), PCH 3.4(A): SOLID STATE CHEMISTRY</td>
</tr>
<tr>
<td>ELECTIVE PAPERS</td>
<td>ELECTIVE PAPERS</td>
</tr>
<tr>
<td>Paper No - PCH - XII(A) : ADVANCED CHEMICAL KINETICS</td>
<td>Paper No-XII(B), PCH 3.4(B) : ADVANCED CHEMICAL KINETICS</td>
</tr>
<tr>
<td>Paper No - PCH - XII (B) : RADIATION AND PHOTOCHEMISTRY</td>
<td>Paper No-XII (C) PCH 3.4(C) : RADIATION AND PHOTOCHEMISTRY</td>
</tr>
<tr>
<td>Modeling</td>
<td>Molecular Modeling</td>
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<tr>
<td><strong>Paper No. PCH-XIV :</strong> CHEMICAL KINETICS</td>
<td><strong>Paper No –XIV, PCH 4.2</strong>: CHEMICAL KINETICS</td>
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<tr>
<td><strong>Paper No. PCH-VX :</strong> MOLECULAR STRUCTURE-II</td>
<td><strong>Paper No-XV, PCH 4.3</strong>: MOLECULAR STRUCTURE-II</td>
</tr>
<tr>
<td><strong>ELECTIVE PAPERS</strong></td>
<td><strong>ELECTIVE PAPERS</strong></td>
</tr>
<tr>
<td><strong>Paper No. PCH-XVI (A) :</strong> SURFACE CHEMISTRY</td>
<td><strong>Paper No-XVI (A), PCH 4.4(A) :</strong> SURFACE CHEMISTRY</td>
</tr>
<tr>
<td><strong>Paper No. PCH-XVI (B) :</strong> CHEMISTRY OF MATERIALS</td>
<td><strong>Paper No-XVI (B), PCH 4.4(B) :</strong> CHEMISTRY OF MATERIALS</td>
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<tr>
<td><strong>Paper No. PCH-XVI (C) :</strong> BIOPHYSICAL CHEMISTRY</td>
<td><strong>Paper No-XVI (C), PCH 4.4(C) :</strong> BIOPHYSICAL CHEMISTRY</td>
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**M. Sc. In Analytical Chemistry Semester III and Semester IV**

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<tr>
<td><strong>SEMESTER III</strong></td>
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</tr>
<tr>
<td><strong>Paper No. ACH – IX :</strong> General Analytical Techniques</td>
<td><strong>Paper No – IX, ACH 3.1</strong>: Advanced Analytical Techniques</td>
</tr>
<tr>
<td><strong>Paper No. ACH – X :</strong> Organo Analytical Chemistry</td>
<td><strong>Paper No– X, ACH 3.2 :</strong> Organo Analytical Chemistry</td>
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<tr>
<td><strong>Paper No. ACH – XI :</strong> Electroanalytical Techniques in Chemical Analysis</td>
<td><strong>Paper No – XI, ACH 3.3</strong>: Electroanalytical Techniques in Chemical Analysis</td>
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<tr>
<td><strong>ELECTIVE PAPERS</strong></td>
<td><strong>ELECTIVE PAPERS</strong></td>
</tr>
<tr>
<td><strong>Paper No. ACH–XII (A) :</strong> Environmental chemical analysis and control</td>
<td><strong>Paper No–XII (A), ACH 3.4(A) :</strong> Environmental chemical analysis and control</td>
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<tr>
<td><strong>Paper No. ACH- XII (B) :</strong> Recent Advances</td>
<td><strong>Paper No- XII (B). ACH 3.4(B) :</strong> Recent</td>
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<tr>
<td>Paper No.</td>
<td>ACH- XII : Chemical Analysis in Agro, Food and Pharmaceutical Industries</td>
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<td>Paper No- XII (B). ACH 3.4(B) : Recent Advances in Analytical Chemistry</td>
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**SEMMESTER IV**

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>ACH – XIII : Modern Separation method in Analysis</th>
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<tbody>
<tr>
<td>Paper No.</td>
<td>XIII, ACH 4.1: Modern Separation method in Analysis</td>
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<table>
<thead>
<tr>
<th>Paper No.</th>
<th>ACH – XIV : Organic Industrial Analysis</th>
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<tr>
<td>Paper No.</td>
<td>XIV ACH 4.2: Organic Industrial Analysis</td>
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<tr>
<th>Paper No.</th>
<th>ACH – XV : Advanced Methods in Chemical Analysis</th>
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<tr>
<td>Paper No.</td>
<td>XV, ACH 4.3: Advanced Methods in Chemical Analysis</td>
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<tbody>
<tr>
<td>Paper No.</td>
<td>XVI (A), ACH 4.4(A): Industrial Analytical Chemistry</td>
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<thead>
<tr>
<th>Paper No.</th>
<th>ACH – XVI (B): Techniques in Forensic sciences and Microbiological Analysis</th>
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<tbody>
<tr>
<td>Paper No.</td>
<td>XVI (A), ACH 4.4(A): Industrial Analytical Chemistry</td>
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<thead>
<tr>
<th>Paper No.</th>
<th>ACH – XVI (C): Computational Chemistry</th>
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<tr>
<td>Paper No.</td>
<td>XVI (A), ACH 4.4(A): Industrial Analytical Chemistry</td>
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</table>

16. Special instructions, if any: -

17. Detailed title of Papers and Units and Number of Lectures.
M. Sc. Part – I (Semester – I)

Paper- I, Inorganic Chemistry – I(CH.1.1/ APCH.1.1/IND.1.1)

Unit-I: Chemistry of transition elements

15L

General characteristic and properties of transition elements, Coordination chemistry of transition metal ions, Stereochemistry of coordination compounds, Crystal field theory for tetrahedral, octahedral, square pyramidal and square planar complexes, Splitting of d- orbital’s, Crystal field stabilization energy (CFSE), Factors affecting the crystal field parameters, Strong and weak field complexes, Spectrochemical series, Jahn-Teller effect, Interpretation of electronic spectra including d-d and charge transfer spectra, Nephelauxetic series

UNIT-II: Transition metal carbonyls and related compounds

15L


UNIT-III: Organometallic Chemistry

15L

Synthesis, bonding, structure and reactivity of organometallic compounds, Classification of organometallic compounds based on hapticity and polarity of M-C bond, Nomenclature and general characters, 18 electron rule-applications and exceptions, Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination, Organometallics in homogeneous catalysis: Hydrogenation, hydroformylation, isomerisation and polymerization.

UNIT-IV:

A) Metal-ligand Equilibrium in solution

15L

8L
Thermodynamic vs. kinetic stability, Stability constant, Stepwise and overall stability constants with their relation, Trends in stepwise stability constant, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect, Ternary complexes and factors affecting their stabilities, Stability of metal complexes of crown ethers, Determination of stability constants by spectrophotometric methods (Job’s and Mole/slope ratio for composition), Bjerrum’s PH metric method.

B) Nuclear and radiochemistry

Nuclear stability and nuclear binding energy, Radioactivity and radioactive decay Radioactive equilibrium, Classification of nuclear reactions, Nuclear reaction cross section, Nuclear fission, Nuclear fusion, Applications of radioactivity in agriculture, medical field, and industry.

Recommended Books
3. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
4. A. R. West, Plenum, Solid State Chemistry and its applications
5. H. J. Emelius and A. G. Sharpe, Modern Inorganic Chemistry
7. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
9. O. A. Phiops, Metals and Metabolism
10. Cullen Dolphin and James, Biological aspects of Inorganic Chemistry
11. Williams, An Introduction to Bioinorganic Chemistry
12. M. N. Hughes, Inorganic Chemistry of Biological Processes
13. Ochi, Bioinorganic Chemistry
15. Willam L. Jooly, Modern Inorganic Chemistry
16. Manas Chanda, Atomic Structure and Chemical bonding
17. N. N. Greenwood and A. Earnshaw, Chemistry of elements, Pergamon

Inorganic Chemistry Practical Course (CHP.1.1/APCHP.1.1/INDP.1.1)

Semester-I, Inorganic Chemistry Practicals

A) Ore Analysis
   Determination of Silica and Manganese in pyrolusite
   Determination of iron from hematite.
B) Alloy Analysis
   Determination of tin & lead from solder
   Determination of copper and nickel from monel metal
C) Preparations and purity (Any four)
   Potassium trisulphatochromate(III) trihydrate
   cis-potassium dioxalatodiaquachromate(III)
   Potassium hexathiocyanatochromate(III)
   Bis(dimethylglyoximato)nickel(II)
   Carbonatotetramminocobalt(III) nitrate
   Hexamminocobaltic(III) chloride
D) Determination of concentration of phosphates in water samples colorimetrically

Recommended Books
2. Experimental Inorganic Chemistry - W. G. Palmer
UNIT-I

A) Reaction Mechanism: Structure and Reactivity
Types of reactions, strength of acids and bases. Generation, structure, stability and reactivity of carbenes, arynes, nitrenes and effect of structure on reactivity, resonance and field, steric effects. Thermodynamic and Kinetic requirements, Introduction to Kinetic and Thermodynamic control reaction.

B) Aliphatic Nucleophilic substitutions
The SN2, SN1 and SNi reactions with respects to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. SN reactions at bridge head carbon, competition between SN1 and SN2, Ambident nucleophiles, Neighbouring Group Participation.

UNIT-II

A) Introduction to aromaticity in Benzenoid and non – Benzenoid compounds.
Three, four and five membered systems. tropone, tropolone, tropylium salts.

B I] Aromatic Electrophilic Substitutions
Introduction, the arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in their ring systems. Diazo-coupling, Vilsmeier-Haak reaction, Von Richter rearrangement

II] Nucleophilic aromatic substitution reactions SN1, SN2.

UNIT-III

A) Elimination Reactions
The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hofman versus Saytzeff elimination, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions. Pyrolytic elimination reactions.
B) Study of following reactions
Mechanism of condensation reaction involving enolates, Benzoin, Stobbe, Robinson annulation, Simon-Smith, Vlhmann, Mc-Murry, Dakin,
prins, Wurtz-Fittig reaction, Hunsdiecker reaction, Pummerer, , Rupe, Gabriel–Colman, Corey-Chaykovsky reaction, Nef reaction, Passerini
reaction, Baylis-Hilman reaction, Mitsunobu Reaction.

UNIT-IV
Stereochemistry: Concept of chirality, Prochiral relationship, homotopic, enantiotopic and distertiotopic groups and faces. Recemic modifications
and their resolution, R and S nomenclature. Conformational analysis: Cyclohexane derivatives, stability and reactivity. Conformational analysis
of disubstituted cyclohexanes. Introduction of optical activity in the absence of chiral carbon (spiranes and allenes)

RECOMMENDED BOOKS
1. A guide book to mechanism in Organic chemistry (Orient-Longmens)- Peter Sykes
2. Organic Reaction Mechanism (Benjamin) R. Breslow
5. Basic principles of Organic Chemistry (Benjamin) J. D. Roberts and M. C. Caserio.
7. Stereochemistry of Carbon compounds, (McGraw-Hill) E. L. Eliel
16. Introduction to stereochemistry(Benjamin) K. Mislow.
17. Stereochemistry by P. S. Kalsi (New Age International)
Semester-I, Organic Chemistry Practical Course (CHP.1.1/APCHP.1.1/INDP.1.1)

ORGANIC CHEMISTRY PRACTICALS

A) Preparations
(One stage preparations involving various types of reactions and confirmation of product by TLC)
1. Coumarin Synthesis - 7-OH-4-methyl coumarine from Resorcinol and EAA.
2. Knoevenagel condensation reaction - Reaction of aldehyde and malononitrile.
3. Preparation of Hydrantoin.
5. Preparation of benzimidazole from OPD.
6. Preparation of Orange II
7. Fischer Indole Synthesis - Reaction of phenyl hydrazine and cyclohexanone.
(Any suitable Expt. may be added)

B) Estimations:
1. Estimation of Unsaturation.
2. Estimation of formalin.
5. Estimation of Glycine.
(Any suitable Expt. may be added.)

RECOMMENDED BOOKS
2. Practical organic chemistry - Mann and Saunders.
5. Practical Med. Chem. - Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy.
UNIT-I: THERMODYNAMICS
15L

UNIT-II: STATISTICAL THERMODYNAMICS
15L

UNIT-III: COLLOIDS AND SURFACE PHENOMENA
15L
Colloidal Systems-Sols, Lyophilic and lyophobic sols, properties of sols, coagulation. Sols of surface active reagents, surface tension and surfactants, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization. Thermodynamics of
micellisation, critical micelle concentration, factors affecting critical micelle concentration (cmc), experimental methods of cmc determination, Micellar catalysis.


UNIT-IV  
MACROMOLECULES

Macromolecules: Mechanism of polymerization, molecular weight of a polymer (Number and mass average ) viscosity average molecular weight, numerical problems. Degree of polymerization and molecular weight, practical significance of polymer molecular weight, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultracentrifugation)

Recommwnded Books

14. Physical Chemistry of macromolecules- D. D. Deshpande, Vishal Publications.

**Semester-I, Physical Chemistry Practical Course (CHP.1.2/APCHP.1.2/INDP.1.2)**

**Physical Chemistry Practicals**
Students are expected to perform at least 8 experiments of three and half hours duration. Experiments are to be set up in the following techniques.

**Potentiometry:**
1. Determination of solubility and solubility product of silver halides.
2. Determination of binary mixture of weak and strong acid.

**Conductometry:**
3. Determination of mixture of acids and relative strength of weak acids.
4. Determination of solubility of lead sulphate.
5. Determination of CMC and ΔG of sodium dodecyl sulphate.

**Refractometry:**
7. Determination of concentration of sugar in unknown sample.

Polarimetry:
8. Kinetics of inversion of cane sugar in presence of strong acid.

pH- metry:
9. Determination of dissociation constant of dibasic acid.

Chemical Kinetics:
10. Kinetics of reaction between bromate and iodide.

Adsorption:
11. Study of adsorption of acetic acid on charcoal.

Viscosity:
12. Determination of molecular weight of polymers

(New experiments may be also be added)

Books recommended for Practicals:
1. Findlay’s Practical Chemistry – Revised by J.A. Kitchner (V edition)
2. Text Book of Quantitative inorganic analysis : A.I. Vogel.
3. Experimental Physical Chemistry : R. C. Das and B. Behera
4. Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
7. Advanced practicals in physical chemistry-Datar and Doke
8. Practical Physical Chemistry- B. D. Khosla, V. C. Garg, A. Gulati

Paper - IV Analytical Chemistry –I(CH.1.4/APCH.1.4/IND.1.4)

UNIT-I

Basics of Analytical Chemistry, Errors, treatments and statistics
Analytical Chemistry, Chemical analysis, instrumental methods, Analytical methods, Techniques of analysis, classification of analytical techniques, Classification of instrumental methods, factors affecting choice of analytical methods, interferences.
Types and sources of error, determinate and indeterminate errors, accuracy and precision Absolute and relative errors, Minimisation of errors, Significant figures, Mean, median and standard deviation, Least square method. Sampling, Types of sampling, Techniques of sampling of gases, fluids, solids, and particulates. Good Laboratory Practices

Problems.

UNIT-II
Fundamentals of Quantitative Analysis

Problems.

UNIT-III
Chromatographic methods
Problems.

UNIT-IV  
15L  
Electro Analytical Techniques
Polarography: Introduction, Instrumentation, Ilkovic equation and its verification. Polarographic measurements, Dropping mercury electrode, Determination of half wave potential, qualitative and quantitative applications.

Amperometry: Basic principles, instrumentation, Amperometric titration curves, Amperometric indicators, procedure for Amperometric titrations, Evaluation of amperometry in research and analytical applications.

Voltammetry: Voltammetric methods of analysis, basic principles, instrumentation, voltammetric measurements, voltammetric techniques, current in voltammetry, shape of voltammograms, quantitative and qualitative aspects of voltammetry, quantitative applications, characterization applications, Evaluation of CV in research and analytical applications.

Problems.

References:
1. Analytical Chemistry: (J.W) G. D. Chirstain.
2. Instrumental Methods of analysis (CBS)- H.H. Willard, L.L. Merrit, J.A. Dean
4. Instrumental Methods of Analysis: Chatwal and Anand
5. Instrumental Methods of Inorganic Analysis (ELBS): A.I. Vogel
7. Physical Chemistry – P.W. Atkins
8. Principal of Instrumental Analysis- D. Skoog and D. West
10. Instrumental methods of chemical analysis, H. Kaur
11. Principles of Instrumental analysis, Holler, Skoog, Crouch
12. Chromatographic methods- H. Kaur
13. Analytical Chemistry- Alka Gupta
15. Advanced Practical Inorganic Chemistry, Gurdeep Raj
Semester-I, Analytical Chemistry Practical Course( CHP.1.2/APCHP.1.2/INDP.1.2)

Analytical Chemistry Practicals
1. To verify Beer-Lambert’s Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample Spectrophotometrically
2. To determine the iron potentiometrically by titrating with potassium dichromate
3. To determine the solubility of Calcium oxalate in presence of different concentration of KCl
4. To determine the solubility of Calcium oxalate in presence of different concentration of HCl
5. Analysis of pharmaceutical tablets for ibuprofen content
6. To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically/spectrophotometrically.
7. To estimate the amount of D-glucose in given solution colorimetrically.
8. To determine the acid value of given oil
9. Determination of standard deviation from the results obtained by redox titration of iron solution against standard potassium dichromate solution
10. Determination of sodium from the fertilizer sample using cation exchange chromatography
11. Determination of calcium from given drug sample.
12. Determination of hardness, alkalinity and salinity of water sample
13. Separation and estimation of Cd$^{2+}$ and Zn$^{2+}$ by ion exchange chromatography for given Cd$^{2+}$ and Zn$^{2+}$ mixture.
   (Any other experiments may be added)

Recommended Books
1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.
M. Sc. Part – I (Semester – II)

Paper- V, Inorganic Chemistry – II(CH.2.1/APCH.2.1/IND.2.1)

Unit I
Chemistry of Non-transition Elements and their compounds
General discussion on the properties of the non–transition elements, Polymorphism in carbon, phosphorous and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur–nitrogen compounds, peroxo compounds of boron, carbon, sulphur, structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, interhalogens, psudohalides

Unit II
A) Stereochemistry and bonding in Main group compounds
Hybridization and structure of molecules, VSEPR Theory, \( \pi-\pi \) and \( \pi-d \) bonds, Bent rule, Walsh Diagram, Back bonding, Some simple reactions of covalently bonded molecules (atomic inversion, Berry Pseudorotation, Nucleophilic displacement, free radical reaction).

B) Non-aqueous solvents
Classification of solvents, Characteristics of solvents, Types of reactions in solvents, Physical and chemical properties of the non-aqueous solvents such as liquid ammonia, sulphur dioxide, dinitrogen tetroxide, anhydrous sulphuric acid and molten salts.

UNIT-III
Chemistry of f-block elements (Lanthanides and Actinides)
Occurrence, properties of the f-block elements, colour, oxidation state, Spectral and magnetic properties of lanthanides and actinides, lanthanide contraction, Use of lanthanide compounds as shift reagents, compounds of lanthanides, Photoluminescence properties of lanthanide compounds, Modern methods of separation of lanthanides and actinides, Applications of lanthanide and actinide compounds in Industries.

UNIT-IV
A) Solid state chemistry  
Crystal structure, Crystal types, Crystal defects, Electronic structure of solids, Band theory, Theory of Metals, Semiconductors and Insulators, Superconductivity, optical and magnetic properties, Solid state reactions, AB [Nickel arsenide (NiAs)], AB$_2$ [fluorite (CaF$_2$) and anifluorite], layer structure [cadmium chloride and iodide (CdCl$_2$ & CdI$_2$)]

B) Bioinorganic Chemistry  
Role of metal ions in biological processes, structure and properties of metalloproteins, porphyrines, metalloenzymes, oxygen transport, electron transfer reactions, cytochromes, ferredoxins and iron sulphur proteins, ion transport across membranes, Nitrogen fixation-nitrogenase, metal complexes in medicines.

Recommended Books

3. J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London
4. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
5. Jones , Elementary coordination Chemistry
6. Martell, Coordination Chemistry
7. T. S. Swain and D. S. T. Black, organometallic Chemistry
11. Willam L. Jooly, Modern Inorganic Chemistry
12. Manas Chanda, Atomic Structure and Chemical bonding
13. P. L. Pauson, Organometallic Chemistry
15. H. J. Arnikar, Essentials of Nuclear Chemistry

**Semester-II, Inorganic Chemistry Practical Course (CHP.2.1/APCHP.2.1/INDP.2.1)**

**Inorganic Chemistry Practicals**

A) Ore Analysis
   - Determination of calcium and magnesium from Dolomite
   - Determination of copper and iron from chalcopyrite

B) Alloy Analysis
   - Determination of copper and zinc from brass alloy
   - Determination of iron & chromium from steel.

C) Preparations and purity (Any four)
   - Tris(acetylacetonato)cobalt(III) trihydrate
   - Pentaaquachlorochromium(III) chloride
   - Hexathioureaplumbus(II) nitrate
Bis(acetylacetonato) copper(II)
Diaquabis(ethylenediammine) copper(II) iodide
Copper ferrite

D) Separation of Fe²⁺ Cu²⁺ Ni²⁺ by anion exchange

Recommended Books
2. Experimental Inorganic Chemistry- W. G. Palmer
3. The analysis of minerals and ores of the rarer elements – W. R. Schoeller
4. A. R. Powell, Charles, Griffin and Company Limited

**Paper-VI, Organic Chemistry-II (CH.2.2/APCH.2.2/IND.2.2)**

**UNIT-I**

A) Study of following rearrangements

Curtius, Lossen, Witting, Neber, Ortaon, Hofmann-Martius and Demjanov reaction.

B) Photochemistry

Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearrangements of 1,4 and 1,5-dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α, β-unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions, dimerisation and oxetane formation, photochemistry of aromatic compounds, photo frys reactions of anilides, photo frys rearrangements. Singlet molecular oxygen reactions.

**UNIT-II**

15L
A) Hydroboration
Various hydroboring agents their mechanism and synthetic applications *viz* 9-borabicyclo-[3.3.1]nonane (9-BBN), thexylborane, H B diisoamylborane. (Sia2BH) BH3•SMe2. (BMS), Borane as reducing agent.

B) Enamins
Formation, reactivity and synthetic applications of enamines

C) Oxidation
Applications of oxidizing agents like chromium trioxide, manganese dioxide, Woodward-Prevost hydroxylation, Chloranil, hydrogen peroxide. Swern oxidation. PCC(Corey’s reagent), PDC(Cornforth reagent), Baejer-Villiger oxidation.

UNIT-III
A) Reductions
Study of following reductions- Catalytic hydrogenation using homogeneous and heterogeneous catalysts. Study of following reducing reagents and reactions: Wolff-Kishner, Birch, Sodium cyano borohydride, Sodium in alcohol, Fe in HCl, Adam’s catalyst, Lindlar catalyst, TBTH.

B) Protection of functional group
Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

UNIT-IV
A) Study of Organometallic compounds
Organo-lithium, Use of lithium dialkyl cuprate, their addition to carbonyl and unsaturated carbonyl compounds. Study of coupling reactions *viz* Heck, Suzuki, Stille, Nigeshi and Sonogashira coupling.

B) Methodologies in organic synthesis
Ideas of synthones and retrones, Functional group transformations and inter conversions of simple functionalities.

RECOMMONDED BOOKS
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
7. Oxidation by-(Marcel Dekker) Augustin

**Semester-II, Organic Chemistry Practical Course ( CHP.2.1/APCHP.2.1/INDP.2.1)**

**Organic Chemistry Practicals**
1. Qualitative analysis:
   Separation and identification of the two component mixtures using
   Chemical and physical methods.
2. Thin layer chromatography (TLC).
3. Column chromatography and steam distillation techniques.
4. Determination of percentage of Keto-enol form.
5. Estimation of Ibuprofen.
(Any other suitable experiments may be added).

RECOMMENDED BOOKS
2. Practical organic chemistry- Mann and Saunders.

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**Paper-VII, PHYSICAL CHEMISTRY – II (CH.2.3/APCH.2.3/IND.2.3)**

**UNIT-I: QUANTUM CHEMISTRY  15L**


**UNIT-II: PHOTOCHEMISTRY  15L**

Absorption of light, laws of photochemistry, electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, construction of Jablonski diagram, electronic transition, Frank Condon principle, selection rules, intensity of absorption bands, nature of electronic spectra and primary process, photo-dissociation, pre-dissociation, Photo physical phenomena: photo-
physical pathways of excited molecular system (radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, collisional quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and applications in chemical analysis. Photochemical reactions, photo-oxidation, photoreduction, photo-dimerization, photoisomerization and photosensitized reactions. Photochemistry of environment: Greenhouse effect.

UNIT-III: ELECTROCHEMISTRY 15L
Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex. Acid and alkaline storage batteries, Abnormal ionic conductance of hydroxyl and hydrogen ions.

UNIT-IV: CHEMICAL KINETICS 15L
Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO₂ and F₂, decomposition of ozone, and nitrogen pentoxide. Ionic reaction: Primary and secondary salt effect, Catalysis: Classification of catalysis, mathematical expression of autocatalytic reactions, Michaelis–Menten enzyme catalysis, Homogeneous catalysis: acid and base catalyzed reactions, Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics, Catalyzed hydrogen-deuterium exchange reaction.

Recommended books:
11. Introduction to Photochemistry-Wells
12. Photochemistry of solutions-C. A. Parker, Elsevier
13. An Introduction to Electrochemistry by S. Glasstone
19. Advanced Physical Chemistry- Gurdeep Raj, Goel Publishing House

Semester-II, Physical Chemistry Practical Course (CHP.2.2/APCHP.2.2/IND.2.2)

Physical Chemistry Practicals

Students are expected to perform at least 8 experiments of three and half-hours duration. Experiments are to be set up in the following techniques.

Potentiometry:
1. Determination formal redox potential of system ($\text{Fe}^{2+}, \text{Fe}^{3+}$)
2. Determination of binary mixture of halides.
3. Dissociation constant of acetic acid.

Conductometry:
4. Titration of ternary acid mixture of acids.
5. Verification of Onsagar Equation for 1:1 type strong electrolyte.

Refractometry:

Cryoscopy:
9. Determination of apparent weight and degree of dissociation a strong electrolyte
Chemical kinetics:

10. Kinetics of iodination of acetone in presence of strong acid

Phase Equilibrium:

11. To construct phase diagrams for ternary system.

Viscosity:

12. Determination of radius of sucrose molecules.

(New experiments may be also be added)

Recommended Books

1. Findlay’s Practical Chemistry – Revised by J.A. Kitchner (Vedition)
2. Text Book of Quantitative inorganic analysis : A.I. Vogel.
3. Experimental Physical Chemistry : By F. Daniels and J. Williams
4. Experimental Physical Chemistry : R.C Das and B.Behera
5 Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
6. Advanced practicals in physical chemistry-Datar and Doke
7 Practical Physical Chemistry- B. D. Khosla, V. C. Garg, A. Gulati

Paper –VIII, Analytical Chemistry –II (CH.2.4/APCH.2.4/IND.2.4)

UNIT-I

UV-Vis and IR Molecular Spectroscopy

a) Ultraviolet and visible spectrophotometry (UV-Vis) Introduction, Beer Lambert’s law, instrumentation, calculation of absorption maxima of dienes, dienones and polyenes, applications.

b) Infrared Spectroscopy (IR) Introduction, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups. Factors affecting frequencies, applications.
c) Luminescence, Chemiluminescence, Fluorimetry and phosphorimetry: Instrumentation, Reporting spectra, applications and comparison.

**Problems:** Simple structural problems based on UV-Vis and IR

**UNIT-II**

Advanced Analytical Tools

15L

a) Nuclear Magnetic Resonance (NMR) Magnetic and non magnetic nuclei, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, chemical shift, anisotropic effect, spin spin coupling, coupling constant, applications to simple structural problems

b) Mass spectrometry (MS), Basic principle, working of mass spectrometer, ionization, types of ionization and classification of MS based on ionization, analyzers (magnetic sector, quadrupole, ion-trap, time of flight, formation of different types of ions, McLafferty rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications.

**Problems:** Simple structural problems based on IR, UV, NMR and MS.

**UNIT-III**

Thermal Analysis

15L

Introduction to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase transformation etc. and general thermal analysis applications, advantages and disadvantages.

a) Thermogravimetry analysis (TGA), principle, instrumentation, working, types of TGA, factors influencing TGA, curve to show nature of decomposition reactions, the product and qualities of compounds expelled, TGA in controlled atmosphere, TGA curves, analysis, research and analytical implications of TGA.

b) Differential thermal analysis (DTA) and differential scanning calorimetry (DSC), instrumentation, methodology, application and research implications. Thermometric titrations method and applications

**Problems:** Simple problems based on TG, DTA and DSC.

**UNIT-IV**

Atomic Spectroscopy

15L

a) Atomic Absorption Spectroscopy Introduction, Principal, difference between AAS and FES, Advantages of AAS over FES, advantages and disadvantages of AAS, Instrumentation, Single and double beam AAS, detection limit and sensitivity, Interferences, applications. Graphite furnace atomic absorption spectroscopy, general description, advantages and disadvantages. Flame photometry, Cold Vapor Mercury, Hydride Generation, Spark emission, challenges and limitations.


**Problems:** Simple problems based on FES, AAS, GFAS, ICP
RECOMMENDED BOOKS
1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.

Semester-II, Analytical Chemistry Practical Course (CHP.2.2/APCHP.2.2/INDP.2.2)

Analytical Chemistry Practicals

1. To estimate the amount of NH₄Cl colorimetrically using Nesseler’s Reagent.
2. To determine the solubility of PbI₂ in presence of different concentration of KNO₃
3. To determine the solubility of PbI₂ in presence of different concentration of KCl
5. Determination of capacity of cation exchanger
6. Determination of capacity of anion exchanger
7. Determination of turbidity of water sample using nephelometer
8. To determine the iron content from soap sample
9. Determination of sulphate by nephelometry/tubidimetry
10. Determination of isoniazid from pharmaceutical tablet
11. Determination of caffeine from tea powder
12. Determination of iron from iron tablet samples
13. Estimation of fatty acid from soap sample
14. (Any other experiments may be added)

**Recommended Books**

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.
M. Sc. Part I and II, Chemistry
(Inorganic, Organic, Physical, Analytical, Applied and Industrial Chemistry)

1. **Nature of the theory Question Papers:**
   1. There shall be 7 questions carrying 16 marks each.
   2. Question No. 1 is compulsory. It consists of fill in the banks, objective or answer in one sentence type questions.
   3. The remaining question No. 2 to 7 are divided into two sections (Section I and II).
   4. Section I consists of question No 2, 3 and 4.
   5. Section II consists of question No 5, 6 and 7.
   6. Questions 2 to 6 consists of 2 or 3 sub questions.
   7. Question No 7 consists of sub questions in which students have to write short notes on any three or four sub questions among the given options.