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MARATHWADA UNIVERSITY, AURANGABAD**



NAAC Reaccredited with 'A' Grade

**Ph.D. Entrance Test 2020**

**Syllabus of Paper II**

**Subject: Chemistry**

Unit. No.	Name of the Unit	Detailing
01	<b>Research Methodology</b>	<p><b>Foundation of research:</b> Meaning of research, objectives, motivation, types of research, significance and approach of research, characteristic of scientific research, research process, criteria of good research, utility. Understanding the language of research, variable research process.</p> <p><b>Defining of research problem:</b> Definition, identification and formulating the research problem, necessity of defining the problem, techniques involved on defining a problem, Importance of literature review in defining a problem.</p> <p><b>Hypothesis:</b> Characteristics of hypothesis, concept of testing of hypothesis, procedure of hypothesis testing, important parametric tests for hypothesis, Logic &amp; importance.</p> <p><b>Research Design:</b> Meaning &amp; need of research design, Features of a good research design, concept relating to research design, Exploratory research, Descriptive &amp; diagnostic research, Basic principles and importance of experimental design, Formal &amp; Informal experimental designs. Qualitative and Quantitative Research.</p> <p><b>Interpretation of data and Paper writing :</b> Layout of a Research Paper, Journals in Chemistry, Impact factor of journals, citation index, When and where to be publish?, Plagiarism</p> <p><b>Ethics of Scientific Publication:</b> Primary ethics of scientific publication, Author responsibilities before and after publication, responsibilities during the peer-review process. Editorial ethics. Use of Encyclopedias, Academic databases for Concerned discipline.</p> <p><b>Use of Tools / Techniques for Research:</b> Roll of computer in research, Methods to search required information effectively, Reference Management Software for paper formating like LaTeX / MSOffice, software for detection of Plagiarism.</p>

		<p><b>Application of Results and Ethics:</b> Ethics of research, Ethics in science governance, Environmental impacts, Ethical issues – ethical Committees, Commercialization, Copy right, Royalty, Intellectual property rights and Patent law, Reproduction of published material - Plagiarism, citation and acknowledgement, Reproducibility and accountability.</p> <p><b>Reporting and Thesis writing:</b> Structure and components of scientific reports and thesis, Significance of Different steps in the preparation, Structure and Language of typical reports, Illustrations and tables, Bibliography, referencing,</p> <p><b>Oral presentation:</b> Preparation and Practice, Making presentation, Use of visual aids, Importance of effective communication.</p>
02	<b>Instrumental Techniques</b>	<p><b>Spectroscopy:</b> Combined applications of IR, UV- Vis, <math>^1\text{H}</math> NMR, <math>^{13}\text{C}</math> NMR and Mass spectroscopic techniques for structural elucidation of compounds.</p> <p><b>Electron spin resonance spectroscopy :</b> Principle, ESR spectrum, zero field splitting, hyperfine splitting, Kramer 's degeneracy Anisotropy in hyperfine coupling, factor affecting the magnitude of 'g' values, applications.</p> <p><b>Mossbauer spectroscopy:</b> Principle, isomer shift &amp; quadrupole splitting of simple iron &amp; tin compounds, applications.</p> <p><b>Separation techniques:</b> distillation and solvent and solid phase extraction.</p> <p><b>Chromatographic techniques:</b> Thin Layer Chromatography, Column Chromatography, Ion- exchange Chromatography, Gas Chromatography, HPLC, Liquid-liquid partition and Gel permeation.</p> <p><b>Titrations:</b> conductometric, potentiometric, pH metric, polarometric, amperometric, high frequency titrimetric and their applications.</p> <p><b>Thermogravimetric techniques :</b>TGA, DTA, DSC.</p> <p><b>Data analysis:</b> Mean and standard deviation, absolute and relative errors, linear regression, covariance and correlation coefficient.</p>
03	<b>Inorganic Chemistry</b>	<p><b>Periodic table and atomic properties :</b> Periodicity of elements and its significance, electronic configuration of atoms, Classification of element into s, p, d &amp; f block, atomic properties, size of atom and ions, ionization energy, electron affinity, electronegativity, periodic trends, percent ionic character.</p> <p><b>Molecular symmetry and group theory :</b> symmetry elements and symmetry operations, point groups, product of symmetry operations, character tables, Mulliken symbols, reducible and irreducible representations, direct product representations and applications.</p> <p><b>Chemical bonding :</b> Structure and bonding in homonuclear and heteronuclear diatomic molecules, shapes of polyatomic molecules, Concept of hybridization, VSEPR Theory.</p>

		<p><b>Acids and bases</b> : Bronsted and Lewis acids and bases, <math>pH</math>, <math>pK_a</math>, Hard-Soft acid base concept, buffer solution, concept of Non-aqueous solvents.</p> <p><b>Redox reaction</b> : oxidation number, redox reactions, redox potential, electrochemical series, redox indicators.</p> <p><b>Transition elements and coordination compounds</b>: , IUPAC nomenclature, Valence bond theory, crystal field theory, molecular orbital theory, ligand field theory, spectroscopic term symbols, microstates, Orgel and Tanabe sugano diagrams, charge transfer transitions, interpretation of electronic spectra of metal complexes. diamagnetic, paramagnetic, ferromagnetic and antiferromagnetism properties. Inorganic reaction mechanisms, ligand substitution reactions, trans effect, acid hydrolysis, factor affecting the acid hydrolysis, base hydrolysis, conjugate base mechanism. Stability constant of complexes, stepwise and overall formation constant &amp; its determination. Inner and outer sphere electron transfer reactions in metal complexes, Iso and heteropoly acids.</p> <p><b>Chemistry of Lanthanides and actinides</b> : spectral and magnetic properties, use of lanthanide compounds as a shift reagents.</p> <p><b>Organometallic chemistry of transition elements</b>: Hapticity, synthesis, structure, bonding and reactivity of sigma and pi- bonded compounds, carbene and carbyne transition metal complexes, Organometallics in homogeneous catalysis, hydrogenation of alkenes, hydrosilation reaction, hydroformulation of alkenes, Ziegler Natta polymerization, Fischer tropch process, Water gas shift reaction, Wacker process, Monsanto process.</p> <p><b>Chemistry of Non-transition elements</b>: General discussion on the properties of nontransition elements, synthesis , properties ad structure of their halides and oxides, polymorphism of carbon, phosphorus and sulphur. Synthesis , properties and structure of boranes, carboranes, borazines, phosphazenes, Silicates, carbides, silicones, oxyacids of nitrogen, phosphorus, sulphur and halogens. Interhalogen , pseudohalides and nobl gas compounds. synthesis, structure &amp; bonding and properties of metal carbonyls, metal nitrosyl compounds , Noncarbonyl metal clusters.</p> <p><b>Nuclear chemistry</b>: Nuclear models, mass defect, binding energy, nuclear fission and fusion, radioactivity, nuclear reactions, Q-value, radioactive techniques, tracer technique, neutron activation analysis, GM counter.</p> <p><b>Solids</b> : Dislocation in solids, Schottky and frenkel defects, electrical properties, Insulators, and semiconductors.</p> <p><b>Bioinorganic chemistry</b>: Metal ions in biological systems and its</p>
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		<p>functions, photosystems, metalloenzymes, oxygen transport, electron-transfer reactions, nitrogen fixation, metal complexes in medicine.</p> <p><b>Nanomaterials</b> : Chemical, Physical and biological methods for synthesis of nanomaterials, Characterization techniques, properties and applications of nanomaterials.</p>
04	<b>Organic Chemistry</b>	<p><b>Nomenclature:</b> IUPAC Nomenclature of Simple Organic Compounds.</p> <p><b>Aromaticity:</b> Huckel's rule and concept of aromaticity: annulenes and heteroannulenes.</p> <p><b>Stereochemistry:</b> Configurational and conformational isomerism in acyclic and cyclic compounds, stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.</p> <p><b>Common Organic Reactions and Mechanisms:</b> Nucleophilic, electrophilic, radical substitution, addition and elimination reactions.</p> <p><b>Familiar named reactions:</b> Aldol, Perkin, Stobbe, Dieckmann, Favorskii, Hoffmann, Schmidt, Lossen, Curtius, Beckmann, Fries, Michael addition, Mannich, Baeyer-villiger, Suzuki Coupling, Reimer-Tiemann, Reformatsky, Grignard reactions, Diels-Alder reaction, Claisen, Friedel- Crafts reaction, Wittig, Vilsmeier-Hack reaction. Hydroboration, Oppenauer oxidation, Clemmensen, Wolf-Kishner, Meerwein-Ponndorf Verley and Birch reductions.</p> <p><b>Organic transformations and reagents:</b> complex metal hydride, Gilman reagent, lithium dimethyl cuprate (LDC), lithiumdisopropylamide (LDA), dicyclohexylcarbodiimide (DCC), 1,3-dithiane, trimethylsilyliodide, tri-n-butyltin hydride, Woodward Prevost hydroxylation, Osmium tetroxide, DDQ, Selenium dioxide, Wilkinson's catalyst, Phase transfer catalysts, Crown ethers &amp; Merrifield resin, Baker yeast, <math>\beta</math>-cyclodextrin.</p> <p><b>Heterocyclic Chemistry:</b> Synthesis and reactivity of furan, thiophene, pyrrole, indole, quinoline &amp; isoquinoline.</p> <p><b>Retrosynthesis:</b> disconnection, synthons, umpolung of reactivity and protecting groups.</p> <p><b>Pericyclic Chemistry:</b> Selection rules and stereochemistry of electrocyclic reactions, cycloaddition and sigmatropic shifts, Sommelet-Hauser, Cope and Claisen rearrangements.</p> <p><b>Photochemistry:</b> Principles and applications of photochemical reactions in organic chemistry.</p> <p><b>Chemistry of natural products:</b> Methods of structure elucidation and biosynthesis of alkaloids, terpenoids, steroids, carbohydrates and proteins, Conformations of proteins and nucleic acids.</p> <p><b>Green Chemistry:</b> Concepts of green chemistry, twelve principles of green chemistry, atom economy, E-factor.</p>

05	<b>Physical Chemistry</b>	<p><b>Basic principles of quantum mechanics:</b> Postulates, operator algebra, exactly-solvable systems, particle-in-a-box, harmonic oscillator and the hydrogen atom.</p> <p><b>Approximate methods of quantum mechanics:</b> Variational principle, perturbation theory up to second order in energy, applications.</p> <p><b>Chemical Bonding:</b> In diatomics; elementary concepts of MO and VB theories, Huckel theory for conjugated <math>\pi</math>-electron systems.</p> <p><b>Chemical Thermodynamics:</b> Laws, state and path functions and their applications, thermodynamic description of various types of processes, Maxwell's relations, spontaneity and equilibria, temperature and pressure dependence of thermodynamic quantities, Le Chatelier principle, elementary description of phase transitions, phase equilibria and phase rule, thermodynamics of ideal and non-ideal gases, and solutions.</p> <p><b>Statistical Thermodynamics:</b> Boltzmann distribution, kinetic theory of gases, partition functions and their relation to thermodynamic quantities – calculations for model systems.</p> <p><b>Electrochemistry:</b> Nernst equation, redox systems, electrochemical cells, Debye-Huckel theory, electrolytic conductance-Kohlrausch's law and its applications, ionic equilibria, conductometric and potentiometric titrations.</p> <p><b>Chemical kinetics:</b> Empirical rate laws and temperature dependence, complex reactions, steady state approximation, determination of reaction mechanisms, collision and transition state theories of rate constants, unimolecular reactions, enzyme kinetics, salt effects, homogeneous catalysis, photochemical reactions.</p> <p><b>Colloids and surfaces:</b> Stability and properties of colloids, isotherms and surface area, heterogeneous catalysis.</p> <p><b>Solid state:</b> Crystal structures; Bragg's law and applications; band structure of solids.</p> <p><b>Molecular spectroscopy:</b> Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities-selection rules; basic principles of magnetic resonance.</p>
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### Reference Books:

#### Unit 01: Research Methodology

1. Research Methodology - C. R. Kothari
2. Practical Research Methods - Catherine Dawson
3. Research Methodology : An Introduction - Stuart Melville and Wayne
4. Handbook on Intellectual Property right in India- Rajkumar S. Adukia

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5. How to Write a Good Scientific Paper – Chris A Mack
  6. Writing Scientific Research Articles Strategy and steps- Margaret Cargill , Patrick O'Connor
  7. Basics of research paper writing and Publishing ; Michael Derntl; Int. J. Technology Enhanced Learning ; 6(2), 105, 2014
  8. Ethics in Science Education, Research and Governance; ; INSA New Delhi - Kambadur Muralidhar , Amit Ghosh, Ashok Kumar Singhvi

### **Unit 02: Instrumental Techniques**

1. Fundamental of Analytical Chemistry- West Hollar, Couch 8<sup>th</sup> Edn. Skoog,.
2. Analytical Chemistry , 6<sup>th</sup> Edn - G.D. Christian
3. Chemical Separations and Measurements, - D.G. Peters, J.M. Hayes and G. M. Hieftie.
4. Instrumental Method of Chemical Analysis - G.R. Chatwal and S.K. Anand
5. Instrumental Methods of Chemical Analysisb - B.K. Sharma
6. Organic Spectroscopy- P.S. Kalsi
7. Spectroscopic Methods in Organic Chemistry - D.H. Williams and I. Fleming
8. Spectrometric Identification of Organic Compounds - R.M. Silverstein, Morrill and G.C. Bassler
9. Introduction to Spectroscopy - Pavia, Lampman and Kriz.
10. Research Techniques in Organic Chemistry - Robert B. Bates and John P. Schaefer, Prentice-Hall, Inc. Englewood Cliffs, N.J. 1971.
11. Coordination Chemistry - E Martell
12. Structural method in Inorganic Chemistry – E A V Ebsworth , D. W. H. Rankin
13. Physical methods in inorganic chemistry - R. S. Drago

### **Unit 03: Inorganic Chemistry**

1. Inorganic chemistry - Catherine E. Housecroft and Alan G. Sharpe
2. Inorganic chemistry - J. D. Lee
3. Inorganic chemistry - Atkins, Overton, Rourke, Armstrong, Hagerman
4. Textbook of inorganic chemistry: A modern approach - P. L. Soni
5. Principles of inorganic chemistry - B. R. Puri, L. R. Sharma, K. C. Kalia
6. Text book of coordination chemistry - R. K. Sharma
7. Principles of bioinorganic chemistry- Stephen J. Lippard
8. Inorganic Chemistry: Principles of Structure and Reactivity -by James E. Huheey.
9. Inorganic and applied chemistry - D. H. Peter and P. B. Soren
10. Symmetry and group theory in chemistry- R. Ameta

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11. Summary and spectroscopy of molecules - K. Veera Reddy
  12. Mechanisms of inorganic reactions: study of metal complexes I-in solution - Fred Basolo and R. G. Pearson
  13. Advanced inorganic chemistry - F.A Cotton, G. Wilkinson
  14. Inorganic electronic spectroscopy - A. B. P. Lever
  15. Inorganic chemistry , 3rd edition- Gary L Miessler, Donald A Tarr
  16. Organometallic chemistry - R. C. Mehrotra, A Singh
  17. Essential of Nuclear Chemistry - H J. Arnikar
  18. Nuclear chemistry- M. G. Aroro , M. Singh
  19. Element of Nuclear Chemistry- A. K. Shrivastav, P. C. Jain
  20. Nanotechnology : Principles and practices- Sulbha K. Kulkarni

#### **Unit 04: Organic Chemistry**

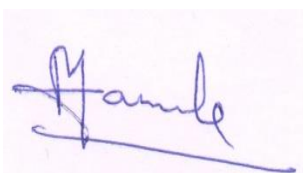
1. Advanced Organic Chemistry- J. March
2. Advanced Organic Chemistry - F.A. Carey and R.J. Sundberg
3. Organic Chemistry - Clayden and Greeves
4. A Guide Book to Mechanism in Organic Chemistry - Peter Sykes
5. Reactions, Rearrangements and Reagents - S.N. Sanyal
6. Organic Reaction Mechanism - R. K. Bansal
7. Modern Organic Reactions - H. O. House
8. Principle of Organic Synthesis - R.O.C. Norman and J. M. Coxon
9. Reaction Mechanism in Organic Chemistry - S. M. Mukharji and S. P. Singh
10. Organic Reaction Mechanism - R. Breslow
11. Basic principles of Organic Chemistry - J.D. Roberts and M.C. Caserio
12. Organic Stereochemistry - Hallas
13. Stereochemistry of Organic Compoundsc - D. Nasipuri
14. Stereochemistry - P. S. Kalsi
15. Organic Chemistry- Robert Thornton Morrison, Robert Neilson Boyd
16. Green Chemistry & Catalysis – Roger A. Sheldon Isabel Arends, Ulf Hanefeld
17. Green Chemistry, Designing chemistry for the environment – Paul T. Anastase, Tracy C. Williamson

#### **Unit 05: Physical Chemistry**

1. Chemical kinetics - Laidler
2. Kinetics and Mechanism of chemical transformation - J. Rajaram & J.Curiacose.
3. Physical Chemistry - P. W. Atkins

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4. Physical Chemistry - T. Engel and P. Reid
  5. Physical Chemistry a Molecular Approach - D. Mcquarie and J. Simon
  6. Thermodynamics for Chemists - S. Glasstone
  7. Physical Chemistry -, G. M. Barrow
  8. Advanced Physical Chemistry - Gurudeep Raj
  9. Text Book of Physical Chemistry - S. Glasstone
  10. An Introduction to Electrochemistry - S. Glasstone
  11. Physical Chemistry - Robert A. Alberty, Robert J. Silbey
  12. Statistical Thermodynamics - M.C.Gupta
  13. Quantum Chemistry - Ira N. Levine
  14. Quantum Chemistry - R.K. Prasad
  15. Quantum Chemistry - B. K. Sen
  16. Principles of Physical Chemistry - Puri, Sharma, Pathania
  17. Physical Chemistry - Maron and Prutton
  18. Introduction to molecular Photo- Chemistry - C.H.J. Wells
  19. Photo-luminescence of Solutions - C.A.Parker
  20. Solid State Chemistry and its Applications - A.R. West
  21. The Determination of Molecular Structure, - P.J.Wheatley
  22. Solid State Chemistry - N.B.Hannary
  23. Physical Chemistry - G.K.Vamulapalli
  24. Fundamentals of molecular spectroscopy - C. N. Banwell

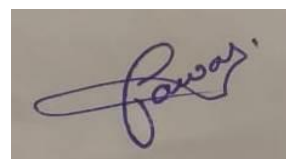
#### **Name & Signatures of Syllabus Committee**



Chairman  
**Prof. M. K. Lande**



Member  
**Prof. S. R. Mirgane**



Member  
**Prof. R. P. Pawar**

Date: 10-06-2020

Place: **AURANGABAD**