SYLLABUS
FOR
M.Sc. Chemistry
Semester (I\textsuperscript{st}, II\textsuperscript{nd}, III\textsuperscript{rd} and IV\textsuperscript{th})
(CBCS- Based)
Effective from session 2018 -20 Onwards

University Department of Chemistry
B. R. Ambedkar Bihar University,
Muzaffarpur-842001
CBCS-based syllabus for M.Sc. Chemistry (2 years) Programme

General Information:-

(1) It is two years Master Degree Programme
(2) There shall be four semester to complete programme. i.e. 1st, 2nd, 3rd and 4th semester
(3) Each semester shall consist of 15 weeks of academic work equivalent to 90 actual teaching days.
(4) This programme will have three types of courses, i.e. Compulsory Courses, Core courses and Elective courses.

Core course – The core courses are those courses whose knowledge is deemed essential for the students registered for a particular Master's degree programme.

Elective course – The elective course can be chosen from a pool of papers in IInd and IVth semester.

(5) Each course will have 100 marks in full and divided as 70 marks for End-Semester Exam and 30 marks for Internal Assessment Work except in AEC, AECC-1, AECC-2 and practical papers. Internal assessment will be in two internal exams of 10 marks each, 5 marks for seminar/internal project and 5 marks for attendance/discipline.

(6) In practical papers the distribution of marks in CIA will be same as prescribed for term end semester practical papers.

(7) A student in fourth semester can choose a generic paper or CC-5 paper of any other subject of the faculty as DSE.

Credits- A unit by which the course work is measured. It determines the number of hours of instruction required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
**M. Sc. Chemistry (Two years Course)**

**CHOICE BASED CREDIT SYSTEM**

**Course Structure**

**M.Sc. 1st Semester**

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Courses</th>
<th>Code</th>
<th>Description</th>
<th>Credits</th>
<th>Max. Marks (100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Core Course I</td>
<td>MSCCHE CC-1</td>
<td>Inorganic Chemistry -1</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Core Course II</td>
<td>MSCCHE CC-2</td>
<td>Physical Chemistry -1</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Core Course III</td>
<td>MSCCHE CC-3</td>
<td>Organic Chemistry -1</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Core Course IV</td>
<td>MSCCHE CC-4</td>
<td>Practical (Physical)</td>
<td>5</td>
<td>50+50</td>
</tr>
<tr>
<td>5</td>
<td>AECC-1</td>
<td></td>
<td>Environmental Sustainability and Swachh Bharat Abhiyan Activities</td>
<td>3+2</td>
<td>50+50</td>
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**M. Sc. 2nd Semester**

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Courses</th>
<th>Code</th>
<th>Description</th>
<th>Credits</th>
<th>Max. Marks (100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Core Course V</td>
<td>MSCCHE CC-5</td>
<td>Advances in Chemistry</td>
<td>5</td>
<td>100</td>
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<tr>
<td>7</td>
<td>Core Course VI</td>
<td>MSCCHE CC-6</td>
<td>Inorganic Chemistry-II</td>
<td>5</td>
<td>100</td>
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<tr>
<td>8</td>
<td>Core Course VII</td>
<td>MSCCHE CC-7</td>
<td>Physical Chemistry-II</td>
<td>5</td>
<td>100</td>
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<tr>
<td>9</td>
<td>Core Course VIII</td>
<td>MSCCHE CC-8</td>
<td>Organic Chemistry-II</td>
<td>5</td>
<td>100</td>
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<tr>
<td>10</td>
<td>Core Course IX</td>
<td>MSCCHE CC-9</td>
<td>Practical (Organic)</td>
<td>5</td>
<td>50+50</td>
</tr>
<tr>
<td>11</td>
<td>AEC-1</td>
<td></td>
<td></td>
<td>5</td>
<td>50+50</td>
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### M. Sc. IIIrd Semester

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<tr>
<th>Serial No.</th>
<th>Courses</th>
<th>Code</th>
<th>Description</th>
<th>Credits</th>
<th>Max. Marks (100)</th>
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<tbody>
<tr>
<td>12</td>
<td>Core Course X</td>
<td>MSCCHE CC-10</td>
<td>Application of Spectroscopy</td>
<td>5</td>
<td>100</td>
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<tr>
<td>13</td>
<td>Core Course XI</td>
<td>MSCCHE CC-11</td>
<td>Bio-inorganic Chemistry</td>
<td>5</td>
<td>100</td>
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<tr>
<td>14</td>
<td>Core Course XII</td>
<td>MSCCHE CC-12</td>
<td>Environmental Chemistry and Green Chemistry</td>
<td>5</td>
<td>100</td>
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<tr>
<td>15</td>
<td>Core Course XIII</td>
<td>MSCCHE CC-13</td>
<td>Bio- Organic Chemistry</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>16</td>
<td>Core Course XIV</td>
<td>MSCCHE CC-14</td>
<td>Practical (Inorganic Chemistry)</td>
<td>5</td>
<td>50+50</td>
</tr>
<tr>
<td>17</td>
<td>AECC-2</td>
<td></td>
<td>Human values and professional ethics &amp; gender sensitization</td>
<td>3+2</td>
<td>50+50</td>
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### M. Sc. IVth Semester

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Courses</th>
<th>Code</th>
<th>Description</th>
<th>Credits</th>
<th>Max. Marks (100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Elective Course-1</td>
<td>MSCCHE EC-1a</td>
<td>Inorganic Chemistry Special</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td>Elective Course-1</td>
<td>MSCCHE EC-1b</td>
<td>Physical Chemistry Special</td>
<td>5</td>
<td>100</td>
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<tr>
<td>20</td>
<td>Elective Course-1</td>
<td>MSCCHE EC-1c</td>
<td>Organic Chemistry Special</td>
<td>5</td>
<td>100</td>
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<tr>
<td>21</td>
<td>Elective Course-1</td>
<td>MSCCHE EC-2a</td>
<td>Inorganic Chemistry Special Practical</td>
<td>5</td>
<td>50+50</td>
</tr>
<tr>
<td>22</td>
<td>Elective Course-1</td>
<td>MSCCHE EC-2b</td>
<td>Physical Chemistry Special Practical</td>
<td>5</td>
<td>50+50</td>
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<tr>
<td>23</td>
<td>Elective Course-1</td>
<td>MSCCHE EC-2c</td>
<td>Organic Chemistry Special Practical</td>
<td>5</td>
<td>50+50</td>
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<tr>
<td>24</td>
<td>DSE-1 or GE-1</td>
<td></td>
<td></td>
<td>5</td>
<td>100</td>
</tr>
</tbody>
</table>

Candidates should choose one among the following groups: 1a & 2a or 1b & 2b or 1c & 2c
Semester - I
Core Course - I
Inorganic I

Full Marks - 70

Credits - 5

Bonding and Stereochemistry

Unit-I (a) VSEPR theory, Walsh diagram (triatomic molecules), dπ - pπ bonding. Bent rule and energetic of hybridization.

(b) M.O. diagram for hetero- nuclear di- and triatomic molecules. Bonding in Boranes, carboranes, Wades rule Anti ferromagnetic coupling.

Unit-II Magneto chemistry

e-e interaction, Term Symbols, spin orbit coupling Quenching of orbital contribution in metal complexes. Derivation of expression with small and large multiple width. Anomalous magnetic moments, magnetic properties of inner transition elements.

Unit-III Metal- Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants. Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin. Determination of formation constants by pH metery and spectrophotometry.

Unit-IV Reaction Mechanism of Transition metal complexes.

Inert and labile complexes, kinetic application of VBT and CFT, kinetics of octahedral substitution, acid hydrolysis, base hydrolysis, CB mechanism, evidences of CB mechanism, Anation reaction, reaction without M-L bond cleavage, substitution reactions in square planar complexes, The trans-effect, Theories of trans-effect, Electron transfer reactions-inner and outer sphere mechanism. Marcus-Hush theory.

Isopoly and Heteropolyacids.

Unit-V Isopoly and Heteropoly Acids and salts, Isopoly and Heteropoly acids and salts of Mo and W. structure of isopoly and heteropoly anions.
Books Recommended:

1. Concise Inorganic Chemistry - J.D. Lee
4. Introduction to ligand field - B.N. Figgis
5. Inorganic Reaction Mechanism - Basalo and Pearson
6. Chemical bonding - O.P. Agrawal/Coulson
7. Structural Principles in Inorganic Chemistry - W.E. Addison
8. Introduction the Magneto Chemistry - A. Earshaw
Semester-I  
Core Course -II  
Physical Chemistry-I

Full Marks - 70  
Credits - 5

Unit-I  Macromolecules  
Types of polymers, Kinetics and mechanisms of polymerization, 
Molecular mass-number and mass average molecular mass, 
determination of molecular mass by osmometry, viscosity and light 
scattering method.

Unit-II Electro Chemistry  
(i) Electrode potential in terms of chemical Potential and activity.  
(ii) Debye Huckel theory of conductance of electrolytic solution, its 
application and limitation.  
(iii) Quantitative treatment of Debye Huckle Limiting law and its 
modification for finite size ions, effect of ion solvent interaction on 
activity coefficients, Debye Huckle Onsager equation.  
(iv) Butle-Volmer equation under equilibrium and non equilibrium 
Exchange current densitry, Tafel Plot.

Unit-III Chemical Dynamics  
(a) Mechanism and Dynamics of consecutive and opposing reactions.  
(b) Activated complex theory of Uni-molecular reaction.  
(c) Mechanism and Dynamics of photolysis of acetaldehyde and photo 
dimerisation of Anthracene, Polymerization and Auto oxidation 
reaction. Study of fast reaction by flow method and relaxation method.

Unit-IV Chemical Thermodynamics  
(a) Partial molar properties in ideal mixture, Chemical Potential, its 
determination and variation with temperature and pressure, 
Gibbs Duhem equation.  
(b) Fugacity and activity, variation with ‘T’ and ‘P’, determination of 
Fugacity of a gas mixture, Duhem- Margules equation and its 
application.
Unit-V  Statistical Thermodynamics


Books Suggested:

1. Physical Chemistry : P.W. Atkins(ELBS)
2. Comprehensive Physical Chemistry : Hemant Snehil
3. Theoretical Physical Chemistry : Glastone.
4. Physical Chemistry : M.G. Barrow.
7. Advanced Physical Chemistry : Gurdeep Raj
Semester-I  
Core Course -III  
Organic Chemistry-I  

Full Marks -70  
Credits-5  

Unit-I  Nature of Bonding in Organic Molecules  
Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Hückel’s rule, energy level of molecular orbitals, annulenes, antiaromaticity, homo-aromaticity, PMO approach.

Unit-II Stereochemistry:  
Chirality, elements of symmetry, molecules with more than one chiral centre, diastereomerism. Determination of relative and absolute configuration. Methods of resolution, optical purity, prochirality, enantiotropic and diastereotropic atoms, groups and faces, asymmetric synthesis, conformational analysis of cycloalkanes (six membered rings), decalins, Effect of conformation on reactivity, optical activity in absence of chiral carbon (biphenyls, allenes and spirones), chirality due to helical shape, stereospecific and stereoselective synthesis. Stability and reactivity of carbocations.

Unit-III Reaction Mechanism: Structure and Reactivity:  
Unit-IV  Aliphatic Nucleophilic Substitution:

The $\text{SN}^2$, $\text{SN}^1$, mixed $\text{SN}^1$ and $\text{SN}^2$, $\text{SN}^1$ and SET mechanisms. The neighbouring group mechanisms, neighbouring group participation by $\pi$ and $\sigma$ bonds anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, Reactivity- effects of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophiles and regioselectivity. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.

Aromatic Nucleophilic Substitution: The $\text{ArSN}^1, \text{ArSN}^2, \text{P}^i$ so attack Benzyne and $\text{SRN}^1$ mechanisms. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von-Richter, Sommelet - Hauser, and Smiles rearrangements.

Unit-V  Aliphatic Electrophilic Substitution:

Bimolecular mechanisms - $\text{SE}^2$ and $\text{SE}^1$. Electrophilic substitution accompanied by double bone shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Elimination Reactions: Mechanism and orientation in pyrolytic elimination. Mechanism and application of Cope elimination, Chugaev reaction, Peterson reaction.
Books Recommendation:


\[29/13/15\]
Semester-I
Practical (Physical Chemistry)
(Core Course -IV)

Full Marks -50  Duration of Exam 6 hrs.  Credits-5  
Any one experiment-  
30 Marks  
1. Water equivalent of calorimeter and determination of  
   (i) Heat of solution of potassium nitrate  
   (ii) Heat of neutralization of strong acid and strong base.  
   (iii) Basicity of polybasic acids.  
2. Determination of rate constant of hydrolysis of methyl acetate in acid medium.  
3. The study of saponification of ethyl acetate by sodium hydroxide and determination of rate constant.  
4. To determine the distribution coefficient of  
   (i) Acetic acid  
   (ii) Benzoic acid between water and benzene by partition method.  
5. Determination of specific and molar rotation of sucrose in different concentrations and to determine the concentration of given solution.  
6. Determination of rate constant of inversion of cane sugar using polarimetric method.  
7. i) Determination of Dissociation constant of acetic acid, by conductometric titration.  
   ii) Solubility product of sparingly soluble salt.  

Viva-voce-15  
Note books-5  

AR.5/29/3/19
Semester-I
AECC-1
Environmental Sustainability and Swachchha Bharat Abhiyan Activities
Semester-II
Core Course-V
Advances in Chemistry

Full Marks - 70
Credits - 5

Unit-I Nuclear Chemistry
(a) Shell model, Liquid drop Model, Nuclear Reactions and their Types. Nuclear Reactions Cross-section.
(b) Application of radio isotopes, tracer techniques, Neutron activation analysis, isotope dilution method.

Unit-II Chemistry of Nanomaterials
Definition, sources, examples, Bottom-up Method of synthesis, Characterizations, and applications

Unit-III Solid state Chemistry
Conductor, Semiconductor, and superconductor; Theory and Application

Unit-IV Industrial Application of Chemistry
Chemistry of Cement, Paper and Pulp, and Petroleum

Unit-V Waste Management
Nuclear waste management,
e-waste management.
Recycling of plastic: (sorting, washing, shredding, identification and classification, extruding.) X delete.

Books recommended:
1. Industrial pollution: by Alka Gupta
2. Solid State Chemistry: by Smart and Moore
3. Nuclear chemistry: Sharon and Sharon
4. Solid State Chemistry and its application: Anthony R. West
5. The chemistry of nanomaterials: CNR Rag A. Muller & A.K. Cheetham
6. Nanomaterials and their application: Zheyan Husain Khan
Semester-II
Core Course-VI
Inorganic Chemistry II

Full Marks - 70


Unit-II Electronic Spectra of Transition Metal Complexes.
Spectroscopic ground states, correlation and spin-orbit coupling in free ions for 1st series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d¹⁻d⁹ states), calculation of Dq, B and β parameters. Structural evidence from electronic spectrum, Spectrochemical and nephalauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

Unit-III Symmetry in Chemistry.
Symmetry elements and symmetry operations, definition of groups, subgroup, conjugate and class. Point symmetry group. Requirements of a mathematical group, multiplication table for C₂ᵥ, C₃ᵥ

Unit-IV Group theory in Chemistry.
Representation of group by matrices. Working out representation of C₂ᵥ, C₃ᵥ point groups. Character of a representation. The great orthogonality theorem (without proof) and its importance in derivation of character table. Construction of character table for C₂ᵥ and C₃ᵥ point group.

Unit-V Metal π-complexes.
Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation. Preparation, bonding, Structure and important reaction of transition metal nitrosyls.
Dinitrogen, tertiary phosphines as ligands. Metal Carbonyl clusters- Low Nuclear Carbonyl clusters Total electron count (TEC)

**Books Recommended**

2. Inorganic Chemistry- Principles of Structure and reactivity – J.E. Huheey
3. Concise Inorganic Chemistry- J.D. Lee
5. Group Theory and its chemical applications- P.K. Bhattacharya
Semester-II  
Core Course-VII  
Physical Chemistry II

Full Marks -70  
Credits-5

Unit-I  Introduction to quantum mechanics.
   (i) Postulates of quantum mechanics, Angular momentum and Linear Operator
   (ii) Hermitian operators, properties of operators.
   (iii) Theorems of operators.

Unit-II  Exactly soluble system.
   (i) Linear Harmonic oscillator, Harmonic Vibration Hermite differential equation and its solution through recursion relation polynomial.
   (ii) H-like atoms, separation or r,θ, φ equation. Laguerre and associated Laguerre Polynomial. Legendre polynomial equation and their solution.

Unit-III  Approximate Method.
   Variation method, Secular equation, Slater determinant, Perturbation method, first order perturbation Application to He-atom. Symmetric and antisymmetric wave functions.

Unit-IV  Huckel Molecular Orbital Theory.
   Huckel theory of conjugated systems, bond order and charge density its calculation. Application to ethylene, butadiene, allyl and benzene

Unit-V  Chemical Bonding
   LCAO-MO theory, application of LCAO-MO theory to H₂⁺ ion and H₂ molecule
Recommended

Book Suggested:
1. Quantum chemistry : I.R. Lavine Prentiiee Hall
2. Quantum chemistry : Pillar
3. Quantum chemistry : R.K. Prasad
4. Quantum chemistry : Satya PrakashSwati Saluja
7. Introduction to quantum Chemistry : A.K. Chandra, Tata

A.R. 29/01/19
Semester-II  
Core Course-VIII  
Organic Chemistry II  

Full Marks -70  
Credits-5  

Unit-I  
**Addition to Carbon-Carbon Multiple Bonds:**  
Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydroboration Michael reaction. Sharpless asymmetric epoxidation.  

**Free Radical Reactions**  
Allylic halogenations (NBS), oxidation of aldehydes to carboxylic acids auto-oxidation, coupling of alkynes, Free radical rearrangement Hunsdiecker reaction.  

Unit-II  
**Photochemistry of carbonyl compounds.**  
Photochemistry of enones, hydrogen abstraction. Rearrangements of $\alpha,\beta$ unsaturated ketones and cyclohexadienones, photochemistry of $p$-benzoquinones.  

**Photochemistry of unsaturated system**  
Olefins, cis-trans isomerisation, dimerisation hydrogen abstraction and additions. Acetylenes-dimerisation, dienes-photochemistry of 1, 3-butadiene (2+2) additions leading to cage structures, photochemistry of cyclohexadienes, photochemistry of aromatic compounds-exited state of benzene and its 1,2 and 1,3-shifts, Photo-Fries rearrangement, Photo-Fries reacton of anilides, photosubstitution reaction of benzene derivatives, Photolysis of nitride esters and Barton reaction.  

Unit-III  
**Pericyclic Reactions**  
Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1,3,5-hexatriene and ally1 system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams, FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, 4n, $4n+2$ and allyl systems. Cycloadditions-anrafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleopticrptic rections.
Sigmatropic rearrangement

Suprafacial and antarafacial shift of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, (3,3) and (5,5) sigmatropic rearrangements detailed treatment of Claisen and Cope-rearrangements. Aza-Cope rearrangements. Introduction to Ene reactions. Simple problems on pericyclic reactions.

Unit-IV Carbohydrate

Conformation of monosaccharides and important derivatives of monosaccharide- glycosides, deoxysugar, aminosugar. Structure determination and chemical synthesis of sucrose, and maltose.

Unit-V Amino acids, peptides and proteins

Semester-II
Core Course – IX
Practical (Organic Chemistry)

Full Marks-50  Duration of Exam 6 hrs.  Credits-5

1. **Quantitative Analysis**
   Separation and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.  15 Marks

2. **Organic Synthesis via two steps preparation**  15 Marks
   a. β-Nitroaniline from acetanilide.
   b. β-Bromoaniline from acetanilide
   c. β-Anthranilic acid from phthalic anhydride.
   d. β-Bromoacetanilide from aniline.
   e. β-Nitroacetanilide from aniline.
   f. β-Aminoazo benzene from aniline.

3. Viva Voce  15 Marks
4. Note Book  05 Marks

**Books Recommendation:**

1. Advanced Practical Chemistry by Jagdamba Singh, L.D.S Yadav and Jaya Singh
2. Systematic Qualitative Organic Analysis by H. Middleton.
3. Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark.

29/12/19
Semester-II
AEC-1

Unit-I: Rotational Spectroscopy

Qualitative discussion of rotational energy and interaction of molecule with rotors. Consideration of energy and rotation, dipole moment, and linearity of symmetric and asymmetric rotors. Interaction of nuclear spin and electronic spin in rotational spectra.

Unit-II (A): Vibrational Spectroscopy


Unit-III: Photoelectron Spectroscopy


Unit-IV: Magnetic Resonance Spectroscopy

Nuclear magnetic resonance, chemical shift, and hyperfine coupling. Principles of EPR spectroscopy, presentation of spectra, theory of hyperfine interactions, and line widths.
Semester –III  
Core Course-X  
Principles & Applications of Spectroscopy

Full Marks-70  
Credits-5

Unit-I  Rotational Spectroscopy

Quantization of rotational energy and interactions of radiation with rotators. Classification of rotators; rigid rotator and Non-rigid rotator linear, symmetric and asymmetric rotators, isotopic effect, stark effect, effect of nuclear spin, and electron spin on rotational spectra, Bond length calculations.

Unit-II (A) Vibrational Spectroscopy

Harmonic oscillator model, harmonic and jharmonic vibration, Normal vibration, Factors affecting vibration frequencies, vibrating rotators, P.Q.R. Branches, overtones, anharmonicity constant, Raman effect, stokes and antistokes lines, selection rules for IR and Raman spectra, Principal of mutual exclusion. Polarization of Raman Lines.

Unit-III  Photoelectron Spectroscopy

Basic principles of photoelectric effect, ionization process, Adiabatic and vertical ionization energy, PESOS(UV-PES) and PESIS (XPES or ESCA). Chemical shift in ESCA. Chemical information from ESCA. Instrument and Techniques of Photoelectron Spectroscopy. Atomic electron spectra of inert gases. Comparison of Photo-electron spectra of Ar, Kr, Xe. Photo-electron spectra of $\text{H}_2$, $\text{O}_2$, $\text{N}_2$ and NO, HBr. XPES or ESCA of Furan, Pyrrole and Thiophene. Zero kinetic energy, Photoelectron Spectroscopy, Auger Spectroscopy(AES), Scanning Auger Microprobes(SAM). Microscopic Technique : SEM, TEM, STEM, Focus ion beam Spectroscopy(FIB). Electron Microscope Koopman's theorem.

Unit-IV  Magnetic Resonance Spectroscopy

Nuclear magnetic resonance, chemical shift of factors controlling its value spin-spin interaction and factors affecting its value. Spin Lattice relaxation and quantitative treatment of relaxation, selection rule and relative intensities of line. Principle of ESR spectroscopy, presentation of spectrum, theory of hyperfine, interaction, Isotopic g and $\Delta$ values.

24
Nuclear quadrupole resonance spectroscopy. Basic Concepts of NQR. Electric field gradient, NQR frequency for $N^{14}$ (I=1) $B^{11}$ (I =3/2), $^{27}$AL(I=5/2). Nuclear quadrupole coupling constant.

Unit-V Applications of Spectroscopy

(A) UV-Visible Spectroscopy
Spectra of carbonyl compounds and conjugated polyenes, Woodward-Fisher rules, aromatic and heterocyclic compounds, and steric effect in diphenyls, quantitative determinations.

(B) Vibrational Spectroscopy
Organic effect of conjugation, resonance inductive effect, ring strain and hydrogen bonding on group frequencies and band shapes.
Inorganic: Changes with vibrational frequencies upon coordination, cases of linkage isomers, I.R. and Raman active form of vibrational geometry of $AB_2$, $AB_3$, $AB_4$, and $AB_5$. Hydrogen bonding.

(C) PMR and CMR Spectroscopy
Chemical shifts value and correlation for proton-bonded with carbon. Effect of chemical exchange on line width, coupling constants, Interpretation of PMR and CMR spectra of organic compounds. Double resonance application of $^{19}$F and $^{31}$P spectra of inorganic compounds.

(D) Mass Spectrometry Ion production and Fragmentation, molecular ion peak, Metastable peak, Mc. Lafferty rearrangement. Examples of mass spectra of organic compounds.
Book Suggested


AP. 29/3/19
Semester –III
Core Course-XI
Bio-Inorganic Chemistry

Full Marks-70
Credits-5

Unit-I   Metal Ions in Biological Systems
Essential and trace metals. Na+/K+ Pump, Role of metal ions in biological processes. Toxicity of heavy metals and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut.

Unit-II   Bioenergetics and ATP Cycle
DNA polymerization, glucose storage, metal complexes in transmission of energy, chlorophylls, photosystem-I and photosystem-II in cleavage of water, Model system.

Unit-III  Transport and Storage of Dioxygen
Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, hemocyanics and hemerythrin, model synthetic complexes of iron, cobalt and copper.

Unit-IV  Electron Transfer in Biology
Structure and function of metalloproteins in electron transport processes- cytochromes and ion-sulphur proteins, synthetic models.

Nitrogenase
Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model system.

Unit-V   Metals in Enzyme and Medicine
The biochemistry of zinc, cobalt, nickel and molybdenum: Transport of Zinc, carbonic anhydrase, carboxypeptidase, alcohol dehydrogenase, Adenosyl cobalmine as a coenzyme. Ribonucleotide reductase, Methylcobalmine and cyano cobalmine as a co-factor, Nickel in urease, Hydrogenase, Molybdenum hydroxylase, Xanthine oxidase, Sulphite oxidase, nitrate reductase.
Biochemical basis of essential metal deficient diseases., Iron copper and Zinc deficiency and their therapies, Carcinogens and carcinostatic agent, Zinc in tumors growth and inhibital anticancer activity and Mechanism of platinum, Rhodium, copper and Gold complexes.

Books Recommend:


29/3/19
Semester-III  
Core Course-XII  
(Environmental Chemistry and Green Chemistry)  
Full Marks-70  
Credits-5  

Unit-I Environment  

Unit-II Hydrosphere  
Chemicals compositions of water bodies-lakes, streams, rivers, and wet lands etc. hydrological cycle, Aquatic Pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand (BOD), Solids, metals, content of chloride, sulphate, phosphate, nitrate and microorganism. Water quality standards. 
Analytical methods for measuring BOD, DO, COD, F, Oils, Metals (As, Cd, Cr, Hg, Pd, Se, etc.). Residual chloride and chlorine demand. Purification and treatment of waste water.

Unit-III Atmosphere  
Unit-IV Green Chemistry: Definition and Objective

The twelve principles of Green Chemistry, atom economy in chemical synthesis, important techniques employed in practice of Green Chemistry, Application of microwave irradiation and ultrasound in chemical reactions. Use of renewable raw materials and biosynthesis, organic waste management, use of safer reagents green solvents and green catalysts.

Unit-IV Green Chemistry: Real Applications

Replacement of CFC and hydrocarbon blowing agents with environmental friendly blowing agent CO$_2$ in the production of polystyrene. Replacement of Ozone depleting and Smog producing solvents by surfactant assisted liquid or supercritical carbon dioxide for cleaning in manufacture of ICs and Computer chips.

Books Suggested

3. Environmental Chemistry S.F. Manahan, Lewis Publishers
Unit-I Enzymes

Basic considerations, Proximity effects and Molecular adaption. Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity extraction and purification. Fischer's lock and key and Koshtand's induced fit hypothesis, concept and identification of active site by the use of inhibitors. Affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweave- Burk plots. Reversible and irreversible Inhibition.

Unit-II Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, lysozyme and carboxypeptidase A.

Unit-III Reactions Catalysed by Enzymes


Unit-IV Co-Enzyme Chemistry

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes, Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD, NADI, FMN,
FAD, Lipole acid, vitamin B12, Mechanisms of reactions catalyzed by the above cofactors.

**Unit-V Bioenergetics and Protein Metabolism**


**Books Recommend:**

1. Understanding Enzymes- Trevor Palmer, Prentice Hall.
2. Enzyme Chemistry - Impact and Application, Ed.- Collin J. Suckling, Chapma and Hall.
5. Immobilized Enzymes- An Introduction and Applications in Biotechnology, Michael O. Trevan, John Wiley.
Semester-III
Core Course-XIV
Practical (Inorganic Chemistry)

Full Marks-50        Duration of Exam 6 hrs.        Credits-5

1. Quantitative analysis of two constituent ions of the following. 15
   (a) Cu, Zn, (b) Fe, Ni (c) Ca, Mg (d) Al, Mg the cations
       Mg$^{2+}$, Ca$^{2+}$ and Al$^{3+}$ can be estimated using EDTA.

2. Green methods of preparation of the following complexes and their study
   by IR, electronic spectra and T.G.A. 15
   (a) Pot trioxalato ferrate (III)
   (b) Pot trioxalato chromate(III)
   (c) Chromus Acetate
   (d) Hg[Co(SCN)$_{4}$]
   (e) Hexa ammine Ni (II) chloride

3. Qualitative analysis of inorganic mixture containing six radicals including
   interfering radicals 15

4. Viva-voce 15

5. Note Book 5

Books Recommend:

1. A text Book of Quantitative Inorganic Analysis- A.I. Vogel
2. Applied Analytical chemistry- O.P. Vermani
Semester-III
AECC-2
Human values and professional ethics & gender sensitization

Unit-I: Allylic and allyloxide reactions
Organocopper reagents in organic synthesis

(i) Compounds of transition metals: carbon multiple bonds
Alkyne, allylic, allyloxy, olefinic, and conjugated ylides

Unit-II: Heterocyclic Compounds
Structures and reactions of heterocyclic compounds

Unit-III: Halogenoalkanes and ethers
Introduction to halogenoalkanes and ethers

Unit-IV: Alkaloids in Medicinal Chemistry
Introduction, basic characteristics, interactions with receptors

(n) Photobiology of metal complexes
Basic principles of photosynthesis, properties of photosensitive metal complexes

34
Semester-IV
Elective Course-1a
Inorganic Chemistry Special

Full Marks-70
Credits-5

Unit-I (A) Alkyls and aryls transition metals
Types, routes of synthesis, stability and decomposition pathways,
Organocopper in organic synthesis.

(B) Compounds of transition metal-carbon multiple bonds.
Alkylidenes, alkylidylenes, low valent carbenes and carbynes synthesis, nature of
bond, structural characteristics, Nucleophilic and electrophilic reactions on the
ligands, Roles in organic synthesis. Fluxional organometallic compounds,
Fluxionality and dynamic equilibria.

Unit-II Transition metal \(\pi\)-complexes.
Transition metal \(\pi\) complexes with unsaturated organic molecules
alkenes, alkynes, allyl, diene, dienyl, arene trienyl complexes, their
structural features and important nucleophilic and electrophilic
reactions.

Unit-III Homogeneous Catalysis.
Stoichiometric reactions for catalysis, homogeneous catalytic
hydrogenation, Zeigler Natta polymerization of olefins, catalytic
reactions involving CO, e.g. hydro-carbonylation of olefins, (oxo
reaction)], oxopalladation reactions, activation of C-H bond.

Unit-IV (A) Supramolecular Chemistry
Introduction, Non covalent interactions, self-assembly in
supromolecular chemistry, Reactivity and catalysis design and
synthesis, transport processes and carrier design.,
supramolecular devices.

(B) Photo chemistry of metal complexes.
Basis of photochemistry, properties of excited states, excited states
of metal complexes and their comparison with organic compounds.
Photo- substitution, photo-oxidation and photo-reduction, Excited electron transfer, Reactions of 2, 2-bipyridines and 1, 10 phenanthroline complexes, metal complexes sensitizers, Application of photochemical reactions of co-ordinance compounds.

Unit-V  (A) Molecular rearrangement

D and A process, reactions of geometrical and optical isomers, optical inversions, isomerisation and recemisation of octahedral complexes, intermolecular and intramolecular rearrangement.

(B) Spectroscopic Application: Application of Mossbauer and ESR spectroscopy in elucidation of structure of inorganic molecule.

Books Recommend:

1. Organometallic Chemistry- Ayodhya Singh and Ratnesh Singh
2. Organometallie Chemistry- RC.Mehrot and A. Singh
3. The Organometallic Chemistry of transition metals- Robert H. Crabtree
4. Organometallic Compounds- Indrajit Kumar.
5. Supramolecular chemistry- concept and perspective- J.M. Lehn
6. Introduetion to Supramolecular chemistry- Hiclena- Dodziuk
7. Supramolecular chemistry Norendra N. Ghosh.
8. Photochemistry- Carle E. Wayne and Richard P. Wayne
9. Inorganic chemistry- Gary Walsberg
11. Inorganic Chemistry -G.L. Miessier and D.A. Tarr
12. Advanced Inorganic chemistry -Cotton and Wilkinson T.
Unit-I (A) Hartree Fock Theory:

Born oppenheimer approximation. Salter-Condon rule, Hartree-Fock equation, Koopman theory.

(B) Semi Empirical Theories

HMO Theory of π systems. Bond order, Free valence and charge density, and its calculation. Extended Huckle theory,

Unit-II Catalysis and Oscillatory Behaviour

Kinetics of catalytic reaction, Arrhenius intermediates, vant-Half intermediates, Theory of acid-base catalyst, Bronsted catalysis law, Hammet equation, Oscillatory reactions.

Unit-III (A) Kinetics of condensed phase Reaction.


(B) Study of Fast reactions.

Flash Photolysis, relaxation techniques, Molecular beam and shock Tube kinetics, stop flow method.

Unit- IV Kinetics of Electrode reactions.

Faradic and non-faradic current rate law in faradic process, current density, factors affecting electrode-reaction, Effect of double layer structure on electrode reaction rates.
Unit-V (A) Corrosion

Scope and economic of corrosion, causes and types of corrosion, electrochemical theories of corrosion, Method of protecting the corrosion

(B) Thermodynamics of solids

Specific heat of solids, Einstein heat capacity equation Debye theory of specific heat.

Books Suggested.

1. Physical chemistry : P.W. Atkins
2. Advance Physical chemistry : Gurdeep Raj
Semester-IV
Elective Course-1c
Organic Chemistry Special

Full Marks-70

Unit-I Terpenoids

Introduction, classification, isoprene rule and special isoprene rule.
Structural determination, stereochemistry and synthesis of citral, α-
Terpeniol, camphor, santonin

Unit-II Alkaloids

Introduction, classification, general method of structure determination.
Structure and synthesis of the following compounds- Papaverine,
Nicotine, Atropine and Morphine.

Unit-III Drug Design

(a) Introduction, classification of drugs. Development of new drugs.
   Receptor. Theories of drug activity with emphasis on Drug-
   receptors interactions.

(b) Application of Mass, IR, UV-Visible, NMR (¹H & ¹³C) in elucidation
   of structure of organic molecules.

Unit-IV Drugs

1. Antineoplastic Agents: Introduction, Cancer chemotherapy, role of
   alkylating agents, antimetabolites, natural products and hormones in
   treatment of cancer. Synthesis of mechlorethamine, cyclophosphamide,
   uracil-mustards, 6- mercaptopurine, melphalan.

2. Cardiovascular Drugs: Cardiovascular disease, drug inhibition of
   peripheral sympathetic function, direct acting arteriolar dilators.
   Synthesis of amyl nitrate, hydrolaxine verapamil, diazoxide propanol,
   sorbitrate, quinidine, Methyldopa, atenolol and oxyprenolol.

3. Anti-tubercular Drugs: PAS, Isoniazid, Ethambutol Thiosemicarbozone,
   Rifampcin.

[Signature: A.R.A.
Date: 29/3/19]
Unit-V Heterocyclic Compounds

1. Benz fused five membered heterocyclic compounds: Classification, nomenclature of aromatic heteroatoms: Synthesis and reaction of benzopyrole, benzofuran, benzothiophene.

2. Five and Six membered Heterocycles with two or more heteroatoms: Synthesis and reaction of oxazole, isooxazole, pyrazole, imidazole, thiazole, diazine and tetrazines.

3. Seven and large membered Heterocycles with two or more heteroatoms: Synthesis and reaction of azepines, oxeepines, diazeepines, azocines and thiapines.

Books Recommend:

1. Natural Products-Chemistry and Biological Significance by J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne.
3. Rodds Chemistry of Carbon Compounds by S. Coffey.
4. Natural Products Chemistry by Jagdamba Singh and Jaya singh.
5. The Chemistry of Natural Products by P.S. Kalsi.
6. Chemistry of Natural Products by Nakamshi.
7. An Introduction to Medicinal Chemistry by Graham L. Patrick.
10. Burgers Medicinal Chemistry and Drug Discovery by M.E. Wolft
11. Heterocyclic Chemistry by RR. Gupta, M. Kumar and V.Gupta.
Semester-IV
Elective Course (P) 2a
Practical (Inorganic Chemistry Special)

Full Marks – 50
Duration of Exam 12 hrs.
Credit – 5

1. Qualitative analysis of Inorganic mixture containing six radicals including Mo, V, W, Ce
   15
2. Analysis of atleast two metal ions in alloys and minerals
   (a) Dolomite (b) Brass (C) Solder (d) Bauxite
   15

OR

Spectrophotometric determination of Fe, Ni, Mn, Cr, V, Ti, F, $\text{NO}_3^-$, and $\text{PO}_4^{3-}$ etc,

3. Viva- Voce
   15
4. Record File
   5

Books Recommended:

1. Qualitative Analysis – A. I. Vogel
2. Quantitative Analysis – A. I. Vogel

ARS
29/5/19
Two experiments have to be set.

1. Conductometric titration of strong acid and strong base (NaOH+HCl)
2. Potentiometrically, pH of a given solution using hydrogen electrode or quinhydrone electrode.
4. Determination of partition coefficient of iodine between CCl$_4$ and water.
5. Determination of partition coefficient of KI$+I_2 = KI_3$ between CCl$_4$ and water.
6. Viva- voce -15
7. Note Book -5
Any two experiments have to be set (Marks 30)

1. Separation and identification of organic compounds using chemical methods from organic mixtures containing up to three components

2. Preparation of organic compounds involving several stages


4. Vivo Voce

5. Note Book

Full Marks - 50

Credits - 5

Duration of Exam 12 hrs.

15 Marks

05 Marks

29/3/19
SYLLABUS
FOR
M.Sc. Chemistry
Semester (I<sup>st</sup>, II<sup>nd</sup>, III<sup>rd</sup> and IV<sup>th</sup>)

Effective from session 2019 Onwards

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