GONDWANA UNIVERSITY, GADCHIROLI

M.Sc.-I Semester I, II (Chemistry)

(Effective from 2016-17)

1. There will be four theory papers in every semester which will carry 80 marks each of 3 hrs. duration.

2. There will be internal assessment of 20 marks per paper per semester.

3. Each paper per semester with total of 100 marks(80+20 i.e. theory+internal assessment) will carry 4 credits.

4. The internal assessment will be based on Attendance, Home assignment, Unit test Terminal test and participation in departmental activities.

5. There will be two practical examinations in each semester i.e. Pract I and Pract II of 6-8 hours duration of 80 marks with 4 credits each.

6. In each semester, the student will have to deliver a seminar on any topic relevant to the syllabus / subject encompassing the recent trends and development in that field / subject. This will carry 25 marks per seminar with one credit.

7. So, the total marks allotted to the Chemistry subject per semester is 625 marks: Theory (320 marks) + Internal assessment (120 marks) + Practicals (160 Marks)+ Seminar (25Marks)= 625marks (total)

8. Each theory paper consists of four units of fifteen hours per unit.

The following syllabi are prescribed on the basis of four hours per week of each paper and nine practical periods per batch per week.

Scheme of Examination for M.Sc. (Chemistry)

Semester I	Internal Assessment	Total Marks	Credits
PSCChT01: Paper I (Inorganic Chemistry)	20 Marks	80 Marks	4 Credits
PSCChT02: Paper II (Organic Chemistry)	20 Marks	80 Marks	4 Credits
PSCChT03: Paper III (Physical Chemistry)	20 Marks	80 Marks	4 Credits
PSCChT04: Paper IV (Analytical Chemistry)	20 Marks	80 Marks	4 Credits
PSCChP01: Practical-I (Inorganic Chemistry)	20 Marks	80 Marks	4 Credits
PSCChP02: Practical-II (Organic Chemistry)	20 Marks	80Marks	4 Credits
PSCChP03: Seminar-I	---- --	25 Marks	1 Credits
Total:	**120 Marks**	**505 Marks**	**25 Credits**

Semester II			
PSCChT05: Paper V (Inorganic Chemistry)	20 Marks	80 Marks	4 Credits
PSCChT06: Paper VI (Organic Chemistry)	20 Marks	80 Marks	4 Credits
PSCChT07: Paper VII (Physical Chemistry)	20 Marks	80 Marks	4 Credits
PSCChT08: Paper VIII (Analytical Chemistry)	20 Marks	80 Marks	4 Credits
PSCChP04: Practical-III (Physical Chemistry)	20 Marks	80 Marks	4 Credits
PSCChP05: Practical-IV (Analytical Chemistry)	20 Marks	80 Marks	4 Credits
PSCChP06: Seminar-II	----	25 Marks	1 Credits
Total:	**120 Marks**	**505Marks**	**25 Credits**

General scheme for distribution of marks in practical examination

Time : 6-8 h (One day Examination) Total Marks : 80)
Exercise-1 - 30 Marks
Exercise-2 - 20 Marks
Viva-Voce -15Marks
Record -15 Marks

Question Paper Pattern: Each paper comprising of Max marks 80 of 3 hours duration

Que.-1 (From Unit I) – (A-8 Marks + B-8 Marks) = 16 Marks or (a-4 + b-4 + c-4 + d-4) = 16 Marks

Que.-2 (From Unit II) – (A-8 Marks + B-8 Marks) = 16 Marks or (a-4 + b-4 + c-4 + d-4) = 16Marks

Que.-3 (From Unit III) – (A-8 Marks + B-8 Marks) = 16 Marks or (a-4 + b-4 + c-4 + d-4) = 16Marks

Que.-4 (From Unit IV) – (A-8 Marks + B-8 Marks) = 16 Marks or (a-4 + b-4 + c-4 + d-4) = 16Marks

Que.-5 Short answer question each carry two marks (2 short questions from each unit)= 16 marks

Total: 80 marks

Syllabus prescribed for M.Sc. Chemistry Semester I

PSCChT01: Paper I (Inorganic Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I

A) **Stereochemistry and Bonding in Main Group Compound**: **5h**

VSEPER-Shape of simple inorganic molecules and ions containing lone pairs, various stereo chemical rules and resultant geometry of the compounds of non-transitional elements, short comings of VSEPR model. Bent's rule and energetics of hybridization.

B**) Metal – Ligand Bonding**: **10h**

Crystal Field Theory: Splitting of d-orbital in tetragonal, square planar and trigonal bipyramid complexes. John teller effect, spectrochemical series, nephelauxetic effect. Limitaion of crystal field theory. M.O.theory for octahedral, tetrahedral & square planar complexes with and without π-bonding.

Unit-II

A) **Metal – Ligand Equilibria in Solution**: **5h**

Stepwise and overall formation constants; trends in stepwise formation constants; factors affecting stability of metal complexes with reference to nature of metal ion, ligand, chelate effect and thermodyanamic origin. Determination of formation constant by : (1)spectrophotometric method (Job's and Mole ratio method) (2) Potentiometric method (Irving-Rossotti Method) B) Reaction Mechanism of Transition metal complexes: 10h

Energy Profile of a reaction, reactivity of metal complexes, Inert and Labile complexes, Kinetics of Octahedral substitution: Acid hydrolysis, factors affecting acid hydrolysis, Stereochmistry of intermidiates in SN1 & SN2 , Base hydrolysis, Conjugate base mechanism, Direct and indirect evidences in favour of conjugate mechanism, Annation reaction, reaction without metal-ligand bond breaking.

Unit-III:

Cluster- I 15h

Boron hydrides: Classification, nomenclature, structure, bonding and topology of boranes, 4-digit coding (s, t, y, x) numbers for higher boranes and their utilities. Chemistry of

diboranes: Study of Metalloboranes, Carboranes and Metallocarboranes with reference to preparations and structures.

Unit – IV

A**) Metal-Metal bonds: 10h**

Occurrence of metal-metal bond, Classification of metal clusters, Binuclear, trinuclear, tetranuclear, pentanuclear and hexanuclear with reference to halide, oxide, alkoxide and acetate clusters.

B) **Isopoly, Heteropoly acids and their anions. 5h**

List of Books

1) S. F. A. Kettle, J. N. Murral and S. T. Teddler: Valency Theory

2) C. A. Coulson: Valency

3) J. E. Huheey :Inorganic Chemistry

4) F .A. Cottonand G. Wilkinson: Advanced Inorganic Chemistry 3rd, 5thand 6th Editions.

5) A. F. Willims: Theoretical Approach in inorganic chemistry.

6) A. Mannas Chanda: Atomic Structure and chemical Bonding

7) L. E. Orgel: An Introduction To transition metal chemistry, Ligand field theory, 2nd Ed.

8) J. J. Logowski: Modern Inorganic Chemistry

9) B.Durrant and P.J.Durrant: Advanced Inorganic Chemistry

10) J. C. Bailar: Chemistry of coordination compounds.

11) W. L. Jolly: Modern Inorganic Chemistry

12) R. S. Drago: Physical methods in inorganic chemistry.

13) Waddington: Nonaqueous solvents.

14) Sisler: Chemistry of nonaqueous solvents.

15) A. K. Barnard: Theoretical Inorganic Chemistry

16) Emeleus and Sharpe: Modern Aspect of Inorganic Chemistry.

17) F. A. Cotton: Chemical Applications of Group theory.

18) Jones: Elementary Coordination chemistry.

19) B. N. Figgis: Introduction to Ligand field.

20) S. F. A. Kettle: Coordination chemistry.

21) M.C.Day and J.Selbin: Theoretical Inorganic Chemistry.

22) J. Lewin and Wilkins: Modern Coordination Chemistry.
23) Gowarikar, Vishwanathan and Sheedar: Polymer science.
24) H. H. Jattey and M. Orchin: Symmetry in chemistry.
25) D. Schonaland: Molecular Symmetry in chemistry.
26) L. H. Hall: Group theory and Symmetry in chemistry
27) H. H. Jattey and M. Orchin: Symmetry in chemistry
28) R.L.Dutta and A.Symal: Elements of magneto chemistry
29) Inorganic Chemistry 4th Edition, P.Atkins, Oxford University Press.
30) Essential Trends in Inorganic Chemistry, D.M.P.Mingos, Oxford University Press

PSCChT02: Paper II (Organic Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: 15 h

A] **Nature and Bonding in Organic Molecule**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyper-conjugation, bonding in fullerenes. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons Huckel's rule, energy level of π-molecules orbitals, annulenes, antiaromaticity, homoaromoaticity. Aromatic character and chemistry of cyclopentadienyl anion, tropylium cation, tropone and tropolone. Bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes

B] Synthetic applications of enamines and imines anions in organic synthesis, phase transfer catalysis, crown ethers and graphene.

Unit-II: 15 h

A] **Streochemistry**

Conformational analysis of cycloalkanes (5 – 8 membered rings), substituted cyclohexanes , mono substituted, disubstituted and trisubstituted cyclohexanes, decalines, effect of conformation on reactivity, Cahn-Ingold-Prelog System to describe configuration at chiral centers . Elements of symmetry, chirality, molecules with more than one chiral center, meso compounds, threo and erythro isomers, method of resolution, optical purity, enantiotopic and distereotopic atoms, groups and faces, prochirality, addition-elimination reactions, stereospecific and steroselective synthesis. Asymmetrical synthesis, optical activity in absence of chiral carbon (biphenyl and allenes)

B] **Reactive Intermediates**

Generation, structure, stability and chemical reactions involving classical and non-classical carbocations, carbanions, free radical, carbenes, nitrenes and arynes. Singlet oxygen, it's generation and reactions with organic substrates.

Unit-III: 15 h

A] **Reaction mechanism: Structure and Reactivity**

Types of mechanism, Types of reaction, thermodynamics and kinetics requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammeett principle, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases.

Effect of Structure on reactivity: Resonance and field effects, Steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft Equation.

B] Concept of neighboring group participation (anchimeric assistance) with mechanism, neighboring group participation by π and σ bonds, classical and non classical carbocations, Intramolecular displacement by hydrogen, oxygen, nitrogen, sulphur and halogen. Alkyl, cycloalkyl, aryl participation, participation in bicyclic system, migartory aptitude, carbocation rearrangements and related rearrangements in neighboring group participation.

Unit IV: 15h

A] **Aliphatic nucleophilic substitution**

The SN1, SN2, mixed SN1, SN2 and SET and SNi mechanisms. Nucleophilicty, effect of leaving group, ambient nucleophiles and ambient substrates regiospecificity, substitution at allylic and vinylic carbon atoms.

B] **Aromatic electrophilic substitution**

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The o/p ratio, ipsoattack, orientation in benzene ring with more than one substituents, orientation in other ring system. Diazonium coupling, Vilsmeir reaction, Gatterman-Koch reaction, Pechman reaction, Reimer-Tieman reaction, Diazonium coupling.

C] **Aromatic Nucleophilic Substitution**

A general introduction to different mechanisms of aromatic nucleophilic substitution SNAr, SN1, benzyne and SRN1 mechanisms. Reactivity - effect of substrate structure leaving group and attacking nucleophile. The Von Richter, Sommlet-Hauser and Smiles rearrangements.

List of books

1] Advanced Organic Chemistry –Reaction mechanism and structure. Jerry March, John Wiley

2] Advanced Organic Chemistry- F.A. Carey and R. J. Sunberg, Plenum

3] A Guidebook to Mechanism in Organic Chemistry-Peter Skyes, Longman

4] Structure and Mechanism in Organic Chemistry-C.K. Gold, Cornell University Press

5] Organic Chemistry, R.T. Morrison Boyd. Prentice Hall

6] Modern Organic Chemistry-H.O. House, Benjamin

7] Principal of Organic Chemistry-R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional

8] Reaction Mechanism in Organic Chemistry-S.M. Mukharji and S.P. Singh, Macmilan

9] Stereochemistry of Organic Compounds- D. Nasipuri, New Age International

10] Stereochemistry of Organic Compounds- P. S. Kalsi, New Age International

11] Frontier Orbitals and Organic Chemical Reactions-I. Fleming

12] Orbital Symmetry – R. E. Lehr and A. P. Marchand

13] Reactive Intermediate in Organic Chemistry-N. S. Isaacs

14] Stereochemistry of Carbon Compounds- E. L. Eliel

15] Physical Organic Chemistry-J. Hine

16] Name Reaction in Organic chemistry –Surrey

17] Advanced Organic Chemistry – L. F. Fieser and M. Fieser.

18] Organic Chemistry Vol. I and II - I. L. Finar

19] Modern Organic Chemistry- J.D. Roberts and M. C. Caserio

20] The Search for Organic Reaction Pathways (Longmann), Peter Skyes

21] Organic Chemistry 5th Edition (McGraw Hill), S. H. Pine

22] Organic Chemistry (Willard Grant Press Botcon), John Mcmurry

23] A Textbook of Organic Chemistry- R. K. Bansal New Age International

24] New Trends in Green Chemistry –V. K. Ahluwalia and M. Kidwai, Anamaya publishers

25] Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press

26] Organic Chemistry, 4th Edition, G Marc Loudon, Oxford University Press

27] Nano Materials 2007, A. K. Bandyopadhyay, New Age International

PSCChT03: Paper III (Physical Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

UNIT I: FORMULATION OF QUANTUM MECHANICS 15h

A] Introduction of quantum mechanics, wave function, acceptability of wave functions, normalized and orthogonal wave functions, operators, properties of operators, eigen functions and eigen values, Hermitian operators, orbital and generalized angular momentum, eigen function and eigen values of angular momentum, postulates of quantum mechanics, (problems on operators, eigen values and average value)

B] Application of Schrodinger wave equation to simple systems: degeneracy in 3-dimensional box, rigid rotator, potential well of finite depth (tunneling effect), simple harmonic oscillator, the Hydrogen atom.

UNIT II: CLASSICAL THEMODYNAMICS 15h

A] Exact and inexact differentials, condition of exactness, Pfaff differential expression, derivation of thermodynamic equation of state, extensive and intensive properties. Homogeneous functions of degree 0 and 1. Maxwell's relations.

B] Third law of thermodynamics, unattainability of absolute zero, calculation of entropy, residual entropy and its application. Varial equation, fugacity, determination of fugacity.

C] Partial molar quantities: Determination of partial molar quantities, chemical potential, escaping tendency, partial molar volume, Gibbs Duhem equation, Gibbs Duhem Mergules equation, reaction potential, Extent of reaction (Xi).

UNIT III: PHASE EQUILIBRIA 15h

Phase rule, calculation of degrees of freedom, reduced phase rule, construction of phase diagram, one component systems: Helium, carbon, two component systems forming solid solutions having congruent and incongruent melting point, partially miscible solid phase, three component systems, graphical presentation, influence of temperature, systems with 1, 2, 3 pairs of partially miscible liquids, transition points, 1st and 2nd order phase transition, lambda line

UNIT IV: CHEMICAL KINETICS 15h

A] Theories of reaction rates: Unimolecular reactions, bimolecular reactions, collision theory, steric factor, temperature effect on reaction rates, Arrhenius equation and its

limitations, activation energy, transition state theory, steady state approximation, Lindeman-Hinshelwood mechanism, RRKM theory

B] Photochemistry: Introduction, quantum yield, photosensitizers, quenching, kinetics of anthrascene reactions, H_2-Br_2 and H_2-I_2 reactions.

C] Catalysis: Acid- base enzymes, enzyme catalysis, Michaelis Menten equation, effect of pH and temperature.

List of books

1. Ira .N. Levine, Quantum Chemistry, 5th edition(2000), Pearson educ., Inc.New Delhi
2. A.K.Chandra, Introductory Quantum Chemistry, 4th edition (1994), Tata Mcgraw Hill, New Delhi.
3. S.K.Dogra, S.Dogra, Physical Chemistry Through Problems.
4. M.W.Hanna, " Quantum Mechanics in Chemistry", Benjamin
5. L. Pualing and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, McGraw Hill, New York (1935).
6. R.P.Rastogi R.R. Mishra 6th revised edition An Introduction to Chemical Themodynamics.
7. Principles of Physical Chemistry by Puri, Sharma and Pathania,
8. P.W.Atkins.Physical chemistry. ELBS
9. E.N.Yenemin, " Fundamentals of Chemical Thermodynamics", MIR Publishers.
10. F.W.Sears, " Introdction to Thermodynamics, Kinetic Theory of Gases and statistical mechanics".Addison Wesley
11. G.M.Panchenkov and V.P.Labadev, " Chemical Kinetics and catalysis", MIR Publishing
12. E.A. Moelwyn- Hughes, " Chemical Kinetics and Kinetics of Solutions", Academic
13. K.J.Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York
14. J.Raja Ram and J.C.Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan Indian Ltd., New Delhi (1993)
15. R.K.Prasad," Quantum Chemistry", Wiley.

PSCChT04: Paper IV (Analytical Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit I: Introduction and statistical analysis 15h

Introduction to analytical chemistry: Types of analysis-qualitative and quantitative. Classification of analytical methods- classical and instrumental, basis of their classification with examples. Statistical analysis and validation: Errors in chemical analysis. Classification of errors- systematic and random, additive and proportional, absolute and relative. Accuracy and precision. Mean, median, average deviation and standard deviation. Significant figures and rules to determine significant figures. Calculations involving significant figures. Confidence limit, correlation coefficient and regression analysis. Comparison of methods: F-test and T-test. Rejection of data based on Q-test. Least squares method for deriving calibration graph. Application of Microsoft Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel). Validation of newly developed analytical method. Certifiedreference materials (CRMs). Numerical problems.

Unit II: Separation techniques 15h

Chromatography: Definition and Classification. Techniques used in Paper, Thin Layer and Column chromatography. Applications in qualitative and quantitative analysis.

Ion exchange: Principle and technique. Types of ion exchangers. Ion exchange equilibria. Ion exchange capacity. Effect of complexing ions. Zeolites as ion-exchangers. Applications.

Solvent extraction: Principle and techniques. Distribution ratio and distribution coefficient. Factors affecting extraction efficiency: Ion association complexes, chelation, synergistic extraction, pH. Numericals based on multiple extractions. Role of chelating ligands, crown ethers, calixarenes and cryptands in solvent extraction. Introduction to Solid phase extraction (SPE) and Microwave assisted extraction (MAE). Applications.

Unit III: Classical methods of analysis 15h

Volumetric analysis: General principle. Criteria for reactions used in titrations. Primary standards and secondary standards. Theory of indicators. Types of titrations with examples- Acid-base, precipitation, redox and complexometric. Titration curves for monoprotic and polyprotic acids and bases. Indicators used in various types of titrations. Masking and demasking agents. Gravimetric analysis: General principles and conditions of precipitation. Concepts of solubility,solubility product and precipitation equilibria. Steps

involved in gravimetric analysis. Purity of precipitate: Co-precipitation and post-precipitation. Fractional precipitation. Precipitation from homogeneous solution. Particle size, crystal growth, colloidal state, aging and peptization phenomena. Ignition of precipitates.

Unit IV: Optical methods of analysis-I 15h

Spectrophotometry and Colorimetry: Principle of colorimetry. Beer's law, its verification and deviations.Instrumentation in colorimetry and spectrophotometry (single and double beam). Sensitivity and analytical significance of molar extinction coefficient and λmax. Comparison method, calibration curve method and standard addition method for quantitative estimation. Role of organic ligands in spectrophotometric analysis of metal ions. Ringbom plot and Sandell's sensitivity. Photometric titrations. Determination of pK value of indicator. Simultaneous determination. Composition and stability constant of complex by Job's and mole ratio methods. Derivative spectrophotometry. Numerical problems.

List of books:

1. Quantitative analysis: Day and Underwood (Prentice-Hall of India)
2. Vogel's Text Book of Quantitative Inorganic Analysis-Bassett, Denney, Jeffery and Mendham (ELBS)
3. Analytical Chemistry: Gary D. Christian (Wiley, India).
4. Instrumental Methods of Analysis: Willard, Merrit, Dean, Settle (CBS Publishers, Delhi, 1986)
5. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
6. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
7. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
8. Analytical Chemistry: Problems and Solution- S. M. Khopkar (New Age International Publication)
9. Basic Concepts in Analytical Chemistry: S. M. Khopkar (New Age International Publication)
10. Advance Analytical Chemistry: Meites and Thomas: (Mc Graw Hill)
11. An Introduction to Separation Science: L. R. Shyder and C. H. Harvath (Wiley Interscience)
12. Fundamentals of Analytical Chemistry: S. A. Skoog and D. W. West
13. Instrumental Methods of Chemical Analysis: G. W. Ewing

PSCChP01: Practical-I (Inorganic Chemistry)

9 h /week Marks: 80

I. Preparation of Inorganic Complexes and their characterization by:

Elemental analysis and physico-chemical methods (Electronic and IR Spectra, magnetic susceptibility measurements, Thermal analysis and Molar conductance studies).

1. K_3 [Al $(C_2O_4)_3$]$(H_2O)_3$ 2. [VO $(acac)_2$] 3. Na [Cr $(NH_3)_2(SCN)_4$]

4. K_3[Cr$(SCN)_6$]. 5. [Mn $(acac)_3$] 6. K_3 [Fe $(C_2O_4)_3$]

7. Hg [Co $(SCN)_4$] 8. [Co $(Py)_2$ Cl_2] 9. [Cu_2 $(CH_3COO)_4(H_2O)_2$]

10. [Ni $(DMG)_2$] 11.[Ni$(NH_3)_6$]Cl_2 12. [Cu$(NH_3)_4(H_2O)_2$]SO_4

II. Quantitative Analysis:

Separation and determination of two metal ions from the following alloys involving:

Volumetric, Gravimetric and Spectrophotometric methods

i) Copper (II) and Nickel (II)

ii) Copper (II) and Zinc (II)

iii) Nickel (II)—Zinc (II) and

iv) Copper (II)—Iron (III)

III. Qualitative analysis of radicals:

Semi-micro Analysis of inorganic mixture containing four cations out of which two will be rare metal ions such as W, Mo,Se,Ti,Zr,Ce,Th,V and U.(Spot Test for individual cations should be performed)

PSCChP02: Practical-II (Organic Chemistry)

9 h /week Marks: 80

[A] Qualitative Analysis

Separation, purification and identification of the mixture of two organic compounds (binary mixture with two solid, one solid one liquid and two liquids) using chemical methods or physical techniques. Minimum 8-10 mixtures to be analyzed.

Purification of the compounds by crystallization, TLC and chromatographic techniques.

[B] Organic preparations:

Student is expected to carry out minimum of 5-6 two stage organic preparation and 5-6 single stage preparation from the following lists.

[1] Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
[2] Benzophenone →benzhydrol
[3] Aldol condensation: Dibenzal acetone from benzaldehyde.
[4] Sandmeyer reaction: p- chlorotoluene from p-toluidine
[5] Cannizzaro reaction
[6] Friedel Crafts Reaction: β-Benzoyl propionic acid from succinic anhydride and benzene.
[7] Benzil _ 2,4,5-triphenyl imidizole
[8] Sucrose _ Oxalic acid
[9] Cyclohexanol_ Adipic acid
[10] Benzaldehyde _ Dibenzal acetone
[11] Phenol formaldehyde resin
[12] Urea formaldehyde resin
[13] Methyl acetoacetate _ 5-methyl-isoxazol-3-ol
[14] Ethyl acetoacetate →4-aryl-6-methyl-3,4-dihydro-2(1H)-pyrimidinone ester
[15] Ethyl acetoacetate →Diethyl 1,4-dihydro-2,6-dimethyl-4-phenylpyridine-3,-5dicarboxylate
[16] Dye prepartion : Sulphanilic acid →Methyl orange
[17] Dye prepartion : p-nitroaniline _ p-red
[18] Acetanilide →p-nitroacetanilide →p-nitroaniline
[19] Aniline →2,4,6-tribromo aniline →2,4,6-tribromoacetanilide
[20] Nitrobenzene →m-dinitrobenzene →m-nitroaniline
[21] toluene →p-nitrotoluene →p-nitrobenzoic acid
[22] Glycine →Benzoyl glycine →4-benzilidene-2-phenyl oxazole
[23] Phathalic anhydride →Phthalimide →Anthranilic acid
[24] Resorcinol →fluoroscein →Eosin

PSCChP03: Seminar-I

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25 marks (1 credit). Seminar should be delivered by the student under the guidance of concerned teacher on the topic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.

Syllabus prescribed for M.Sc. Chemistry Semester II

PSCChT05: Paper V (Inorganic Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit I: A**) Electronic spectra of Transition Metal complexes 10h**

Determining the Energy terms, Spin-orbit (L-S) coupling scheme, Hund's rule, Hole Formulation, Derivation of the term symbol for a d^2 configuration, Electronic spectra of transition metal complexes – Laporte 'orbital' selection rule,spin selection rule. Orgel diagrams for octahedral metal complexes. Charge transfer spectra, Racah parameters, calculations of 10 Dq, B, β parameters. Tanabe- Sugano Diagrams of octahedral complexes with d^2 & d^8 configuration.

B**) Magnetic Properties of Transition Metal complexes 5h**

Abnormal magnetic properties, orbital contributions and quenching of orbital angular momentum, spinorbit coupling. Magnetic moment, electronic spectra and structure of tetrahalocobalt(II) complexes, tetrahedral and octahedral Ni(II) complexes. High spin-low spins crossover.

Unit – II 15h

Reaction mechanism of Transition Metal Complexres-II

Substitution reaction in square planer complexes: the trans effect, cis effect, steric effect, solvent effect, effect of leaving group, effect of charge, effect of nucleophile, effect of temperature. Trans effect theories, uses of trans-effect, mechanism of substitution reactions in Pt(II) complexes.Electron transfer reactions. Types of electron transfer reactions, conditions of electron transfer, and mechanism of oneelectron transfer reactions, outer sphere and inner sphere mechanisms, two electron transfer reactions complimentary and non-complimentary reactions. Tunneling effect, cross-reaction, Marcus-Hush theory, bridged activated mechanism.

Unit-III: Metal pi-Complexes - I 15h

Metal carbonyls

Structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reaction of metal carbonyls.Metal carbonyl clusters with reference to classification, EAN rule, synthesis and structures.

Unit – IV: Metal pi-Complexes – II 15h

Metal nitrosyls

Nitrosylating agents for synthesis of metal nitrosyls, vibrational spectra and X-ray diffraction studies of transition metal nitrosyls for bonding and structure

elucidation, important reactions of transition metal nitrosyls, structure and bonding. Dinitrogen and dioxygen complexes. Wilkinson's catalyst and Vaska's compound.

List of Books

1. J.E.Huheey :Inorganic Chemistry
2. F.A.Cotton and G. Wilkinson: Advanced Inorganic Chemistry 3rd, 5th and 6th Editions.
3. A.F. Willims: Theoretical Approach in inorganic chemistry.
4. Mannas Chanda: Atomic Structure and chemical Bonding
5. L. E. Orgel: An Introduction To transition metal chemistry, Ligand field theory, 2nd Edition.
6. J. J. Logowski: Modern Inorganic Chemistry
7. B.Durrant and P.J.Durrant: Advanced Inorganic Chemistry
8. J C. Bailar: Chemistry of coordination compounds.
9. W. L. Jolly: Modern Inorganic ChemistryJones: Elementry Coordination chemistry.
10. B. N. Figgis: Introduction to Ligand field.
11. M.C.Day and J.Selbin: Therotical Inorganic Chemistry.
12. J. Lewin and Wilkins: Modern Co-ordination chemistry.
13. Purcell and Kotz: Inorganic Chemistry.
14. D. Banerjea: Co-ordination chemistry, Tata Mc. Graw. Pub.
15. A.F. Wells: Structural inorganic chemistry, 5th Edition, Oxford.
16. S. G. Davies: Organotransition metal chemistry applications to organic synthesis.
17. R. C. Mehrotra: Organometallic chemistry Tata McGraw Hill. Pub.
18. G. S. Manku: Thereotical priciples of inorganic chemistry
19. A. B. P. Lever: Inorganic electronic spectroscopy.
20. R.C.Maurya:Synthesis and charecterisation of novel nitrosyls compounds, Pioneer Pub. Jabalpur 2000.

21. R.H.Crabtree:The Organometalic chemistry of Transition metals, John Wiley.
22. D.N.Styanaryan:Electronic Absorption Spectroscopy and related techniques, University Press.
23. R. S. Drago: Physical methods in inorganic chemistry
24. F.Basolo and G.Pearson: Inorganic Reaction Mechanism
25. Organometallics II and I complexes with transition metal- carbon bonds: Manfred Bochmann-Oxford Press.
26. Advanced Inorganic Chemistry Vol I and II – Satyaprakash, Tuli, Bassu and Madan- S Chand.
27. M.Tsusui,M.Nlevy,M.Ichikwa and K.Mori:Introduction to metal pi-complexe chemistry,Plenum press,NY
28. A.E.Martel;Coordination Chemistry-VolIandII,VNR.

PSCChT06: Paper VI (Organic Chemistry)

60 h (4 h per week): 15 h per unit 80Marks

Unit-I 15 h

A] **Addition to carbon-carbon multiple bond**

Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, Orientation and stereochemistry, Addition to cyclopropanes, Hydrogenation of double bond and triple bonds. Hydrogenation of aromatic rings, hydroboration, Michael reaction.

B] **Addition to carbon-hetero atom multiple bond**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters, and nitriles, Addition of Grignard reagents, organozinc and organolithium reagents to carbonyls and unsaturated carbonyl compounds, Wittig reaction, Mechanisms of condensation reactions involvingenolates- Aldol, Knoevengel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction, Hydrolysis of esters and amide, ammonolysis of esters.

Unit-II 15 h

A] **Mechanism of molecular rearrangement**

Classification and General mechanistic treatment of electrophilic, nucleophilic and free radical moleculer rearrangement. Mechanism of the following rearrangement –Wagner-Meerwin, Pinacol-Pinacolone, Tiffenev –Demjnov ring expansion, benzil-benzilic acid, Arndt-Eistert synthesis, Curtius Lossen, Beckman, Hoffman, Schmidt rearrangement.

B**] Free radical reactions-I**

Type of free radical reactions, free radical substitution mechanism at an aromatic substrate, aliphatic substrate, reactivity at a bridgehead position. Neighbouring group assistance, reactivity for aliphatic and aromatic substrates, reactivity in attacking radicals, effect of solvent on reactivity.

UNIT-III

A**] Free radical reactions-II 15 h**

Halogenation at an alkyl carbon, allylic carbon (NBS), hydroxylation at an aromatic carbon by means of Fenton's reagent. Auto-oxidation, chlorosulphonation (Reed Reaction) Coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction.

B] **Elimination reactions**

The E1, E2 and E1CB mechanisms and orientation of the double bond. Saytzeff and Hoffman's rule. Effect of substrate structure, attacking base, leaving group and medium. Mechanism and orientation in pyrolytic elimination.

Unit IV: Green chemistry 15 h

Introduction, Education and need of Green chemistry, Basic principles of green chemistry. Prevention or minimization of hazardous products , choice of solvents. Sonochemistry, microvave induced reactions, polymer supported reagents, reactions in aqueous medium, zeolites and ionic liquid supported reaction, Solvent free reactions, Multi-component reactions (Biginelli, Ugi and Passereno reaction), Rearrangements reaction, Addition reaction, substitution, elimination reaction, photochemical and electrochemical reactions, Biocatalysts in Organic synthesis. Synthesis involving basic principles of green chemistry- Synthesis of paracetamol and Ibuprofen, styrene, urethanes, Free radical bromination, Green chemistry for drug development, Synthesis of. Introduction to nanochemistry, nanorods and nanotubes.

List of books

1] Books as Suggested in Semester I for Organic Chemistry
2] A Textbook of organic chemistry- R.K. Bansal
3] New trends in green chemistry –V.K. Ahluwalia and M. Kidwai, Anamaya publishers New Delhi
4] Heterocyclic Chemistry, John Joule, Oxford University Press

PSCChT07: Paper VII (Physical Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

UNIT I: APPLICATION OF QUANTUM MECHANICS 15h

A] Approximate methods, variation principle, MO theory applied to H_2+ molecule and H_2 molecule (calculation of energy), perturbation theory, application of perturbation theory to helium atom .

B] Electronic structure of atoms: Russel Sanders terms and coupling schemes, Slater-condon parameters,term separation energies of the pn configuration, term separation energies for dn configuraconfiguration, magnetic effects: spin orbit coupling and Zeeman splitting.

C] Hybridization, hybrid orbitals in terms of wave functions of s and p orbitals, sp and sp^2 hybridizations, Simple Huckel theory applied to: ethylene, butadiene, cyclobutadiene, cyclopropenyl radical.

UNIT II: THERMODYNAMICS 15h

A] Non-ideal Systems: Excess functions for non ideal solutions, Entropy of mixing, Enthalpy of mixing, Activity, activity coefficients, Debye Huckel theory for activity coefficients of electrolytic solutions, determination of activity and activity coefficients, ionic strength.

B] Statistical thermodynamics: Stirling Approximation, Maxwell Boltzmann, Bose Einestein, Fermi Dirac statistics, comparison between three statistics.

C] Irreversible Thermodynamics: Thermodynamic criteria for non equilibrium states, Le Chatelier principle, Conservation of mass and energy in closed and open systems, entropy production.

UNIT III: SOLID STATE CHEMISTRY 15h

A] Crystal Defects and Non-stiochiometry: Perfect and imperfect crystals, Electronic structure of solids— band theory intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky defects and Frenkel defects, p-n junction. Thermodynamics of Schottky and Frenkel defects, colour centres, non-stiochiometric defects. Superconductors—Meissner effect, BCS theory.

B] Solid State Reactions: General Principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

UNIT IV: NUCLEAR CHEMISTRY 15h

A] Introduction, radioactive decay and equilibrium, thermonuclear reactions, photonuclear reactions, Radiometric titration, isotopic dilution analysis, NAA.

B] Nuclear models: Fermi gas model, shell model, liquid drop model, application of liquid drop modelsemiempirical mass equation.

C] Counters: proportional counter, GM counter, scintillation counter, ionization chamber counter.

List of books

1. Ira N. Levine, Quantum Chemistry, 5th edition(2000), Pearson educ., Inc.New Delhi
2. A.K.Chandra, Introductory Quantum Chemistry, 4th edition (1994), Tata Mcgraw Hill, New Delhi.
3. S.K.Dogra, S.Dogra, Physical Chemistry Through Problems.
4. M.W.Hanna, " Quantum Mechanics in Chemistry", Benjamin
5. L. Pualing and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, McGraw Hill, New York (1935).
6. R.P.Rastogi R.R. Mishra 6th revised edition An Introduction to CHEMICAL THERMODYNAMICS
7. Principles of Physical Chemistry by Puri, Sharma and Pathania,
8. Physical chemistry. P.W.Atkins.ELBS
9. E.N.Yenemin, "Fundamentals of Chemical Thermodynamics", MIR Publishers.
10. F.W.Sears, " Introdction to Thermodynamics, Kinetic Theory of Gases and statistical mechanics".Addison Wesley
11. M.C.Gupta, Statistical Mechanics
12. I.Prigoggine, " An Introduction to Thermodynamics of Irreversible Processes," Interscience
13. Andrew Maczek, Statistical Thermodynamics, Oxford University Press Inc., New York (1998).
14. C.N.Rao. Nuclear Chemistry
15. B. G. Harvey, Introduction to Nuclear Physics and Chemistry, Prentice Hall, Inc. (1969).
16. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th Edition (1995), Wiely-Eastern Ltd., New Delhi.
17. C.Kittel, " Introduction to solid state Physics",Wiley
18. L.V.Azaroff, " Introduction to solids", McGraw Hill

PSCChT08: Paper VIII (Analytical Chemistry)

60 h (4 h per week): 15 h per unit 80 Marks

Unit-I: Sampling and quantification 15h

Sampling and sample treatment: Criteria for representative sample. Techniques of sampling of gases (ambient air and exhaust gases), liquids (water and milk samples), solids (soil and coal samples) and particulates. Hazards in sampling. Safety aspects in handling hazardous chemicals. Sample dissolution methods for elemental analysis: Dry and wet ashing, acid digestion, fusion processes and dissolution of organic samples.

Detection and quantification: Concepts and difference between sensitivity, limit of detection and limit of quantification, role of noise in determination of detection limit of analytical techniques. Units in chemical analysis and their interconversion. Stoichiometry: Stoichiometric and sub-stoichiometric reactions and calculations.

Unit-II: Modern separation techniques 15h

Gas Chromatography: Principle including concept of theoretical plates and van-Deemter equation. Instrumental set up- carrier gas, sampling system, column and detector. Types of columns, their advantages and limitations. Detectors in GC analysis. Temperature programmed GC. Factors affecting retention, peak resolution and peak broadening.

Liquid chromatography: Principle, Instrumentation, Advantages and applications of HPLC. Types of columns and detectors. Principle and applications of size exclusion, gel permeation, ion retardation, normal phase and reverse phase chromatography.

Supercritical fluid chromatography: Introduction and applications.

Unit-III: Optical methods of analysis-II 15h

Fluorometry and phosphorimetry: Principles of fluorescence and phosphorescence. Jablonski diagram. Concentration dependence of fluorescence intensity. Fluorescence quenching. Instrumentation. Applications.

Flame photometry: Principle. Instrumentation and types of burners. Factors affecting flame photometric determination. Limitations of flame photometry. Interferences in flame photometry. Applications. Nephelometry and turbidimetry: Theory, instrumentation and applications. Optical sensors: Fibre-optic properties, Fibre-optic sensors.

Unit-IV:Electrochemical methods of analysis-I 15h

Polarography: Principle of DC polarography. Instrumentation in polarography. Advantages and limitations of DME. Types of currents- residual current, migration current, diffusion current, limiting current, adsorption current, kinetic current and catalytic current. Ilkovic equation-diffusion current constant and capillary characteristics. Derivation of equation of polarographic wave and half wave potential. Experimental determination of half wave potential. Reversible, quasi reversible and irreversible electrode reactions. Polarographic maxima and maximum suppressor. Oxygen interference and deaeration. Introduction to pulse, a.c. and oscillographic techniques and their advantages. Applications of polarography in determination of dissolved oxygen, metal ion quantification and speciation, simultaneous determination of metal ions, analysis of organic compounds. Limitations of polarography. Amperometric titrations- Principle, types and applications in analytical chemistry.

List of books:

1. Quantitative analysis: Day and Underwood (Prentice-Hall of India)
2. Vogel's Text Book of Quantitative Inorganic Analysis-Bassett, Denney, Jeffery and Mendham (ELBS)
3. Analytical Chemistry: Gary D. Christian (Wiley India).
4. Instrumental Methods of Analysis: Willard, Merrit, Dean, Settle (CBS Publishers, Delhi, 1986)
5. Sample Pre-treatment and Separation: R. Anderson (John Wiley and Sons)
6. Stoichiometry: B.I.Bhatt and S.M. Vora, 2nd Edition (Tata Mc-Graw Hill publication)
7. Instrumental Methods of Chemical Analysis: Braun (Tata McGraw-Hill)
8. Advanced Analytical Chemistry: Meites and Thomas (McGraw-Hill)
9. Instrumental Methods of Analysis: G. Chatwal and S. Anand (Himalaya Publishing House)
10. Analytical Chemistry: Problems and Solution- S. M. Khopkar (New Age International Publication)
11. Basic Concepts in Analytical Chemistry: S. M. Khopkar (New Age International Publication)
12. Advance Analytical Chemistry: Meites and Thomas: (Mc Graw Hill)

13. An Introduction to Separation Science: L. R. Shyder and C. H. Harvath (WileyInterscience)
14. Fundamental of Analytical Chemistry: S. A. Skoog and D. W. West
15. Instrumental Methods of Chemical Analysis: G. W. Ewing
16. Polarography: Koltoff and Ligane
17. Electroanalytical Chemistry: Sane and Joshi (Quest Publications)

PSCChP04: Practical-IV (Physical Chemistry)

9 h /week Marks: 80

1. To study the variation of volume contraction with mole fraction of alcohol in alcohol - water system
2. To determine the activation parameters of viscous flow for a given liquid
3. Determination of molecular mass of a polymer by viscometry method.
4. To determine integral heat of KNO3, at two different conc. and calculation of heat of dilution.
5. Effect of 1% NaCl, 1% succinic acid, 0.5% naphthalene on CST in phenol-water systems.
6. Distribution of succinic acid in H2O- benzene, H2O-ether and comparison of distribution coefficient.
7. To construct the phase diagrams of two components system (phenol- urea, diphenyl aminebenzophenone; a-naphtyl amine-phenol) forming compounds with congruent melting points.
8. To study the mutual solubility of glycerol-m-toluidine and to determine congruent points.
9. To study kinetics of hydrolysis of an ester by NaOH reaction.
10. To determine equilibrium constant of the equation $KI+I_2=KI_3$ by distribution method.
11. To study the kinetics of the reaction between potassium persulphate and potassium iodide.
12. Determination of order of reaction of oxidation of ethyl alcohol by acid dichromate.
13. To titrate conductometrically monobasic and dibasic acids with NaOH and determine the strength of given acid.
14. To determine equivalent conductance of weak electrolyte at infinite dilution by kaulrausch's method.
15. Determination of heat of reaction, entropy change and equilibrium constant of the reaction between metallic zinc and Cu^{+2} ions in solution.
16. Determination of thermodynamic constants ΔG, ΔH, ΔS for Zn^{+} $H_2SO_4= ZnSO_4+ 2H$ by emf measurement.

PSCChP05: Practical-V (Analytical Chemistry)

9 h /week Marks: 80

Section (A): Classical methods and separation techniques

Calibration, validation and computers

1. Calibration of pipette and burette.
2. Statistical analysis of data.
3. Use of MS-Excel in statistical analysis of data and curve fitting.

Volummetry

1. Determination of Na_2CO_3 in washing soda.
2. Determination of NaOH and Na_2CO_3 in a mixture.
3. Estimation of nickel in given solution by direct complexometric titration with EDTA using bromopyrogallol red.
4. Estimation of nickel in given solution by complexometric back-titration with EDTA using murexide.
5. Estimation of chloride in given solution by Mohr's titration.
6. Estimation of chloride in given solution by Volhard's titration.
7. Determination of volume strength of commercial hydrogen peroxide by redox titration with $KMnO_4$.
8. Estimation of phenol/ aniline by bromination method.

Gravimetry

1. Estimation of barium as barium sulphate.
2. Estimation of calcium as calcium oxalate/ calcium carbonate/ calcium oxide.

Separation techniques

1. Qualitative separation of metal ions by paper chromatography for 2/3 components.
2. Determination of ion-exchange capacity of resin.

Section (B): Instrumental techniques

Electroanalytical techniques

1. Analysis of commercial vinegar by conductometric titration.
2. Determination of strength of HCl and CH_3COOH in a mixture conductometrically.
3. Determination of strength of HCl and oxalic acid in a mixture conductometrically.
4. Determination of strength of oxalic acid and CH_3COOH in a mixture conductometrically.

5. Determination of degree of dissociation and dissociation constant of acetic acid conductometrically.

6. Determination of strength of HCl and CH_3COOH in a mixture potentiometrically.

7. Determination of Fe(II) by potentiometric titration with $K_2Cr_2O_7$.

8. Determination of three dissociation constants of H_3PO_4 by pH-metric titration.

Optical Optical methods

1. Determination of pK of indicator by colorimetry.

2. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent.

3. To study the complex formation between Fe(III) and salicylic acid and find the formula and stability constant of the complex colorimetrically (Job's method).

4. To determine the dissociation constant of phenolphthalein colorimetrically.

Note: One experiment from each section should be performed in the examination

PSCChP03: Seminar-II

2 h /week Marks: 25

Seminar of 30 minutes duration will be a part of internal assessment for 25 marks (1 credit). Seminar should be delivered by the student under the guidance of concerned teacher on the topic allotted by the teacher. The topic will be related to the syllabus. Marks will be allotted by a group of teachers.