Scheme for UG Syllabus
Annual System
(Effective from 2018-19)

Under

CHOICE BASED CREDIT SYSTEM (CBCS)

In

Bachelor of Science Physical Science
(Physics, Chemistry and Mathematics)
And

Bachelor of Science with Chemistry

Department of Chemistry
Himachal Pradesh University
Shimla-5
CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student’s performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate’s proficiency/skill is called an Elective Course.

2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course: The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). “AECC” courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL (Modern Indian Language) Communication are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training,
competencies, skills, etc.

3.1 **AE Compulsory Course (AECC):** Environmental Science, English Communication/MIL Communication.

3.2 **AE Elective Course (AEEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving/analyzing/exploring a real life situation/difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.
### Details of Courses Under Undergraduate Program (B.Sc.)

<table>
<thead>
<tr>
<th>Course</th>
<th>*Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory+ Practical</td>
</tr>
<tr>
<td>I. Core Course</td>
<td>12×4= 48</td>
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<tr>
<td><em>(12 Papers)</em></td>
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</tr>
<tr>
<td>04 Courses from each of the</td>
<td></td>
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<tr>
<td>03 disciplines of choice</td>
<td></td>
</tr>
<tr>
<td>Core Course Practical / Tutorial*</td>
<td>12×2=24</td>
</tr>
<tr>
<td><em>(12 Practical/ Tutorials</em>)</td>
<td></td>
</tr>
<tr>
<td>04 Courses from each of the</td>
<td></td>
</tr>
<tr>
<td>03 Disciplines of choice</td>
<td></td>
</tr>
<tr>
<td>II. Discipline Specific Course</td>
<td></td>
</tr>
<tr>
<td>Elective Course</td>
<td>6×4=24</td>
</tr>
<tr>
<td><em>(6 Papers)</em></td>
<td></td>
</tr>
<tr>
<td>Two papers from each discipline of choice including paper of interdisciplinary nature.</td>
<td></td>
</tr>
<tr>
<td>Discipline Specific Course Practical / Tutorials*</td>
<td>6×2=12</td>
</tr>
<tr>
<td><em>(6 Practical / Tutorials</em>)</td>
<td></td>
</tr>
<tr>
<td>Two Papers from each discipline of choice including paper of interdisciplinary nature</td>
<td></td>
</tr>
<tr>
<td>• Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 3rd year</td>
<td></td>
</tr>
</tbody>
</table>
III. Ability Enhancement Courses

1. Ability Enhancement Compulsory
   2 × 4 = 8
   (2 Papers of 4 credits each)
   Environmental Science English/MIL Communication

2. Skill Enhancement Course
   4 × 4 = 16
   (Skill Based)
   (4 Papers of 4 credits each)

   Total credit = 132

College should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

*wherever there is practical there will be no tutorials and vice versa.

❖ In case of theory and tutorial 1 credit will be of 1 hour class room teaching, while in case of Practical/Practical Skill Exam 1 credit will be of 2 hours Laboratory class/project work.
## Scheme for Choice Based Credit System (CBCS) in Bachelor of Science Physical Science and Bachelor of Science with Chemistry Annual Pattern

<table>
<thead>
<tr>
<th>Year</th>
<th>Core Course (12)</th>
<th>Ability Enhancement Compulsory Course AECC (2)</th>
<th>Skill Enhancement Courses SEC (4)</th>
<th>Elective Course Discipline Specific Elective DSE (6)</th>
<th>Total Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>DSC-1A = 6 Credit DSC-1B = 6 Credit DSC-2A = 6 Credit DSC-2B = 6 Credit DSC-3A = 6 Credit DSC-3B = 6 Credit</td>
<td>Eng and EVS = 4 Each Credit</td>
<td>NIL</td>
<td>NIL</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Credits = 36</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>II</td>
<td>DSC-1C = 6 Credit DSC-1D = 6 Credit DSC-2C = 6 Credit DSC-2D = 6 Credit DSC-3C = 6 Credit DSC-3D = 6 Credit</td>
<td>NIL</td>
<td>SEC-1 = 4 Credit SEC-2 = 4 Credit</td>
<td>NIL</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Credits = 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>NIL</td>
<td>NIL</td>
<td>SEC-3 = 4 Credit SEC-4 = 4 Credit</td>
<td>DSE-1A = 6 Credit DSE-1B = 6 Credit DSE-2A = 6 Credit DSE-2B = 6 Credit DSE-3A = 6 Credit DSE-3B = 6 Credit</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Credits = 36</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits in B.Sc. Physical Science and B.Sc. with Chemistry Degree Courses = 44 × 3 = 132

### Credits (hours) Split:

- **Theory** = 04 (4 hours)
- **Theory** = 05 (5 hours)
- **Practical** = 02 (4 hours)
- **Tutorial** = 01 (1 hour)
- **For SEC:**
  - **Theory** = 03 (3 hours)
  - **Skill Exam (SE)** = 01 (2 hours)
**Details of CBCS Scheme for Undergraduate Three Year Degree Course: B.Sc. Physical Science and B.Sc. with Chemistry: Teaching Hours and Credits Plan in Annual System for Three years**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Course (6 Credits)</th>
<th>Teaching Hrs.</th>
<th>Credits as per annual Plan</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>1st Week</td>
<td>2nd Week</td>
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<tr>
<td>1</td>
<td>Core Courses (12)</td>
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<tr>
<td>a</td>
<td>Discipline Specific Courses (4+4+4 =12)</td>
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<tr>
<td>i</td>
<td>DSC-1A</td>
<td>03</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>DSC-1B</td>
<td>03</td>
<td>06</td>
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<tr>
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<td>DSC-1C</td>
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<td></td>
<td>DCS-1D</td>
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<td>06</td>
</tr>
<tr>
<td>ii</td>
<td>DSC-2A</td>
<td>03</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>DSC-2B</td>
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<td>06</td>
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<tr>
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<td>DSC-2C</td>
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<td>DCS-2D</td>
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<td>06</td>
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<tr>
<td>iii</td>
<td>DSC-3A</td>
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<td>DSC-3B</td>
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<td><strong>Total Credits of Core Courses</strong></td>
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<td>Ability Enhancement Courses (6)</td>
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<td>a</td>
<td>Ability Enhancement Compulsory Courses (2)</td>
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<tr>
<td>i</td>
<td>Eng/MIL Communication/EVS</td>
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<td>04</td>
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<tr>
<td></td>
<td>Eng/MIL Communication/EVS</td>
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</tr>
<tr>
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<td><strong>Total Credits of Ability Enhancement Compulsory Courses (AECC)</strong></td>
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<td>b</td>
<td>Skill Enhancement Courses (4)</td>
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<tr>
<td></td>
<td>SEC-1</td>
<td>02</td>
<td>04</td>
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<td>SEC-2</td>
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<td>04</td>
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<td>04</td>
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<td>SEC-4</td>
<td>02</td>
<td>04</td>
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<td><strong>Total Credits of Skill Enhancement Courses (SEC)</strong></td>
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</table>
**Total Credits of Ability Enhancement Courses (AEC) = 08 + 16**

<table>
<thead>
<tr>
<th>3</th>
<th>Elective Courses (6)</th>
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<td>DSE Specific Elective Courses</td>
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<tr>
<td>i</td>
<td>DSE-1A</td>
<td>03</td>
<td>06</td>
<td>05</td>
<td>01</td>
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<tr>
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<td>DSE-1B</td>
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<td>06</td>
<td>05</td>
<td>01</td>
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<td>06</td>
<td>05</td>
<td>01</td>
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<td>DSE-2B</td>
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<td>06</td>
<td>05</td>
<td>01</td>
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<tr>
<td></td>
<td>DSE-3A</td>
<td>03</td>
<td>06</td>
<td>05</td>
<td>01</td>
</tr>
<tr>
<td></td>
<td>DSE-3B</td>
<td>03</td>
<td>06</td>
<td>05</td>
<td>01</td>
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</table>

**Total Credits of Discipline Specific Elective (DSE) Courses** 36

**Grand Total Credits in Three Year Degree Course: B.Sc. Physical Science and B.Sc. with Chemistry: 72 + 24 +36** 132

*As per teaching hours given in column three above table, each course of 6 credits [{4 credits Theory (4 hours) + 2 credits Practical (4 hours)} or {5 credits Theory (5 hours) + 1 credits Tutorial (1 hours)}] and of 4 credits {3 credits SEC Theory (3hours) + 1 Credit Tutorial (2 hours)} should be completed within every two weeks of the annual system.*
Comprehensive Continuous Assessment (CCA) and yearly Scheme in Chemistry of Three years

B.Sc. Physical Sciences

Scheme of Examination for every course except Skill enhancement course*

English shall be the medium of instructions and Examinations. Examinations shall be conducted at the end of each year as per the academic calendar notified by H.P. University Shimla-5

Each course of 6 credits will carry 100 marks (theory + practical) and will have following components:

1. Theory
   i) Comprehensive Continuous Assessment 50 marks
      30 marks
      a) Assignment/Quiz/Seminar/model/ Mid-Term Examination 15 marks
      b) Attendance 05 marks
      c) Lab Seminar /Lab CCA 10 marks
   ii) Yearly Examination 50 marks

II. Practical 20 marks

Practical examination will have following components:
   i) Performing the two practical exercises assigned by the examiner in terms of requirement of chemicals/apparatus/ theory/ reaction (if any) involved, procedure/ scheme/ observations/calculations and results. 10 marks
   ii) viva-voce examination 5 marks
   iii) Practical note book and regularity during practical classes 5 Marks

{Theory Paper (CCA + yearly Examination) +Practical [30 +50 +20] =100 marks}

* Each Skill Enhancement course will be of 4 credits and scheme of examination for these courses is as under:

{CCA + yearly Examination [30 + 70] =100 marks}

Criterion for marks on the basis of Class-room attendance (0 - 5 marks) under component CCA/ IA be defined as follows:

a) Attendance 75 -- 80% = 3 marks
b) Attendance 81 – 90 % = 4 marks
c) Attendance 91% and above = 5 marks
d) Candidates securing 75% Attendance after condonation will not be entitled to get any mark.
<table>
<thead>
<tr>
<th>Year</th>
<th>Course Type</th>
<th>Course Code</th>
<th>Title of paper</th>
<th>Credits</th>
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<tr>
<td>I</td>
<td>CORE COURSE-I</td>
<td>PHYS101TH</td>
<td>MECHANICS Theory</td>
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<td></td>
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<td>PHYS101IA</td>
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<tr>
<td></td>
<td></td>
<td>PHYS101PR</td>
<td>MECHANICS Lab</td>
<td>2</td>
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<tr>
<td></td>
<td>CORE COURSE-II</td>
<td>CHEM101TH</td>
<td>ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY &amp; ALIPHATIC HYDROCARBONS</td>
<td>6</td>
</tr>
<tr>
<td></td>
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<td>CHEM101IA</td>
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<td>CHEM101PR</td>
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<td>CORE COURSE-III</td>
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<td>A.E.C. COURSE-I</td>
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<td>CORE COURSE-IV</td>
<td>PHYS102TH</td>
<td>ELECTRICITY, MAGNETISIM AND EMT Theory</td>
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<td>CORE COURSE-V</td>
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<td>STATES OF MATTER, CHEMICAL KINETICS &amp; FUNCTIONAL ORGANIC CHEMISTRY</td>
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<td>MATH102TH</td>
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<td>CORE COURSE-VII</td>
<td>PHYS201TH</td>
<td>STATISTICAL AND THERMAL PHYSICS Theory</td>
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<td>CORE COURSE-VIII</td>
<td>CHEM201TH</td>
<td>SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY &amp; ORGANIC CHEMISTRY</td>
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<td>CORE COURSE-X</td>
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<td>CHEMISTRY OF MAIN GROUP ELEMENTS, CHEMICAL ENERGETICS AND EQUILIBRIA</td>
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<tr>
<td>SEC1 (CHOOSE ANY ONE FROM GIVEN THREE)</td>
<td>PHYS203TH PHYS203IA</td>
<td>PHYSICS WORKSHOP SKILLS Theory</td>
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<td>PHYS203SE</td>
<td>PHYSICS WORKSHOP SKILLS Skill Exam</td>
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<td>PHYS205TH PHYS205IA</td>
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<td>PHYS205SE</td>
<td>ELECTRICAL CIRCUITS AND NETWORK SKILLS Skill Exam</td>
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<td>SEC2 (CHOOSE ANY ONE FROM GIVEN TWO)</td>
<td>CHEM203TH CHEM203IA</td>
<td>BASIC ANALYTICAL CHEMISTRY</td>
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<td>CHEM204TH CHEM204IA</td>
<td>FUEL CHEMISTRY &amp; CHEMISTRY OF COSMETICS &amp; PERFUMES</td>
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<td>III DISCIPLINE SPECIFIC ELECTIVES DSE:1A (CHOOSE ANY ONE FROM GIVEN THREE)</td>
<td>PHYS301TH PHYS301IA</td>
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<td>CHEM301TH CHEM301IA CHEM301PR</td>
<td>POLYNUCLEAR HYDROCARBONS, DYES, HETEROCYCLIC COMPOUNDS AND SPECTROSCOPY (UV, IR, NMR)</td>
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*TH = Theory, IA = Internal Assessment, PR = Practical, TU = Tutorials and SE = Skill Exam
## HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATION FOR B.Sc. WITH CHEMISTRY

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COURSE CONTENTS

Core Courses (CC) for CHEMISTRY (1-4)

(Credits: 06 each)
First Year
CHEM 101TH
ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Max. Marks: 50
Credits: 4

Time Allowed: 3 Hours

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A
Atomic Structure

SECTION - B
Chemical Bonding and Molecular Structure
Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé 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 resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules up to Ne (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches. (16 Hours)

SECTION - C
Fundamentals of Organic Chemistry

Stereochemistry
Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer projections. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems). (10 Hours)
SECTION – D

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


Alkenes: (Upto 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. KMnO₄) and trans-addition (bromine), Addition of HX (Markownikoff’s and anti-Markownikoff’s addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC₂ 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 KMnO₄, ozonolysis and oxidation with hot alkaline KMnO₄. (12 Hours)

Reference Books:

LAB COURSE
CHEM 101 PR
ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS LAB

TIME ALLOWED: 03 HOURS
Max Marks: 20

I. 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 KMnO₄.
3. Estimation of water of crystallization in Mohr’s salt by titrating with KMnO₄.
4. Estimation of Fe (II) ions by titrating it with K₂Cr₂O₇ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using Na₂S₂O₃.

II. Organic Chemistry
1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Separation of mixtures by Chromatography: Measure of Rf value of a mixture of two organic compounds.

Reference Books:
CHEM 102TH
STATES OF MATTER, CHEMICAL KINETICS & FUNCTIONAL ORGANIC CHEMISTRY
Max. Marks: 50 Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A
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. Andrews isotherms of CO₂. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids
Surface tension and its determination using stalgmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

SECTION - B
Solids

Chemical Kinetics

SECTION - C
Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
Aromatic hydrocarbons
Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN₁, SN₂ and SNi) reactions.
Preparation: from alkenes and alcohols.
**Reactions:** hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation, Williamson’s ether synthesis. 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: KNH₂/NH₃ (or NaNH₂/NH₃).

**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: KNH₂/NH₃ (or NaNH₂/NH₃).

**Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.**

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**SECTION - D**

**Alcohols, Phenols and Ethers (Upto 5 Carbons)**

**Alcohols:** Preparation: Preparation of 1°, 2° and 3° 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. KMnO₄, acidic dichromate, conc. HNO₃). Oppenea uer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.


**Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.

**Aldehydes and ketones (aliphatic and aromatic):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

**Preparation:** From acid chlorides and from nitriles.


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**Reference Books:**


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**LAB COURSE**

**CHEM 102 PR**

**STATES OF MATTER, CHEMICAL KINETICS & FUNCTIONAL ORGANIC CHEMISTRY LAB**

**TIME ALLOWED: 03 HOURS**

Max Marks: 20

Credits – 2

**I Physical Chemistry Practicals**

1. **Surface tension measurement** (use of organic solvents excluded).
   a) Determination of the surface tension of a liquid or a dilute solution using a stahlgometer.
   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.

3. **Chemical Kinetics**
   Study the kinetics of the following reaction:
   i). Acid hydrolysis of methyl acetate with hydrochloric acid.
   ii). Saponification of ethyl acetate.
   iii). Compare the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate

**II Organic Chemistry**

1. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups
(-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative and melting point determination.

Reference Books

SECOND YEAR
CHEM 201TH
SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & ORGANIC CHEMISTRY

Max. Marks: 50
Credits: 4

Time Allowed: 3 Hours

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A

Solutions

Phase Equilibrium
Phases, components and degrees 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 diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, NaCl-H2O and Mg-Zn only).

(15 Hours)

SECTION - B

Conductance
Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid base).

Electrochemistry

(15 Hours)
SECTION – C

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


**Carboxylic acid derivatives (aliphatic)**: (Upto 5 carbons) - Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion.

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

**Amines and Diazonium Salts**


(15 Hours)

SECTION - D

**Carbohydrates**: Classification, and 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 monosaccharide. Structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

(15 Hours)

Reference Books:

LAB COURSE

CHEM 201PR

SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & ORGANIC CHEMISTRY LAB

IME ALLOWED: 03 HOURS
Max Marks: 20 Credits – 2

I. **Distribution Law**
   Determination of distribution coefficient of
   i) iodine between CCl₄ and Water
   ii) benzoic acid between benzene and water

II. **Conductance**
   1. Determination of cell constant
   2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
   3. Perform the following conductometric titrations:
      i) Strong acid vs. strong base
      ii) Weak acid vs. strong base

III. **Organic Chemistry**
1. Preparations of organic compounds – Iodoform and Glucosazone

2. Any Two of the following:
   i) Separation of amino acids by paper chromatography
   ii) Determination of the concentration of glycine solution by formylation method.
   iii) Titration curve of glycine
   iv) Action of salivary amylase on starch
   v) Effect of temperature on the action of salivary amylase on starch.
   vi) Differentiation between a reducing and a non-reducing sugar.

Reference Books:

CHEM 202TH
CHEMISTRY OF MAIN GROUP ELEMENTS, CHEMICAL ENERGETICS AND EQUILIBRIA
Max. Marks: 50
Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A

Hydrogen

S-Block Elements
Periodicity of elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling Scale). General characteristics of s-block elements like density, melting points, flame colouration and reducing character, solvation and complexation tendencies and solutions of metals in liquid ammonia. (16 Hours)

SECTION – B

P- Block Elements

Noble Gases
Occurrence of noble gases, History of discovery of noble gases and isolation of noble gases form air. Preparation properties and structure of important compounds of noble gases-flourides, oxides, oxyfluorides of xenon (valence bond structure only). Krypton diflroride and clatherate compounds of noble gases. (16 Hours)

SECTION - C

Chemical Energetics:

SECTIO - D

Chemical Equilibrium:
Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between $\Delta G$ and $\Delta G^\circ$, Le Chatelier’s principle. Relationships between $K_p$, $K_c$ and $K_x$ for reactions involving ideal gases.

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

Reference Books:

Lab Course
CHEM 202PR
CHEMISTRY OF MAIN GROUP ELEMENTS, CHEMICAL ENERGETICS AND EQUILIBRIA

LAB

TIME ALLOWED: 03 HOURS
Max Marks: 20

Credits – 2

1. Inorganic Mixture Analysis - Semi-micro qualitative analysis of inorganic mixture using $\text{H}_2\text{S}$ of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following: Cations : $\text{NH}_4^+$, $\text{Pb}^{2+}$, $\text{Ag}^+$, $\text{Bi}^{3+}$, $\text{Cu}^{2+}$, $\text{Cd}^{2+}$, $\text{Sn}^{4+}$, $\text{Fe}^{3+}$, $\text{Al}^{3+}$, $\text{Co}^{2+}$, $\text{Cr}^{3+}$, $\text{Ni}^{2+}$, $\text{Mn}^{2+}$, $\text{Zn}^{2+}$, $\text{Cu}^{2+}$, $\text{Ca}^{2+}$, $\text{K}^+$ Anions : $\text{CO}_3^{2-}$, $\text{S}^2-$, $\text{SO}_4^{2-}$, $\text{S}_2\text{O}_3^{2-}$, $\text{NO}_2^-$, $\text{CH}_3\text{COO}^-$, $\text{Cl}^-$, $\text{Br}^-$, $\Gamma$, $\text{NO}_3^-$, $\text{SO}_4^{2-}$, $\text{PO}_4^{3-}$, $\text{BO}_3^{3-}$, $\text{C}_2\text{O}_4^{2-}$
(Spot tests should be carried out wherever feasible)

2. Thermochemistry
1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (KNO$_3$, NH$_4$Cl).
4. Determination of enthalpy of hydration of copper sulphate.

3. Ionic Equilibria: pH measurements
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.
Reference Books:
COURSE CONTENT FOR

Skill Enhancement Courses

(CHEMISTRY)

(4 Courses)

(Credit: 04 each)
CHEM 203
BASIC ANALYTICAL CHEMISTRY

Max. Marks: 70
Credits: 4

Time allowed: 03 Hours

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Section E will be of 10 marks and consists of 10 objective type questions (in MCQ/true and false / fill in the blanks) of one mark each covering the entire syllabus of the paper.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION – A

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators.
   a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. (15 Hours)

SECTION – B

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.
   a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.
   a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter. (18 Hours)

SECTION – C

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.
   a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). b. To compare paint samples by TLC method. Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible). (12 Hours)

SECTION – D

Analysis of cosmetics: Major and minor constituents and their function
   a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.
   Suggested Applications (Any one):
      a. To study the use of phenolphthalein in trap cases. b. To analyze arson accelerants. c. To carry out analysis of gasoline. (15 Hours)

Suggested Instrumental demonstrations:
   a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
   b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
   c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink

Reference Books:

CHEM 204
FUEL CHEMISTRY
&
CHEMISTRY OF COSMETICS & PERFUMES

Max. Marks: 80
Credits: 4

Time allowed: 03 Hours

Note for Examiners and Students:

1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Section E will be of 20 marks and consists of 10 objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and 5 short answer questions of two marks each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.
Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications. (18 Hours)

SECTION-B

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination. (18 Hours)

SECTION-C

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. (12 Hours)

SECTION-D
Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone. (12 Hours)

Reference Books:

CHEM 307
CHEMICAL TECHNOLOGY & SOCIETY and BUSINESS SKILLS FOR CHEMISTRY

Max. Marks: 70
Credits: 4

Time allowed: 03 Hours

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Section E will be of 10 marks and consists of 10 objective type questions (in MCQ/true and false / fill in the blanks) of one mark each covering the entire syllabus of the paper.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A
Chemical Technology
Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology. (18 Hours)

SECTION-B
Society
Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs. (18 Hours)

SECTION-C
Business Basics
Key business concepts: Business plans, market need, project management and routes to market.

Chemistry in Industry
Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies. (12 Hours)

SECTION-D
Making money
Financial aspects of business with case studies

Intellectual property
Concept of intellectual property, patents. (12 Hours)

Reference Books:
1. www.rsc.org
2. John W. Hill, Terry W. McCreary & Doris K. Kolb, Chemistry for changing times 13th Ed.

CHEM 308
PESTICIDE CHEMISTRY & PHARMACEUTICAL CHEMISTRY
Max. Marks: 70
Time allowed: 03 Hours
Credits: 4

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Section E will be of 10 marks and consists of 10 objective type questions (in MCQ/true and false / fill in the blanks) of one mark each covering the entire syllabus of the paper.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A
General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship. (12 Hours)

SECTION - B
Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion ); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor). (15 Hours)

SECTION - C
Drugs & Pharmaceuticals Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaproxy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine). (18 Hours)

SECTION - D
Fermentation Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C. (15 Hours)

Reference Books:
1. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK
Discipline Specific Electives (DSE) Courses (CHEMISTRY)

(Two papers from Each Discipline)

(Credits: Theory-04/Practical-02)
THIRD YEAR
CHEM 301TH
POLYNUCLEAR HYDROCARBONS, DYES, HETEROCYCLIC COMPOUNDS AND SPECTROSCOPY (UV, IR, NMR)

Max. Marks: 50
Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION – A

Polynuclear Hydrocarbons:
Synthesis & reactions of Naphthalene, Anthracene & Phenanthrene. Relative reactivity of these compounds at various positions.

Synthetic dyes:
Colour and constitution [electronic concept], classification of dyes. Chemistry and synthesis of methyl orange, congo red, malachite green, crystal violet, phenolphthalein, fluorescein, alizarin and indigo. (12 Hours)

SECTION - B

Heterocyclic compounds:
Introduction: Classification and nomenclature, Molecular orbital picture & aromatic characteristics of pyrrole, furan, thiophene & pyridine. Methods of synthesis, chemical reactions with emphasis on mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine, comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five & six-membered heterocyclic compounds, preparation & reactions of indole, quinoline & isoquinoline with special reference to Fisher indole synthesis Skraup synthesis & Bischler – Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline, & isoquinoline . (16 Hours)

SECTION - C

Application of UV and IR Spectroscopy to Simple Organic Molecules
Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, $\lambda$max. & $\varepsilon$max. chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating $\lambda$max. of conjugated dienes and $\alpha$, $\beta$ – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). (16 Hours)

Section D

Nuclear Magnetic Resonance Spectroscopy:
Principle of nuclear magnetic resonance, number of signals, peak areas equivalent & non-equivalent protons, positions of signals, chemical shift. Shielding & deshielding of protons, proton counting, splitting of signals & coupling constants, magnetic equivalence of protons. Discussion of PMR spectra of molecules : ethyl bromide, n – propyl bromide, isopropyl bromide 1,1-dibromoethane 1,1,2- tribromo ethane, ethanol, toluene, acetaldehyde, acetophenone. Simple problems on PMR spectroscopy for structure determination of organic compounds. (16 Hours)
Reference Books:
3. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.

LAB COURSE
CHEM 301PR
POLYNUCLEAR HYDROCARBONS, DYES, HETEROCYCLIC COMPOUNDS AND SPECTROSCOPY (UV, IR, NMR) LAB
TIME ALLOWED: 03 HOURS
Max Marks: 20
Credits – 2

1. Separation of mixtures by chromatography: Measure the Rf value in each case. (Combination of two ions to be given) Paper chromatographic separation of Fe^{3+}, Al^{3+} and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:
   (i) tetraamminecarbonatocobalt(III) nitrate
   (ii) tetraamminecopper(II) sulphate
   (iii) potassium trioxalatoferrate(III) trihydrate
3. Colorimetry
   Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound (KMnO_4/ CuSO_4) and estimate the concentration of the same in a given solution.

Reference Books:
1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.

CHEM 302TH
INDUSTRIAL CHEMISTRY AND ENVIRONMENT
Max. Marks: 50
Credits: 4
Time Allowed: 3 Hours

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION – A

Industrial Gases and Inorganic Chemicals
Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

SECTION - B

Industrial Metallurgy
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.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond’s process. Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.


SECTION - C

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electrolysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

SECTION - D

Energy & Environment
Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydro, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis: Introduction to biocatalysis: Importance in “Green Chemistry” and Chemical Industry.

Reference Books:

LAB COURSE

CHEM 302PR
INDUSTRIAL CHEMISTRY AND ENVIRONMENT LAB

TIME ALLOWED: 03 HOURS
Max Marks: 20

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
Determination of Biological Oxygen Demand (BOD)

Percentage of available chlorine in bleaching powder.

Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO₃ and potassium chromate).

Estimation of total alkalinity of water samples (CO₃²⁻, HCO₃⁻) using double titration method.

Measurement of dissolved CO₂.

Study of some of the common bio-indicators of pollution.

Estimation of SPM in air samples.

Preparation of borax/ boric acid.

Reference Books:

CHEM 303TH
QUANTUM CHEMISTRY, MOLECULAR SPECTROSCOPY & PHOTOCHEMISTRY
Max. Marks: 50
Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION – A
Quantum Chemistry

SECTION – B
Molecular Spectroscopy
Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. 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. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. (16 Hours)

SECTION - C
Raman spectroscopy
Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.
Electronic spectroscopy
Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. **Nuclear Magnetic Resonance (NMR) spectroscopy:** Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. Electron Spin Resonance (ESR) spectroscopy: Its principle and hyperfine structure, ESR of simple radicals. **SECTION - D**

**Photochemistry**
Characteristics of electromagnetic radiation, Lambert-Beer’s law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence. (16 Hours)

**Reference Books:**

**LAB COURSE**
**CHEM 303PR**
**QUANTUM CHEMISTRY, MOLECULAR SPECTROSCOPY & PHOTOCHEMISTRY LAB**

**TIME ALLOWED: 03 HOURS**
Max Marks: 20 Credits - 2

I. Verify Lambert-Beer’s law and determine the concentration of CuSO₄/ KMnO₄/ K₂Cr₂O₇ in a solution of unknown concentration
II. Determine the concentrations of KMnO₄ and K₂Cr₂O₇ in a mixture.
III. Study the kinetics of iodination of propanone in acidic medium.
IV. Determine the amount of iron present in a sample using 1,10-phenanthroline.
V. Determine the dissociation constant of an indicator (phenolphthalein).
VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
VII. Analyse the given vibration-rotation spectrum of HCl(g)

**Reference Books**

**CHEM 304TH**
**CHEMISTRY OF TRANSITION AND INNER TRANSITION ELEMENTS, COORDINATION CHEMISTRY, ORGANOMETALLICS, ACIDS and BASES**
Max. Marks: 50 Time Allowed: 3 Hours Credits: 4

**Note for Examiners and Students:**
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A

Transition Elements (3d series) - Chemistry of elements 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 Cr,
K₂Cr₂O₇, KMnO₄, K₃[Fe(CN)₆]₃, sodium nitroprusside, [Co(NH₃)₆]Cl₃, Na₃[Co(NO₂)₆].
General group trends with special reference to electronic configuration, variable valency, colour, magnetic and
catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe
and Cu.
Lanthanides and actinides: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide
contraction, separation of lanthanides and actinides (ion exchange method only). (16 Hours)

SECTION – B

Coordination Chemistry
Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4
and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT.
IUPAC nomenclature of coordination compounds.
Organometallic Compounds
Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and
multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls.
Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor
behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic
effect to IR frequencies). (16 Hours)

SECTION - C

Crystal Field Theory
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE). Crystal field effects for weak
Comparison of CF Splitting for Octahedral and tetrahedral complexes, Tetragonal distortion of octahedral geometry.
Jahn-Teller distortion, Square planar coordination. (14 Hours)

SECTION – D

Acids and Bases
Arrhenius, Bronsted and Lowry, Lewis, Lux flood and solvent system concepts of acids and bases. Classification
of acids and bases as hard and soft. Pearson’s HSAB concept, application of HSAB principle. Relative strength of
acids and bases and effect of substituents and solvent on their strength. (14 Hours)

Books Recommended:
2. Inorganic Chemistry by T. Moeller.
5. Theoretical Inorganic Chemistry by Day & Selbin.
LAB COURSE
CHEM 304PR
CHEMISTRY OF TRANSITION AND INNER TRANSITION ELEMENTS, COORDINATION CHEMISTRY, ORGANOMETALICS, ACIDS and BASES LAB

TIME ALLOWED: 03 HOURS
Max Marks: 20
Credits: 2

1. Iodometric estimation of potassium dichromate and copper estimate.
2. Iodimetric estimation of antimony in tartar emetic.
3. Estimation of amount of available chlorine in bleaching powder and household bleachers.
4. Estimation of iodine in iodized salts
5. Iodimetric estimation of ascorbic acid in fruit juices.
8. Inorganic preparation of
   i) Potash alum
   ii) Chrome alum
   iii) tetraamminecopper(II) sulphate
   iv) potassium trioxalatoferrate(III)
   v) hexaaamin nickel(II) chloride
9. Complexometric titrations
   a) Estimation of (i) Mg$^{2+}$ or (ii) Zn$^{2+}$ by complexometric titrations using EDTA.
   b) Estimation of total hardness of a given sample of water by complexometric titration

CHEM 305TH
POLYMER CHEMISTRY

Max. Marks: 50
Credits: 4

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION - A
Introduction and history of polymeric materials:
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems. (15 Hours)

SECTION - B
Kinetics of Polymerization:
Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity:
Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Nature and structure of polymers-Structure Property relationships. (15 Hours)

SECTION - C
Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. Glass transition temperature (Tg) and determination of Tg. Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

**Polymer Solution** – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

**SECTION - D**

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polypyliophene)].

**LAB COURSE**

**CHEM 305PR**

**POLYMER CHEMISTRY LAB**

**TIME ALLOWED: 03 HOURS**

Max Marks: 20

Credits - 2

I. Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
   - Purification of monomer
   - Polymerization using benzoyl peroxide (BPO) / 2,2’azo-bis-isobutylonitrile (AIBN)
2. Redox polymerization of acrylamide
3. Precipitation polymerization of acrylonitrile
4. Preparation of urea-formaldehyde resin
5. Preparations of novalac resin/resold resin.

II. Polymer characterization

1. Determination of molecular weight by viscometry:
   - (a) Polyacrylamide-aq NaNO₂ solution
   - (b) Polyvinyl propyldiene (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of “head-to-head” monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis; Polyethylene glycol (PEG) (OH group).
5. Determination of hydroxyl number of a polymer using colorimetric method.

*At least 6 experiments to be carried out.

**Reference Books:**

CHEM 306TH
MOLECULES OF LIFE

Max. Marks: 50
Credits: 4

Time Allowed: 3 Hours

Note for Examiners and Students:
1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 10 marks each and may contain more than one part. Section E will be of 10 marks and consists of objective type questions (MCQ/true and false / fill in the blanks etc.) of one mark each covering the entire paper.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION – A

Bioinorganic Chemistry:

Essential and trace elements in biological process, metalloporphyrrinn with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metals ion with reference to Ca²⁺ and nitrogen fixation.

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). (16 Hours)

SECTION – B

Amino Acids, Peptides and Proteins
Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiodyantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (butoxy carbonyl and phthalyl) & C-activating groups and Merrifield solid phase synthesis. (16 Hours)

SECTION – C

Enzymes and correlation with drug action
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). Drug action–receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group, -NH₂ group, double bond and aromatic ring, (13 Hours)

SECTION – D

Nucleic Acids
Components of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Concept of Energy in Biosystems
and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates. (15 Hours)

**Recommended Texts:**

**LAB COURSE**
**CHEM 306 PR**
**MOLECULES OF LIFE LAB**

**TIME ALLOWED: 03 HOURS**

**Max Marks: 20**

**Credits – 2**

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Extraction of DNA from onion/cauliflower

**Recommended Texts:**