DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD, SUB-CAMPUS OSMANABAD

(M.S.) INDIA 413 501

DEPARTMENT OF CHEMISTRY

M.Sc. DEGREE SYLLABUS
(Choice Based Credit System – CBCS)

(W.E.F. June, 2011)

Head
Department of Chemistry
Dr.Babasaheb Ambedkar Marathwada
University Sub Campus,Osmanabad

M. Sc. First Year
(Semester–I and Semester–II)

First Semester

Paper Number	Name of the Paper	Total Marks	Total Hours	Total Credits	Hours/ Week
101	Inorganic Chemistry	100	60	4	4
102	Organic Chemistry	100	60	4	4
103	Physical Chemistry	100	60	4	4
104	Analytical Chemistry **OR** Analytical Techniques	100	60	4	4
105	Practical Course–I (Inorganic + Organic)	100	120	4	8
106	Practical Course–II (Physical + Analytical)	100	120	4	8

Second Semester

Paper Number	Name of the Paper	Total Marks	Total Hours	Total Credits	Hours/ Week
201	Inorganic Chemistry	100	60	4	4
202	Organic Chemistry	100	60	4	4
203	Physical Chemistry	100	60	4	4
204	Spectroscopy OR Techniques for Analysis	100	60	4	4
205	Practical Course–III (Inorganic + Organic)	100	120	4	8
206	Practical Course–IV (Physical + Analytical)	100	120	4	8

M. Sc. Second Year
(Semester–III and Semester–IV)

Third Semester

Paper Number	Name of the Paper (Special Subjects)		Total Marks	Total Hours	Total Credits	Hours/ Week
	Analytical Chemistry	Drug Chemistry				
301	Application of Spectroscopy	Application of Spectroscopy	100	60	4	4
302	Environmental Chemistry	Bioorganic & Green Chemistry	100	60	4	4

303	Organic Reactions & Rearrangements	Organic Reactions & Rearrangements	100	60	4	4
304	Analytical Methods in Chemical Analysis OR Advanced Techniques	Applied Organic Chemistry OR Heterocyclic Chemistry	100	60	4	4
	Service Course	Service Course	100	60	4	4
305	Practical Course–V	Practical Course–V	100	120	4	8
306	Spectral Interpretation VI	Spectral Interpretation VI	100	120	4	8

Fourth Semester

Paper Number	Name of the Paper (Special Subjects)		Total Marks	Total Hours	Total Credits	Hours/ Week
	Analytical Chemistry	Drug Chemistry				
401	Applied Analytical Chemistry–I	Introduction to Medicinal Chemistry	100	60	4	4
402	Applied Analytical Chemistry–II	Drug Synthesis	100	60	4	4
403	Pharmaceutical & Clinical Analysis	Drug Action & Development	100	60	4	4
404	Applied Analytical Chemistry–III **OR** Applied Analytical Chemistry IV	Pharmaceutical & Industrial practices **OR** Applied Bio-inorganic Chemistry	100	60	4	4
	Course Subject	Course Subject	100	60	4	4
405	Practical Course–VII	Practical Course–VII	100	120	4	8
406	Practical Course–VIII (Project Work or Inplant Training)	Practical Course–VIII (Project Work or Inplant Training)	100	120	4	8

M. Sc. First Year (*First Semester*)

PAPER 101 : INORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Theories of Metal–Ligand Bonding in Complexes **20 Hrs.**

Valence Bond Theory: Assumptions of VBT, VBT applied to Octahedral (inner & outer orbital) complexes, Limitations of VBT.

Crystal field Theory: Important features of CFT, Crystal field splitting of d–orbital in Octahedral, Tetrahedral, Square–planar and Tetragonal complexes, Crystal field splitting energy and its use, Factors affecting the magnitude of Δo, Applications of CFT, Limitations of CFT.

Molecular Orbital Theory: Molecular orbital theory applied to various octahedral complexes using suitable examples, Construction and explanation of molecular orbital energy level diagram of Octahedral, Tetrahedral, Square–planar complexes involving sigma– as well as Π–bonding.

Unit II: Reaction Mechanism of Transition Metal Complexes **20 Hrs.**

Classification of Inorganic reactions, Energy profile diagram with terminology, Types of ligand or nucleophilic substitution reactions in octahedral complexes with their mechanism, Reactivity of metal complexes with Valence Bond & Crystal Field theories approach, Acid hydrolysis and its factors affecting (atleast four factors), Base hydrolysis and its conjugate base mechanism, Anation reaction with

mechanism, Reactions without metal–ligand bond cleavage, Nucleophilic substitution reactions in square planner complexes, Trans effect, Trans–directing series, Polarization and Π–bonding theories of trans effect, Applications of trans effect, Electron transfer redox reactions of complexes, Inner and Outer sphere redox reactions with features & mechanisms.

Unit III: Metal–Ligand Equilibria in Solution **05 Hrs.**

Thermodynamic vs. Kinetic Stability, Definition of Stability constant, Stepwise and Overall formation constants with relation, Factors affecting the stability of metal complexes with reference to the nature of metal ion, nature of ligand, chelate effect and steric effect. Determination of formation constants for binary complexes using Spectrophotometric and pH–metric techniques.

Unit IV: Symmetry and Group Theory in Chemistry **15 Hrs.**

Introduction to Symmetry, Symmetry operation, Symmetry elements, Point group and its classification (Cn, Dn, Special type), Schoenflies symbol for point groups, Determination of point group of H_2O, NH_3, CO_2, BF_3, C_2H_4, PCl_5, PCl_3, C_6H_6, $[PtCl_4]^{2-}$, HCl, CO, $[FeF_6]^{3-}$, Ortho–, meta– & para–disubstituted benzene molecules. Symmetry and stereoisomerisms, Definition of group, Properties of group, Group multiplication table, Subgroups, Classes, Matrix representation of symmetry elements and point groups, Reducible and Irreducible representations, Character of a representation (character of matrix and conjugate matrix), Properties of Irreducible representation, Great orthogonally theorem (without proof) and its importance, Construction of character table of C_{2v} & C_{3v} point groups, Mulliken symbolism rules for irreducible representations & its illustrations. Standard reduction formula, Direct product and its uses.

Reference Books:

1. Inorganic Chemistry, *IVth Eds., Shriver and Atkins*, Atkins, Overton, Rourke, Weller, Armstrong.
2. Mechanism of Inorganic Reaction, *IInd Eds.*, F. Basolo and R. G. Pearsons.
3. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson.
4. Advanced Inorganic Chemistry, Vol. I & II, Gurdeep Raj.
5. Concise Inorganic Chemistry, J.D. Lee.
6. Chemical applications of Group Theory, F.A. Cotton.
7. Symmetry and Spectroscopy of Molecules, *IInd Rev. Eds., New Age Inter. Publishers 2009* K. Veera Reddy.
8. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D Madan.
9. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S.K. Basu, R.D. Madan.
10. Group Theory and Symmetry in Chemistry, Gurdeep Raj, Ajay Bhagi, Vinod Jain
11. Inorganic Chemistry, J. E. Huhhey, E.A. Keiter, R.L. Keiter, O.K. Medhi.
12. Symmetry and Group Theory in Chemistry, Mark Ladd.
13. Inorganic Chemistry, Holleman–Wiberg.
14. Reaction Mechanism of Metal Complexes, R.W. Hay.
15. Inorganic Chemistry, Willam W. Porefield
16. Inorganic Chemistry, J.E. House.

M. Sc. First Year (*First Semester*)

PAPER 102 : ORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Nature of Bonding in Organic Molecules **12 Hrs.**

Delocalized chemical bonding conjugation, Resonance, Hyperconjugation, Bonding in fullerenes, Tautomerism.

Aromaticity in benzenoid and non–benzenoid compounds, Alternant and non–alternant compounds, Huckel rule, Annulenes, Aromaticity, homo–aromaticity, ψ–aromaticity, PMO approach, Crown ethers complexes and cryptands, Inclusion compounds.

Unit II: Reaction Mechanism: Structure and Reactivity **13 Hrs.**

Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammonds postulates, Curtin–Hammett principle, Potential energy diagrams, Transition states and intermediates, Methods of determining mechanisms, Isotope effects, Hard and soft acids and bases, Generation, structure, stability and reactivity of carbocations, Carbanions, Free radicals, Carbenes and Nitrenes. Effect of structure on reactivity, Resonance and field effect, Steric effect, Quantitative treatment, The Hammett equation, Linear free energy relationship, Substituents and reaction constants, Taft equation.

Unit III: Stereo–chemistry **20 Hrs.**

Elements of symmery, Chirality, Enantiomeric and diastereomeric Relationships, R and S–, E and Z– nomenclature, Molecules with more than one chiral center, Threo– and Erythro– isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions. Optical activity in the absence of Chiral carbon (Biphenyls, allenes and Spiranes), Chirality due to helical shape, Methods of resolution, optical purity, stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous, Conformations analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, Effect of conformation on reactivity.

Unit IV: Aliphatic Nucleophilic Substitutions **12 Hrs.**

The SN^2, SN^1, mixed SN^1 & SN^2, and SET mechanisms, Neighboring group participation by π and 6–bonds, anchimeric assistance. Nucleophilic at an allylic aliphatic trigonal and a vinylic carbon.

Reactivity: Effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophiles, regioselectivity.

Unit V: Aliphatic Electrophilic Substitution **03 Hrs.**

Bimolecular mechanisms –SE^2 and SE^i The SE^1 mechanisms. Electrophilic substitution accompanied by double bond shifts.

Reference Books

1. Advanced Organic Chemistry, IV Edn –J. March
2. Stereochemistry of carbon Compounds – E. L. Eliel
3. Advanced organic chemistry, F. A. Carey and R. J. Sundberg
4. A guide book to mechanism in organic chemistry: Peter Sykes.
5. Mechanism and Structure in organic Chemisry ,E.S.Gould
6. Principle of Organic Synthesis: R.O.C. Norman.
7. Modern Methods of Organic Synthesis: W. Carruthers

M. Sc. First Year (*First Semester*)

PAPER 103 : PHYSICAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Differential Calculus **08 Hrs.**

A. Functions: Differentiation, Rules for differentiation, Applications of differential calculus including maxima and minima, Simple differentials with their applications to Chemistry.

B. Integral Calculus: Basic rules for integration, Integration by partial fraction and substitution, Permutation and combination probability and Thermodynamic probability, Graphical representation for linear equations.

Unit II: Chemical Dynamics **15 Hrs.**

Collision theory, Modified collision theory, Weakness of the collision theory, Theory of absolute reaction rates, Equilibrium hypothesis, Derivation of rate equation, Statistical mechanical derivation and thermodynamic formulation. Isotope effect on reaction rate. Primary salt effect. Dynamics of uni–molecular reaction, Lindmann, Hinshelwood, KRR and Slater's treatment for unimolecular reaction. Kinetics of fast reactions, Study of fast reaction by flow method, relaxation method, flash photolysis and NMR method. Reactions in solution: reaction between ions fluency of solvent–double sphere model, single sphere model, Influence of ionic strength, Numericals.

Unit III: Classical Thermodynamics **10 Hrs.**

Third law of thermodynamics Nernst heat theorem, the third law of thermodynamics, determination of absolute entropies of solids, liquids and gases. Partial molar properties: Partial molar free energy, chemical potential, partial molar volume and partial molar heat content and their significance, determination of these quantities, concept of fugacity and determination of fugacity

Non–Ideal Systems: Excess functions for non–ideal solutions, activity and activity coefficient. Debye Huckel theory for activity coefficient of electrolytic solutions; determination of activity anJ activity coefficient, ionic strength, Numericals.

Unit IV: Surface Chemistry **12 Hrs.**

A. Micelles:

Surface active agents, Classification of surface active agents, Micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants. Thermodynamics of micellizatioti, solubilization .micro emulsion.

B. Adsorption:

Surface tension, capillary action, pressure difference across curved surface (Laplace equation) vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm. estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces, Numericals.

Unit V: Electro–Chemistry **15 Hrs.**

Debye–Huckel theory of Strong electrolytes, Debye–Huckel–Onsager equation, Testing of the equation, Dehye–Falkenhagen, Wein effect, activity coefficient, mean ionic activity coefficient; Debye–Huckel limiting law ionic strength Electro capillary phenomena, and its measurements Effect of anions, cations and molecules on electro–capillary curves Electro capillary properties of mercury– solution interface. Lppmann equation. Structure of electrified interfaces –Helmholtz, Gouy–Chapman, Stern, Grahm, Devnathhan models.

References Books:

1. Mathematics for Chemists, Bhupendra Smgh (Pragati Prakashan).
2. Mathematical Techniques of Chemistry and other Physical Sciences, B. K. Sen. (Kalyani Publication)
3. Chemical Kinetics, Laidler (McGraw–Hill).
4. Kinetic and Mechanism of Chemical Transformations, J Rajaram & J.C. Curiacose.
5. Physical Chemistry, Atkins (Oxford).
6. Thermodynamics for Chemists, S. Gladstone (EWP. Neiv Dellir)
7. Physical Chemistry, G. M Barrow.
8. Advanced Physical Chemistry, Gurdeep Raj.
9. Micelles: Theoretical and Applied Aspects, V. Moroi (Plenum).
10. Text Book of Physical Chemistry – S. Glasstone (McMillan).
11. An Introduction lo Electrochemistry – S Glasstone (EWP. New Delhi).
12. Modem Electrochemistry. Vol. I and II – J.O.M. Bockris and A K.N Reddy (Plenum).
13. Electrochemistry: Principles, Methods and Application, C.M. A. Brett & A.M.O. Brett (Oxford).

M. Sc. First Year (*First Semester*)

PAPER 104 : ANALYTICAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Analytical Chemistry – A Perspective **05 Hrs.**

Basics of Analytical Chemistry, The nature of analytical Chemistry, The role of analytical chemists, Qualitative and quantitative analysis, Analytical methodology (Sampling, Sample dissolution, Conversion of the analyte to a measurable form, Measurments, Calculation and Interpretation of the measurments).

Unit II: Statistical Treatment of Analytical Data: **10 Hrs.**

Introduction, Error & its types, Significant figures, Accuracy and Precision, Methods of expressing accuracy, Methods of expressing precision, Statistical treatment of finite samples (Mean, Median, Range, Average deviation, Relative average deviation, Standard Deviation, Coefficient of Variation, Variance), Confidence limit, Tests of significance–the 'F' test, the student's 't' test, Rejection of results–'Q' test, Numericals.

Unit III: Volumetric and Gravimetric Analysis **12 Hrs.**

Volumetric Analysis – Titration, Equivalence and End point, Standard solutions, Indicators, Theory of indicators, Types of titrations in Volumetric analysis (Acid–Base, Precipitation, Redox, complexometric titrations with principle, sub–types, applications to each).

Gravimetric Analysis – Precipitation, Properties of Precipitates and precipitating reagents, Types of Precipitating reagents/agents (Inorganic, Organic, Reducing), Particle Size and Filterability of Precipitates (Factors determining size, mechanism of precipitate formation, Control of particle size), Colloidal Precipitates (Coagulation of colloids, Peptization of colloids), Crystalline Precipitates, Coprecipitation & its types, Post–precipitation, Precipitation from homogenous solution, Drying and Ignition of Precipitates.

Unit IV: Basic Separation Techniques: Distillation and Solvent Extraction **10 Hrs.**

Distillation, Fractional distillation, Distillation under vacuum, Theory of operation of distillation methods, Some practical considerations.

Solvent Extraction: Principle, Partition/Distribution coefficient and Distribution ratio, Classification of extractions, Mechanism of Extraction, Extraction by Chelation with equilibrium, Extraction by Solvation with equilibrium, Practical Illustrations – Extraction of metals, Extraction by Ion pair, Accelerated and Microwave assisted extraction, Solid phase extraction, Numericals.

Unit V: Chromatography **07 Hrs.**

Definition of Chromatography, Classification of Chromatographic methods, Theory of chromatographic techniques (plate theory, rate theory), Zone broadening, Development of the chromatograms (Frontal analysis, elution analysis, displacement analysis), Selection of chromatograph system, Qualitative and Quantitative analysis by chromatography.

Unit VI: Thin layer Chromatography **03 Hrs.**

Basic Principles, Experimental Techniques–Solvent systems, Plate development, Detection of components, Evaluation of chromatogram by different methods, Applications of TLC.

Unit VII: Column Chromatography **03 Hrs.**

Principle, Experimental Details, Theory of development, Column efficiency, Factors affecting column efficiency, Applications.

Unit VIII: Gas Chromatography **05 Hrs.**

Principles, Types of GC (Gas–Liquid and Gas–Solid), Instrumentation and Working of GLC (Carrier gas, Sample introduction system, Columns and Stationary Phases, Detectors), Theory of GLC (Theoretical plate concept, Calculation of number of theoretical plates, The van Deemter Equation, Resolution, Factors in Retention), Applications, Numericals.

Unit IX: High Performance Liquid chromatography **05 Hrs.**

Principle, Instrumentation (Solvent systems, Pumping systems, Sample Injection system, Columns, Detectors systems), Applications, HPLC adsorption and partition chromatography.

Reference Books

1. Quantitative Analysis, 6th Eds., R.A. Day Jr., A.L. Underwood
2. Fundamental of Analytical Chemistry, 8th Eds., D.A. Skoog, D.M. West, F.J. Holler, S.R. Crough.
3. Analytical Chemistry, 6th Eds. G D. Christian.
4. Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.O. Barnes, M. Thomas, B. Sivasankar.
5. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr.
6. Basic Concepts in Analytical Chemistry, S.M. Khopkar,
7. Quantitative Analytical Chemistry, 2nd Eds. James S Fritz and George H. Schenk Jr.
8. Handbook of Instrumental Methods for Analytical Chemistry, F. Settle.
9. Treatise on Analytical Chemistry: Vol. I to Vol. II–I .M. Kolthoff.
10. Modern Instrumental Analysis, Volume 47. Edited by S. Ahuja, N. Jespersen, Elsevier
11. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, John Wiley & Sons, 1989

M. Sc. First Year (*First Semester*)

PAPER 104 : ANALYTICAL TECHNIQUES

100 Marks **60 Hours**

Unit I: **15 Hrs.**

Paper Chromatography: Definition, theory and principle, techniques, one, two dimensional and circular paper chromatography, mechanism of separation, structure of cellulose and types of paper, methodology–separation of sample, choice of solvents, location of spots and measurement of R_f value, factors affecting R_f value, advantages and applications.

Affinity Chromatography: Introduction, theory stationary phase, preparation of column, separation of antigens.

Exclusion Chromatography: Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography (GFC) and gel–permeation chromatography (GPC), materials for packing–factors governing column efficiency, methodology and applications.

Unit II: Ion exchange Chromatography **15 Hrs.**

Fundamentals, Properties of ion exchangers, Theory of ion exchange, Exchange capacity, Screening effect, Penetration of electrolytes into ion exchange resins, Sorption of complex ions, Cation and Anion exchangers, Action of ion exchange resins, Ion–exchange equilibria and ion exchange capacity. Strongly and weakly acidic cation exchangers, Strongly and weakly basic anion exchangers, Liquid ion exchangers, Chelation ion exchangers, Techniques of ion exchange, Use of non aqueous solvents in one exchange separation, Application of ion exchange separation in determination of total salt concentration, Removal of interfering ions, Separation of anions and metals and Applications in analytical chemistry, Separation using solvent mixture.

Unit III: **15 Hrs.**

Membrane–Based Methods: Dialysis– Working of techniques, Membranes, General consideration of diffusion, Donnan Membrane equilibrium and Applications.

Electrodialysis– Working of techniques, Membranes, Electrodialysis cells and Applications.

Ultrafiltration– Working of techniques, Membranes, Non–gelatinous membranes and Applications. Dialysis compared with other membrane–separation methods.

Other Separation Methods: Ultracentrifugation–Principle, Sedimentation constant, Sedimentation equilibrium, Sedimentation velocity, Methodology and Applications.

Zone refining– Principle, Zone leveling and Applications.

Unit IV: Electoanalytical Techniques **15 Hrs.**

Potentiometry & pH Metry: Potentiometry, Indicator electrodes: Hydrogen electrode, Quinhydrone electrode, Antimony electrode and glass electrode, Reference electrodes, Bimetallic electrode, Theory

of potentiometric titrations, Problems, Nernst equation, Standard electrode potential, Determination of cell potential, n, Kf and Ksp. pH titrations.

Conductometry: Principal of analysis, Measurement of conductance, Analytical applications of conductometry, Conductometric titrations. High frequency titrations. Types of cells used, Instrumentation and Applications. Problems.

Electrogravimery: Theory of electrolysis, Electrode reactions, Over voltage, Characteristics of deposits and completion of deposition, Separation of metals.

References Books:

1. A Textbook of Inorganic Qualitative Analysis. By A I Vogel.
2. Chromatography. By E Heftman, 5th edition, part–A and part–B, Elsewhere Science Publisher, 1992.
3. Chromatography Today. By C F Poole and S K Poole, Elsewhere Science Publisher, 1991.
4. Analytical Chemistry. By G D Christian 4th edition, John Wiley and Sons, 1986.
5. Instrumental Methods of Analysis, by B K Sharma, 19th edition, Goel Pubisher,2000.
6. Basic Concept in Analytical chemistry, by S.M. Khopkar.
7. Braun: Instrumental Methods of Chemical Analysis
8. Willard, Merritt and Dean: Instrumental Methods of Analysis
9. Strouts, Crifillan and Wison: Analytical Chemistry.
10. Quantitative Analysis, 6th Eds., R.A. Day Jr., A.L. Underwood
11. Fundamental of Analytical Chemistry, 8th Eds., D.A. Skoog, D.M. West, F.J. Holler, S.R. Crough.
12. Analytical Chemistry, 6th Eds. G D. Christian.

M. Sc. First Year (*First Semester*)

PAPER 105 : PRACTICAL COURSE–I

(PART A: INORGANIC CHEMISTRY PRACTICALS & PART B: ORGANIC CHEMISTRY PRACTICALS)

100 Marks **60 Hours**

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PART A: INORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

I) Separation and estimation of metal ions from the following binary mixture solution:

1. Copper–Nickel 2. Copper–Iron 3. Nickel–Zinc 4. Iron–Magnesium
5. Copper–Barium 6. Iron–Aluminum 7. Cadmium-Manganese 8. Iron-Calcium

OR

I) Separation & estimation of metal ions from the ternary mixture solution:

1. Copper–Nickel–Zinc 2. Copper–Nickel–Magnesium. 3. Iron–Nickel–Zinc
4. Silver–Nickel–Magnesium 5. Silver–Copper–Zinc.

II) Synthesize, characterization and estimation the amount of metal ion from the metal complexes:

1. $Ti(C_9H_8NO)_2\,2H_2O$ 2. $VO\,(acac)_2$ 3. $Cis–K[Cr(C_2O_4)_2(H_2O)_2]$
4. $[Mn(acac)_3]$ 5. $K_3[Fe(C_2O_4)_3]$ 6. $[Co(II)(Py)_2Cl_2]$
7. $[Co(III)(NH_3)_6]Cl_3$ 8. $[Co(III)(NO_2)(NH_3)_5]Cl_2$ 9. $[Ni(NH_3)_6]Cl_2$
10. $[Cu(NH_3)_4].SO_4.H_2O$ 11. $Hg[Co(SCN)_4]$ 12. $NH_4.[Cr(NH_3)_2(SCN)_4]$

Reference Book:

1) A Text book of Quantitative Inorganic Analysis A. I. Vogel.
2) Practical Inorganic Chemistry, Pass Geoffrey and Haydn Sutcliffe.
3) Advanced Practical Inorganic Chemistry :Gurudeep Raj;
4) Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Logman Ltd.
5) M.A. Malati, Experiments in Inorganic/Physical Chemistry.

PART B: ORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

Qualitative Organic Analysis

Separation, Purification and Identification of binary/ternary mixture of Compounds.

The two-components may be solid-solid, solid-liquid or liquid-liquid (non volatile)

The water soluble solid/liquid should also be given

Student should submit purified sample of the separated compound and prepare suitable derivatives of the compounds.

M. Sc. First Year (*First Semester*)

PAPER 106 : PRACTICAL COURSE–II

(PART A: PHYSICAL CHEMISTRY PRACTICALS & PART B: ANALYTICAL CHEMISTRY PRACTICALS)

100 Marks **60 Hours**

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PART A: PHYSICAL CHEMISTRY PRACTICALS **(50 Marks)**

NON-INSTRUMENTAL EXPERIMENTS

Chemical Kinetics

1. To investigate the auto-catalytic reaction between potassium permanganate and oxalic acid.
2. Iodonation of acetone
3. Determination of energy of activation of acid catalyzed hydrolysis of an ester.

Adsorption

1. Acetic acid on activated animal charcoal

Phase Equilibria

1. Three component system: Acetic acid, chloroform, water
2. To determine the CST of phenol-water system in presence of 1% NaCl

Surface Tension:

1. To determine the surface tension of a liquid by stalagmometer (drop number method)

INSTRUMENTAL EXPERIMENTS

pH metry

1. Determination of pKa of dibasic acid (Oxalic acid)
2. Determination of hydrolysis constant of aniline hydrochloride

Conductometry

1. Titration of $ZnSO_4$ / $MgSO_4$ against $BaCl_2$ and $Ba(CH_3COO)_2$ and calculation of amount of Sulphate Present .
2. Conductometric estimation of NH_4Cl with NaOH solution.

Potentiometry

1. To determine the basicity and pKa value of organic acids by potentimetric method.
2. Determine the solubility and solubility product of sparingly soluble salts.

PART B: ANALYTICAL CHEMISTRY PRACTICALS **(50 Marks)**

1. Extraction of organic compounds from natural sources
    - Isolation of caffeine from tea or coffee.
    - Isolation of nicotine (an alkaloid) from tobacco.
    - Isolation of piperine from black papper (piper rigrum).
    - Isolation of lactose from milk.
2. Spectrophotometric (UV/VIS) estimations

- Vitamin-C by ultraviolet spectrophotometer.
- Amino acids using ninhydrin method.
- Ascorbic acid.
- Ascorbic acid in plant tissues.

Reference Books:

1. Organic Chemistry-A Lab Manual by Pavia, Lampman, Kriz, Engel
2. Advanced Practical Chemistry by J. Singh, L. D. S. Yadav, R. K. P. Singh, I. R. Siddiqui, J. Singh, J. Srivastava
3. Practical Biochemistry for Students by V. K. Malhotra
4. Methodology for Water Analysis (Third Edition-2006) by Indian Association of Aquatic Biologists (IAAB)

M. Sc. First Year (*Second Semester*)

PAPER 201 : INORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Spectroscopic Symbols **5 Hrs.**

Terms, States, Microstates, Inter–electronic repulsion, Spin–orbit vector coupling, Ground term and excited terms, Determination of terms symbol for d^1 to d^5 Configurations, Microstate table, Hunds rule, Fine, Hyperfine and Superhyperfine Splitting of Free ions, Racah Parameters, Numericals.

Unit II: Term Diagrams **5 Hrs.**

Weak and stronger field approach of terms, Orgel diagrams of d^1 to d^9 configuration in Octahedral and Tetrahedral environments, Correlation diagrams of d^1, d^2, d^8 and d^9 configuration in Octahedral and Tetrahedral environments, Non–crossing Rule, Tanabe–Sugano diagrams of d^2 and d^3 configurations of an octahedral environment.

Unit III: Electronic Spectra of Transition Metal Complexes **12 Hrs.**

Types of experimental recording of the spectra, Selection rule for electronic spectra, Relaxation in Selection rules, Band intensities, Intensity of d–d bands, Intensity of change transfer bands, Classification of Electronic spectra, Interpretation of electronic spectra of transition metal ions with suitable examples, Charge transfer spectra & its types with mechanism, Evaluation of D_q, B' and β parameters (Graphical and Konig method), Numericals.

Unit IV: Magnetic Properties of Transition Metal Complexes **08 Hrs.**

Types of magnetic materials, Magnetic moment, Electronic spectrum and structure of Cobalt and Nickel complexes. Anomalous magnetic moments, Account on various models used for the anomalous behavior of magnetism, Magnetic Exchange Coupling, Types of antiferromagnetism

Unit V: Chemistry of Metal Carbonyls **10 Hrs.**

Classification, Preparation, properties, structures and bonding in –iron carbonyls, $Ni(CO)_4$ $Co_2(Co)_8$ $Mn_2(CO)_{10}$, $Cr(CO)_6$, $Mo(CO)_6$,$W(CO)_6$, $C_{O4}(CO)_{12}$ and V $(CO)_6$, Effective Atomic Number (EAN or 18 electron) rule applied to these carbonyls. Structures of mixed carbonyls of transition metals and EAN rule applied to these carbonyls. Preparations of carbonylate ions, and carbonyl hydrides.

Unit VI: Metal Nitrosyl Compounds **05 Hrs.**

Classification, Preparations and properties of Nitrosyl halides (NOX), Metal nitrosyl, Compounds containing neutral NO, NO^- group, NO^+ group, Preparation, structure and application of Sodium Nitropruside, EAN rule applied to Nitrosyl compounds of Cobalt, Iron and Manganese, Significance of NO for the life of living animals.

Unit VII: Chemistry of Non–Transition elements **15 Hrs.**

General discussion on the properties of the non–transition elements, Synthesis, properties and structure of halides and oxides of the non–transition elements, Polymorphism in Carbon, Phosphorous and Sulphur, Synthesis, properties and structure of Boranes, Carboranes,

Silicates, Silicones, Carbides, Phosphazenes, sulphur–nitrogen compounds, Structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, Interhalogens, Pseudohalides.

Reference Books:

1. Inorganic Chemistry, IVth Eds., *Shriver and Atkins*, Atkins, Overton, Rourke, Weller, Armstrong.
2. Inorganic Chemistry (IIIrd Eds.)– By G. Y. Miessler, D.A. Tarr.
3. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson.
4. Advanced Inorganic Chemistry, Vol. I & II, Gurdeep Raj.
5. Concise Inorganic Chemistry, J.D. Lee.
6. Chemical applications of Group Theory, F.A. Cotton.
7. Symmetry and Spectroscopy of Molecules, *IInd Rev. Eds., New Age Inter. Publishers 2009* K. Veera Reddy.
8. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli, R.D Madan
9. Advanced Inorganic Chemistry, Satyaprakash, G. D. Tuli, S.K. Basu and R.D. Madan.
10. Inorganic Chemistry, J. E. Huhhey, E.A. Keiter, R.L. Keiter, O.K. Medhi.
11. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw.
12. Inorganic Chemistry, Holleman–Wiberg.
13. Reaction Mechanism of Metal Complexes, R.W. Hay.
14. Inorganic Chemistry, Willam W. Porefield
15. Inorganic Chemistry, J.E. House.
16. Inorganic electronic spectroscopy,–A.B.P. Lever.
17. Element of Magnetochemistry– By A. Samal & R.L. Datta.
18. Introduction to Magnotochemistry – Alan Earnshaw.
19. Introduction to Ligand Field – B. N. Figgis

M. Sc. First Year (*Second Semester*)

PAPER 202 : ORGANIC CHEMISTRY

100 Marks **60 Hours**

Unit I: Aromatic Electrophilic Substitution **10 Hrs.**

The arenium ion mechanism , orientation and reactivity, energy profile diagram ,orto/para ratio, IPSO substitution , orientation in other ring system, recapitulation of halogenations , nitration ,sulphonation and friedel craft's reactions. Diazonium coupling.

Unit II: Aromatic Nucleophilic Substitution **5 Hrs.**

The SN^{Ar}, SN^{1}, benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophilic on reactivity

Unit III: Addition to Carbon–Carbon multiple bond **10 Hrs.**

Mechanism and streochemical aspect of addition reaction involving electrophile, Nucleophile and free radical, Regioselectivity and chemo selectivity, orientation and reactivity, Michael addition, Sharpless asymmetric epoxidation.

Unit IV: Addition to Carbon –Hetero multiple bond **12Hrs.**

Mechanism of Metal hydride reduction of saturated and unsaturated carbonyl compound, acid, ester and nitriles , Addition of Grignard reagent , Organo zinc and organo lithium reagent to carbonyl and unsaturated carbonyl compounds,Witting reaction , Mechanism of condensation reaction involving enolates–Aldol, Knovenagel, claisen , Mannich , Benzoin ,Perkin, Stobbe reaction , Hydrolysis of ester and amides.

Unit V: Elimination Reaction **08 Hrs.**

The E1, E2 and E1cs mechanism. Orientation of double bond , reactivity: Effect of substrate substance , attacking base , the leaving group and the medium , pyrolytic elimination .

Unit VI: Oxidation and Reduction **15Hrs.**

Oxidation : Introduction , different oxidative process, hydrocarbon –alkanes, aromatic ring s, alcohol, diol,s, aldehyde,ketones, Ketal and carboxylic acids,amine , hydramine, and sulphide ,Oxidation with Ruthenium tetraoxide, ,Iodobenzene diaacetate and Thallium (III) nitrate.

Reduction: Introduction, different reductive process , alkenes, alkynes and aromatic ring carbonyl compounds ,aldehydes, ketones,acids and their derivatives , epoxides , nitroso,azo and oxime groups, hydrogenolysis.

Reference Books

1. Advanced Organic Chemistry, IV Edn –J. March
2. Stereochemistry of carbon Compounds – E. L. Eliel
3. Advanced organic chemistry, F. A. Carey and R. J. Sundberg
4. A guide book to mechanism in organic chemistry: Peter Sykes.
5. Mechanism and Structure in organic Chemisry ,E.S.Gould
6. Principle of Organic Synthesis: R.O.C. Norman.
7. Modern Methods of Organic Synthesis: W. Carruthers

M. Sc. First Year (*Second Semester*)

PAPER 203 : PHYSICAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Quantum Chemistry **25 Hrs.**

A) Introduction to Quantum Mechanics

The Schrodinger equation, Discussion of solution of the Schrodinger equation to some model system viz particle in a one dimensional box and three dimensional box , Harmonic oscillator, Rigid rotor, the hydrogen atom, Numericals.

B) Approximate Methods

The variation Theorem, Linear variation principle, Perturbation theory (First order and non–degenerate), Applications of variation method and perturbation theory to Helium atom.

Theory of Angular Momentum: Angular momentum vector, Angular momentum operator, Commutation rules and their physical signification, Ladder operator, Orbital and Spin angular momentum, Addition of angular momenta: Russell–Saunder coupling scheme and term symbols, Numericals.

C) Molecular Orbital theory

Huckel Theory of conjugated systems, Application to ethylene, butadiene, cyclopropenyl radical and cyclobutadiene, Numericals

Unit II: Phase Rule **10 Hrs.**

Recapitulation of phase rule and terms involved in it, One component, Two component system(solid–solid, solid–liquid and liquid–liquid), Reduced phase rule, Three component systems, Partially miscible three liquid system: One partially miscible pairs, Two partially miscible pairs, Three partially miscible pairs, System composed of two solid and a liquid : Crystallization of pure component only, Formation of binary compounds, Formation of ternary compounds, Formation of solid compounds, Partially miscibility of solid phases, Numericals.

Unit III: Crystallography **15 Hrs.**

Classification of solids on the basis of shapes, Crystal lattice and unit cell, Law of crystallography, Crystal symmetry, Lattice planes and their designation.

Principle of crystal structures: Close packing of atoms, packing of equal sized spheres in HCP, CCP, BCC structures, packing in ionic solids, ionic radius, radius ratio rule (3,4,6,8 co–ordinate structures), octahedral and tetrahedral voids, isomorphism and polymorphism, Numericals.

Unit IV: Photochemistry **10 Hrs.**

Absorption of light and nature of absorption spectra, Electronic transition, Franck–Condon principle, Photo–dissociation and pre–dissociation, Photo–oxidation and photo–dimerization, Photo–physical phenomenon, Jablonski diagram, Photo–physical pathway of molecular de–excitation, Difference between delayed fluoresesence and phosphorescence, Quenching of fluorescence, Formation of excimer and examples.

Reference Books

1. Quantum Chemistry, Ira N. Levine.
2. Quantum Chemistry, R.K.Prasad.
3. Quantum Chemistry, B.K.Sen.
4. Principle of Physical Chemistry, Puri, Sharma, Pathania.
5. Advanced Physical Chemistry, Gurdeep Raj.
6. Physical Chemistry, Maron and Prutton
7. Fundamentals of Photochemistry, Rohatgi – Mukherjee.
8 Photochemistry, J.G.Calvert and J.N.Pitts.
9 Photo–luminescence of solutions, C.A. Parrker
10. Photochemistry, A. Singh and R. Singh
11. Solid State Chemistry, D.K.Chakraborti.
12. Solid State Chemistry and its applications, A. R. West.
13. Principle of Solid State, H.V.Keer.

M. Sc. First Year (*Second Semester*)

PAPER 204 : SPECTROSCOPY, DIFFRACTION & THERMAL METHODS OF ANALYSIS

100 Marks **60 Hours**

Unit I: General Introduction of Spectral Methods **05 Hrs.**

Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter–absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra, Basic elements of practical spectroscopy, Resolving power, Signal to noise ratio, Uncertainty relation and natural line width, Natural line broadening, Intensity of spectral lines, Energy levels, Selection rules, Components of spectrometer and their functions.

Unit II: Microwave spectroscopy **05 Hrs.**

Rotation of molecules, Rotational spectra, Diatomic molecules–rigid diatomic molecules, Intensities of spectral lines, Effect of isotopic substitution, Non–rigid rotator, The spectrum of non–rigid rotator, Polyatomic molecules, Technique and instrumentation in outline, Applications, Numericals.

Unit III: Vibrational Spectroscopy **10 Hrs.**

A. Infrared spectroscopy – Review of linear harmonic oscillator, The vibrating diatomic molecule, The simple harmonic oscillator, The anharmonic oscillator, The diatomic vibrating rotator, Vibration– rotation spectrum of carbon monoxide, Breakdown of Born–Oppenheimur approximation, The vibration of polyatomic molecules, Overtones and combination frequencies, The influence of rotation of the spectra of polyatomic molecules the influence of nuclear spin, Symmetric top molecules analysis by infra–red technique–Group frequencies, Outline of technique and Instrumentation.

B. Raman spectroscopy –Classical and Quantum of theory of Raman effect, Pure rotational, vibration and vibrational–rotational Raman spectra, Rule of mutual exclusion, Overtone and combination vibrations Rotational fine structure, Outline of technique and instrumentation, Applications.

Unit IV: Electronic Spectroscopy **07 Hrs.**

A. Atomic spectroscopy: Energies of atomic orbitals, Vector representation of momenta and vector coupling, Spectra of hydrogen and alkali metal atoms.

B. Molecular spectroscopy: Energy levels, Molecular orbitals, Vibronic coupling, Vibrational progression, Franck–Condon principle, Electronic spectra of polyatomic molecules.

C. Photoelectron spectroscopy: Basic principle, photoelectric effect, ionizatioprocess, Koopman theorem, Instrumentation (Sources for ESCA & AES, Vaccum System, Specimen & its manipulation, Analyzers, Detectors), Satellite peaks, Spectral splitting ESCA, Chemical shifts, PES spectra of simple molecule, Applications, Auger effect (KLL effect).

Unit V: Thermal Analysis **06 Hrs.**

General introduction, Classification of thermal methods of analysis,

Thermogravimetric analysis: Principles, Thermobalance, Factors affecting thermal curve, Derivative thermogravimetric analysis, Applications.

Differential thermal analysis: Principles, Instrumentation, Factors affecting DTA curve, Applications. Differential scanning calorimetry: Principles, DSC vs DTA, Instrumentation, Applications. Thermometric titrations, Numericals.

Unit VI: X–ray Diffraction **07 Hrs.**

Generation of X–rays, Interaction of X–rays with matter, Bragg's law, Miller indices, Diffraction methods (Laue/Single crystal and Powder/Debye–Scherrer methods), General instrumentation, Factors affecting X–ray intensity calculations, Identification of unit cells from systematic absences, Structure factor and its relation to electron density and intensity, Indexing of lattice planes in cubic system, Structure of NaCl and KCl, Avogadro's number from cubic lattice dimensions, Applications.

Unit VII: Ultraviolet-Visible Spectroscopy **04 Hrs.**

Various Electronic transition, Chromophores, Auxochromers, Bathochromic and Hypsochromic Shifts, Effect of solvent on electronic transitions, Woodward–Fieser rules dienes, enones and aromatic compounds, Applications.

Unit VIII: Infrared Spectroscopy **04 Hrs.**

Instrumentation and sample handling, Various vibrational transitions, Characteristic vibrationl frequencies of alkenes, alkynes, aromatic compounds, Carbonyl compounds, hydroxyl compound and amines. Factors affecting IR group frequencies, overtone, combination bands and Fermi resonance. Applications

Unit IX: Nuclear Magnetic Resonance Spectroscopy **06 Hrs.**

Elementary Ideas, Chemical Shifts, Factors affecting chemical shifts, Spin–Spin coupling constants (J) Instrumentations, Applications.

Unit X: Problems based on combined application of UV, IR and NMR **06 Hrs.**

Reference Books:

1. The Determination of Molecular Structure, P. J Wheatly
1. Physical Chemistry, G. M. Barrow
2. Instrumental Methods of Chemical Analysis, Chatwal Anand
3. A Text book of Physical Chemistry, A. S. Negi & S.C. Anand
4. Instrumental Methods of Chemical Analysis, Willard, Merritt, Dean & Seatle
5. Instrumental Methods of Chemical Analysis, B. K. Sharma
7. Instrumental Methods of Chemical analysis, R.D. Braun
8. Principles of Instrumental Analysis, Skoog and West
9. Fundamental of Molecular Spectroscopy, Banwell
10. Atomic and Molecular structure, Manas Chanda
11. Molecular Spectroscopy, B. D Acharya
12. Molecular Spectroscopy, Dyer
13. Organic Spectroscopy P. S. Kalsi (6^{th}Edition)
14. Spectroscopy Methods in Organic Chemistry D. H. Williams and I. Fleming
15. X–ray Diffraction, B.D. Cullity.

M. Sc. First Year (*Second Semester*)

PAPER 204 : TECHNIQUES FOR ANALYSIS

100 Marks **60 Hours**

Unit I: Radiochemical Methods **12 Hrs.**

Elementary working, Principles of Geiger Muller, Ionisation, proportional and l-ray counters. Radiotracer techniques, Application of radiotracers in analytical Chemistry.

Neutron activation analysis (NAA): Principle, technique and applications in preparation of some commonly used radioactive isotopes. Isotopic Dilution Analysis (IDA), Substoichiometric IDA, Experimental technique and applications of IDA, Advantages and limitations of IDA and comparison of IDA with NAA. Principle of Radiometric titrations, Types, Experimental techniques and its applications. Carbon dating. Numericals.

Unit II: Online Analyzers **12 Hrs.**

Introduction, Classification of automated methods, Principles and techniques of auto-analyzers employed for microanalysis with emphasis on the basis sequences in operational modes in segmented and non-segmented flow and applications. Selection of online analyzers.

Flow Injection Analysis: Introduction, Principal, theoretical aspects of FIA, Techniques, Pretreatment of sample in packed reactions, Components of FIA apparatus, Factors affecting FIA and applications for the determination F^-, Cl^-, PO_4^{-3}, NO^-_2, NO_3^-, SO_4^{2-},BO_3^{3-}, Ca^{2+}, Mg^{2+}, Al^{3+}, Mn^{2+}, Cr^{6+}, Fe^{3+} in water.

Unit III: Atomic Emission spectroscopy **8 Hrs.**

Introduction, Arc and spark atomization, spectra from higher energy sources, emission spectroscopy based upon plasma sources, atomic fluorescence method based upon plasma atomization. Emission spectroscopy based upon arc and spark sources. X-ray fluorescence and its principle.

Unit IV: Neutron & Electron diffraction **8 Hrs.**

Neutron Diffraction: Introduction, NRD vs. XRD, Instrumentation, Magnetic Scattering, Applications.

Electron Diffraction: Scattering intensity Vs scattering angle, Wierl equation, Measurment techniques, Elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surface.

Unit V: Optical Rotatory Dispersion (ORD) and circular Dichroism (CD) **5 Hrs.**

Definition, cotton effect, deduction of absolute configuration, octant rule for ketones.

Unit VI: Electron Microscopy **15 Hrs.**

Classification of electron microscopy methods, Scanning electron microscopy, Transmission electron microscopy, Probe microscopy: Scanning tunneling microscopy (STM) & atomic force microscopy (AFM), Application of EM, Comparison of electron microscopy with electron spectroscopy.

M. Sc. First Year (*Second Semester*)

PAPER 205 : PRACTICAL COURSE–III

(PART A: INORGANIC CHEMISTRY PRACTICALS & PART B: ORGANIC CHEMISTRY PRACTICALS)

100 Marks **60 Hours**

PART A: INORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

Semi-micro Qualitative Inorganic Analysis **(Atleast 08 mixture)**

Three acidic & three basic radicals including basic radicals (like Ba, Ca, Mn, Zn, Cu, Na, K, V, Co, Pb, Cd, Ag, etc) and acidic radicals (like Carbonate, Chloride, Nitrate, Iodide, Oxalate, Acetate, Sulphate, etc)

Reference Books

1. A Text book of Quantitative & Qualitative Inorganic Analysis, A. I. Vogel.
2. Practical Inorganic Chemistry, Pass Geoffrey and Haydn Sutcliffe.
3. Advanced Practical Inorganic Chemistry :Gurudeep Raj;

4. Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Logman Ltd.
5. M.A. Malati, Experiments in Inorganic/Physical Chemistry.

PART B: ORGANIC CHEMISTRY PRACTICALS **(50 Marks)**

Estimations & Preparations

M. Sc. First Year *(Second Semester)*

PAPER 206 : PRACTICAL COURSE–IV

(PART A: PHYSICAL CHEMISTRY PRACTICALS & PART B: ANALYTICAL CHEMISTRY PRACTICALS)

100 Marks **60 Hours**

PART A: PHYSICAL CHEMISTRY PRACTICALS **(50 Marks)**

NON-INSTRUMENTAL EXPERIMENTS

Chemical Kinetics

1. Determination of order of reaction by differential method
2. Comparison of acid strength by hydrolysis of ester

Viscosity

1. Determine the radius of molecule by viscosity measurements (glycerol / sucrose).

Adsorption

1. Oxalic acid on activated animal charcoal

Phase Equilibria

1. Three component system: Benzene, ethyl alcohol and water
2. To determine the CST of phenol-water system in presence of 0.5% naphthalene (or acid)

INSTRUMENTAL EXPERIMENTS

Refractometry

1. To determine the electron polarization and electron polarizability of a liquid.

pH metry

1. Determination of pKa of acid (Succinic acid)
2. Determination of hydrolysis constant of aniline hydrochloride

Conductometry

1. Solubility and solubility product of spranigly soluble salts.
2. Titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against alkali.

Potentiometery

1. Estimate the amount of halides present in the given mixture by titrating with $AgNO_3$ solution.
2. Titration of mixture of acids with base.

Polarimetry

1. To determine the percentage of two optically active substances (d-sucrose and d-tartaric acid) in a given solution.

PART B: ANALYTICAL CHEMISTRY PRACTICALS **(50 Marks)**

1. Redox titrations
   - Determination of the percentage of W/V of H_2O_2
   - Determination of percentage of KBr.
2. Quantitative analysis
   - Determination of saponification value of an oil or fat.

- Determination of iodine value of an oil or fat.
- Determination of acid value of oil or fat.
- Determination of dissolved oxygen (DO) in water sample.
- Determination of biochemical oxygen demand (BOD) in water sample.
- Determination of chemical oxygen demand (COD) in water sample.
- Determination of acetic acid in commercial vinegar using NaOH.

3. Etc.

Reference Books:

1. Organic Chemistry-A Lab Manual by Pavia, Lampman, Kriz, Engel
2. Advanced Practical Chemistry by J. Singh, L. D. S. Yadav, R. K. P. Singh, I. R. Siddiqui, J. Singh, J. Srivastava
3. Practical Biochemistry for Students by V. K. Malhotra
4. Methodology for Water Analysis (Third Edition-2006) by Indian Association of Aquatic Biologists (IAAB)

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

PAPER 301: APPLICATIONS OF SPECTROSCOPY

100 Marks **60 Hours**

Unit I: Nuclear Magnetic Resonance (^{1}H-NMR) **10 Hrs.**

Elementary Ideas (Recapitulation)

Spin-spin coupling, Different types of coupling, Factors affecting coupling constant, Karplus equation, Spin system (AB, AX, ABX, AMX, etc), Rate processes, Spin decoupling, Shift reagents, Nuclear over Hauser effect (NOE).

Unit II: C^{13}-NMR Spectroscopy **7 Hrs.**

Elementary Ideas, Instrumental aspects, chemical shift (Aliphatic, Olefinic, Alkyne, Aromatic, Heteroaromatic & carbonyl carbon), Effects of constituents on chemical shifts. Two dimensional (2D) NMR techniques: COSY, NOESY, DEPT, APT, INEPT & INADQUATE.

Unit III: Mass Spectrometry **7 Hrs.**

Introduction, Ion production (EI, CI, FD & FAB), Ion analysis, Ion abundance, Factors affecting fragmentation, Fragmentation of different functional groups, Molecular ion peaks, Metastable peaks Nitrogen rule, McLafferty rearrangement, Retro-Diels Alder reaction.

Unit IV: Problems based on joint application of UV, IR, NMR & Mass spectroscopy **6 Hrs.**

Unit V: Mossbauer Spectroscopy **10 Hrs.**

Principle of Mossbauer spectroscopy, Instrumentation, Isomer shift and its factors affecting, Quadrupole splitting, Temperature Dependence of MB parameters, Zeeman Splitting (Six fingered MB lines), MB spectra of iron and tin compounds, Applications, Numericals.

Unit VI: Electron Spin Resonance Spectroscopy **12 Hrs.**

Introduction, Principle of ESR Spectroscopy, Instrumentation, Presentation of spectrum, Hyperfine splitting in some simple systems, Hyperfine splitting in various structure (Naphthalene anion radical, Pyrazine anion radical, Isomers of Xylene anion radicals, VO^{2+}, Quinoline radical, Isoquinoline radical, Quinoxaline radical, Anthracene radical, Phenanthracne radical, Pyrene radical, Alkyl halide radicals, Quinone & Isoquinone anion radicals, nitrogen/deuterium containing radicals), Hyperfine splitting diagram, 'g' value, g-marker, Factors affecting the magnitude of 'g' values, Determination of g-value, Zero field splitting, Karmers's degeneracy, Applications, Numericals.

Unit VII: IR & Raman Studies of Complexes **8 Hrs.**

Origin of Molecular Spectra, Origin of Infrared and Raman Spectra, Modes of vibrations, Selection Rules for Infrared and Raman Spectra, Normal modes of vibrations in AB_2 (Linear/Bent), AB_3, AB_4, AB_5, Octahedral AB_6 molecules with factors affecting band frequencies.

Reference Books

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein- 6th Edition
2. Spectroscopy of Organic Compounds, V.M. Parikh.
3. Organic Spectroscopy, P.S. Kalsi
4. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.L. Nelson.
5. Mass Spectroscopy, K.G. Das & James.
6. Physical Methods in Chemistry, IInd Edition, R. S. Drago.
7. P.H. Rieger, Electron Spin Resonance: Analysis & Interpretation, RSC Publishing, 2007.
8. B. Simovic, Introduction to the Technique of ESR Spectroscopy. 2004.
9. A. Lund, M. Siotani, S. Shimada, Principles and Applications of ESR Spectroscopy, Springer.
10. P. Gutlich, E. Bill, A.X. Trautwein, Mossbauer Spectroscopy & Transition Metal Chemistry, Springer Publications, 2011.
11. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A & Part B, John Wiley & Sons Publishers.
12. Mossbauer Spectroscopy: Principles and Applications of the Techniques, A.G. Maddock.
13. An introduction to Electron Paramagnetic Resonance, *M. Bersohn & J.C.Baired,* W.A.Benjamin, Inc N.Y.
14. High resolution ESR Spectroscopy, F.Gerson (John Wiley & sons)
15. An introduction to Electron Paramagnetic Resonance, M. Bersohn & J.C. Baired, W.A. Benjamin, Inc N.Y.

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

PAPER 302: ENVIRONEMTAL CHEMISTRY

100 Marks **60 Hours**

Unit I: Air Pollution **10 Hrs.**

General consideration, Sources and sinks of air pollutants, Classification of air pollutants, Effect of air pollutants on living and non-living things, Sources and control of air pollution, Air quality standards and Sampling. Analysis of air pollutants (CO, CO_2, NOx, SOx,

H_2S, NH_3, Hydrocarbons and particulates). Green house effect, Acid rain, Ozone depletion and their consequences on environment. Effects of air pollution, Photochemical smog and monitoring of air pollution.

Unit II: Water pollution **13 Hrs.**

A. General: Origin of wastewater, Types of water pollutants and their effects, Sources of water pollution: domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Water quality parameters & standards, Sampling methods & prevention, Objective of analysis, Parameters for analysis: colour, turbidity, total solid, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution, public health significance of Cadmium, Chromium, Copper, Zinc Lead, Manganese, Mercury and Arsenic.

B. Analysis & Treatment of Waste Water **12 Hrs.**

General survey of instrumental techniques for the analysis of heavy metals in aqueous systems. Oxygen content of water and aquatic life. Measurements of Dissolved oxygen (DO), Biological Oxygen Demand & Chemical oxygen demand and their significance as pollution indicators., Monitoring techniques & methodology with special reference to Ammonia, Chloride, Fluoride, Nitrate, Nitrite, Cyanide, Lead, Cadmium, Mercury. Sewage composition & treatment.

Unit III: Chemical Toxicology **10 Hrs.**

Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Chromium, Carbon monoxide, Sulphur dioxide, Pesticides.

Unit IV: Noise Pollution **5 Hrs.**

Introduction, Difference between sound & noise pollution, Sources, Noise level measurments, Sonic boom, Anaerobic chamber & Reverberating of sound, Effects & Control.

Unit V: Effluent Analysis **10 Hrs.**

Effluent treatment and legislation, Characterization of waste water, Classification of effluents, Waste water treatment processes and recycling, Analysis of waste water, Physical methods of characterization, Analysis of organic and inorganic pollutants, Pollution from different industries: Sugar, Distillery, Paper & Pulp, Pharmaceuticals.

Reference Books

1. A.K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. R.K. Trivedi, P.K. Goel, Chemical and Biological Methods for Water Pollution Studies Environmental publication.
3. S.C. Santara, Environmental Science, Central Publications.
4. S.L. Chopra, J.S. Kanwar, Analytical & Agricultaure Chemistry, Kalyani publications.
5. S.M. Khopkar, Environmental Chemistry.
6. V.Subramanim, Environmental Science, Narosa Publishing House.
7. E. Bhatucha, Environmental Studies, UGC Press.
8. D.E. Newton, Chemistry of the Environment, Infobase Publishing-New York, 2007.
9. S.E. Manahan, Environmental Chemistry, Lewis Publishers.
10. A. Sharma & A. Kaur, Environmental Chemistry, Krishna publishers.
11. S.M. Khopkar, Environmental Pollution Analysis, Wiley Eastern Ltd. New Delhi.
12. Environmental Toxicology, Eds. J. Rose, Gordon and Breach Science Publications.
13. Atmospheric Pollution, W. Buch, McGraw Hill, New York.
14. Fundamentals of Air Pollution, S.J. Williason, Addison–Wesley Publishers.
14. Analytical Aspect of Environmental Chemistry, D.F.S. Natush and P.K. Hopke, John Wiley & Sons, New York.
16. J.W. Vanloon, Environmental Chemistry, Oxford University Press.

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

PAPER 303: ORGANIC REACTIONS & REARRANGEMENTS

100 Marks **60 Hours**

1. Name Reactions

Reaction, Mechanism and applications of following reactions: Gabriel synthesis, Streker amino acid synthesis, Ullmann, Mitsnobu, Favorski, Hofmann-Loffler-Freytag, Shapiro, Dakin, Von Richter, Henery, Mukaiyama reaction, Sonogishira reaction.

2. Rearrangement

Introduction

(A) Migration to Electron deficient Carbon: i) Pinacol-Pinacolone, ii) Wagner-Meerwein, iii) Demjanov, iv) Wolf, v) Benzil-Benzilic acid rearrangement.

(B) Migration to Electron deficient Nitrogen: i) Beckmann, ii) Hoffmann, iii)Curtius, iv) Lossen, v) Schimidt rearrangement.

(C) Migration to Electron deficient Oxygen: i) Favorskii, ii) Neber, iii) Dakin rearrangement.

(D) Electrophilic Rearrangement: i) Stevens, ii) Wittig, iii) Smile rearrangement.

3. Pericyclic Reaction

Introduction, Classification, Molecular Orbital Conservation Approach

(A) Cycloaddition reaction: Cycloaddition reactions and their stereochemical aspects, Woodward-Haffman rule, Selection rule for cycloaddition reaction, Details with examples of Diels-Alder reaction, (2+2) cycloaddition, (1, 3) polar cycloaddition, Cycloaddition of alkenes with OsO_4 and ozone, Cheleotropic reactions, Analyses of cycloaddition by FMO, Moblus-Huckel and Corrlaion diagram methods.

(B) Electrocyclic Reaction: Electrocyclic reactions and their stereochemical aspects, Selection rule of electrocyclic reaction, Con-rotations and dis-rotations, Methods of analyses of the electrocyclic reactions: FMO, Mobius-Huckel and Correlation diagram approaches.

(C) Sigmatropic rearrangements: Sigmatropic rearrangements and their stereochemistry, Rules for Sigmatropic rearrangements, Examples on (1, 3), (1, 5), (1, 7), (3, 3), (2, 3) Sigmatropic shifts, Claisen, Cope, Oxy-cope, Aza-cope, Sommelet-Hauser rearrangements, Ene reaction, Methods of analyses of the rearrangements: FMO, Mobius-Huckel and Correlation diagram approaches.

4. Photochemical Reaction

(A) Photochemistry of Alkenes: Intermolecular reactions of the Olefinic Bond-Geometrical Isomerism, Cyclization reactions, Rearrangement of 1, 4- and 1, 5-dienes.

(B) Photochemistry of Carbonyl compounds: Intermolecular reactions of the Carbonyl compounds-saturated, Cyclic and acyclic, β, γ-gamma unsaturated and α, β-unsaturated compounds, Cyclohexadienones, Intermolecular Cycloaddition reactions, Dimerizations and Oxetane formation.

(C) Photochemistry of Aromatic Compounds: Isomerization, Additions and Substitutions.

5. Protecting Groups

Introduction, Principle, Protecting groups for alcohols, carbonyl, carboxylic acids, amino groups.

Reference Books:

1. Designing Organic Synthesis: S. Warren, Wiley.
2. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers
3. Protective Groups in Organic Synthesis: T. W. Greene, G. M. Wuts.
4. Organic Syntheis: Jagdama Singh and L. D. S. Yadav
5. Advanced organic Chemistry: Part A & B, Reactions and Synthesis, F. A. Carey and R. J. Sundberg.
6. Organic Synthesis: M. B. Smith.

7. Principle of organic synthesis: Norman and Coxon
8. Advanced organic chemistry: Jerry March

Organic Photochemistry: Robert Kan

M. Sc. Second Year (*Third Semester*) Analytical Chemistry

PAPER 304: ANALYTICAL METHODS IN CHEMICAL ANALYSIS

100 Marks **60 Hours**

Unit I: Fluorescence and phosphorescence Spectrophotometry **05 Hrs.**

Structural factors, Phosphorescence intensity as related to concentration, Instrumentation for fluoresce-nce phosphorescence measurements, Problems.

Unit II: Atomic Absorption & Flame Emission Spectroscopy **10 Hrs.**

Flame Emission Spectroscopy: Elementary theory of flame photometry, Instrumentation and experimental techniques. Interferences & Methods for their Overcoming, Types of FES and Applications.

Atomic absorption spectrometry (AAS): Introduction, Principles, Advantages of AAS over FES, Instrumentation, Flame & Non-flame atomization. Sources of AAS (EDL, TGL, HCL), Interferences and Applications, Comparison of atomic absorption with flame emission spectroscopy, Numericals.

Unit III: Ion Selective Electrodes **05 Hrs.**

Terminology, Types and construction of electrodes, Glass electrode, Solid state and Precipitate electrode, Liquid-liquid membrane electrodes, Enzyme & Gas electrodes, Applications.

Unit IV: Coulometry **05 Hrs.**

Introduction, Principle, Techniques, Coulometer at constant & controlled current and Potential Coulometer, Primary & Secondary coulometric titrations, Errors in coulometric titrations, and Applications.

Unit V: Polarography **10 Hrs.**

Introduction, Theory (include Ilkovic equation, Reversible & Irreversible electrode processes, Reversible polarographic waves), Instrumentation, Modified Polarography techniques (include Sinusoidal AC Polarography, Square wave polarography, Oscillographic polarography, Rapid scan Polarography), Pulse Polarography, Chronopotentiometry & its practical aspects, Applications in qualitative and quantitative analysis, Numericals.

Unit VI: Cyclic Voltammetery **10 Hrs.**

Introduction, Reduction Potential, Electrode kinetics, Instrumentation, Cyclic voltammetric experiment (include electrochemical cell, electrochemical mechanism, distortions of Faradaic response), Microelectrodes & fast scan voltametry, Potential step methods and cyclic voltametry, Construction of a fast potentiostat, Numericals.

Unit VII: Electrophoresis **10 Hrs.**

Introduction, Paper electrophoresis and its advantages with limitations, Techniques in paper electrophoresis, Calculation of electrophoretic mobility, Factors affecting migration of the ions, Continuous electrophoresis, Thin layer electrophoresis, Density gradient electrophoresis, Zone electrophoresis, Curtain electrophoresis, Reverse Osmosis, Electrodialysis, Capillary electrophoresis or Capillary zone electrophoresis & its applications, Applications of paper electrophoresis.

Unit VIII: Chemical & Bio- Sensors **5 Hrs.**

Introduction, Sensor Design, Detection Methods, Sensing Principle of sensors, Various Chemical sensors include Oxygen gas sensors, pH sensors, Acidic/basic gas sensors using pH sensitive dyes, Cationic sensors, Anionic sensors, Biosensors.

Reference Books

1. D.K. Gosser (Jr.), Cyclic Voltammetry: Simulation and Analysis of Reaction Mechanisms, VCH Publishers, 1994.
2. K. Zutshi, Introduction to Polarography and Allied Techniques, New Age Publications, 2006.
3. Comprehensive Analytical Chemistry, Eds. D. Barcelo, Elsevier Publications, 2006.
4. Modern Instrumental Analysis, Volume 47. Eds. S. Ahuja, N. Jespersen, Elsevier Publications, 2006.
5. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edition, G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, John Wiley & Sons, 1989.
6. A.J. Bard, L.R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley & Sons.

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

PAPER 401: APPLIED ANALYTICAL CHEMISTRY-I

(Ores, Alloys, Soil, Fertilizers, Soap, Detergents, Paints & Pigments)

100 Marks **60 Hours**

Unit I: Analysis of Ores **10 Hrs.**

Constituents and Analysis of the following ores:

Iron ore for total iron by volumetric and gravimetric method (Hematite),

Manganese ore for total Manganese by gravimetric & volumetric method (Pyrolusite),

Chromium ore for chromium by volumetric and gravimetric method (Chromite),

Aluminium ore for aluminium by volumetric method (Bauxite),

Titanium ore for titanium by volumetric and colorimetric method (Ilemenite),

Monazite ore for thorium & its oxides, Copper ores (Malachite Green), Dolomite, Galena ores.

Unit II: Analysis of Alloys **10 Hrs.**

Analysis of major & minor components of the following Alloys:

Brass, Bronze, Monel-Metal, Types-metal, Solder, Silver-coin, Steel, Stainless steel

Unit III: Analysis of Soil **15 Hrs.**

Fundamentals, Soil Sampling, Determination of soil moisture (Gravimetric, Electrical Conductivity, Tensitometer), pH determination of Soil (Colorimetric, Potentiometric methods)

Determination of lime & liming materials in soil, Determination of silica and Phosphorus in soil

Determination of total manganese in soil, Determination of soluble salts (alkali salts) in soil

Factors affecting fertility of soil, Analysis of organic content in soil samples include total carbon by Wet method, total nitrogen by Wet & Kjeldahl methods.

Unit IV: Analysis of Fertilizers **10 Hrs.**

Classification of fertilizers (Nitrogeneous, Phosphatic and Potassic fertilizers),

Analysis of Nitrogenous fertilizers for ammonium sulphate (titrimetric, Spectrophotometric),

Microdetermination of nitrogen (Duma's method), Determination of ammonical and Nitrate nitrogen.

Analysis of Phosphatic fertilizers for ammonium sulphate, Analysis of Superphosphate, Analysis of water soluble phosphate (or available phosphate).

Analysis of Potassium by Perchlorate method, Cobaltnitrite method and Flame Photometric method.

Unit V: Analysis of Paints & Pigments **10 Hrs.**

Introduction, Determination of non-volatile & volatile components, Flash points, Separation, Isolation & Determination of pigments and thinners of solvent types coating, Types of Pigments, Isolation & Determinations of binders (IP method).

Unit VI: Analysis of Soap & Detergents **05 Hrs.**

Soaps:

Introduction, Types of soap, Manufacturing steps of soap (such as Boiling, Graining/Salting out, finishing), Cleansing action of soap.

Detergents:

Introduction, Raw materials for detergents, Types of Detergents,

Comparision of cleansing action between soaps and detergents.

References Books

1. M. Pansu, J. Gautheyrou, Handbook of Soil Analysis (Mineralogical, Organic and Inorganic Methods), Springer Publications, 2010.
2. B.K. Sharma, Analytical Chemistry.
3. Chopra and Kanwar, Analytical Agriculture Chemistry, Kalyani Publications.
4. S.K. Jain, Introduction to Metallurgical Analysis: Chemical Analysis and Instrumental.
5. F.J. Welcher, Standards Methods of Chemical Analysis.

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

PAPER 402: APPLIED ANALYTICAL CHEMISTRY–II

(Food, Pesticides, Oils & Fats)

100 Marks **60 Hours**

Unit I: General Concepts of Food Analysis **10 Hrs.**

i) Food contamination & spoilage: Causes, Microbial spoilage of fish, Bacterial spoilage of meat & its products, spoilage of milk & its products

ii) Food safety considerations. Appearance, Texture, Flavor

iii) Legislation related to food & recent amendments

Unit II: Methods of Food Analysis **10 Hrs.**

i) Food sampling for analysis

ii) Proximate composition of food: Water, Ash mineral matter, Nitrogen & crude nitrogen, Carbohydrates, Lipids/Fats, Proteins.

iii) Chemical characteristics & constituents.

Unit III: Analysis of Food Additives **05 Hrs.**

i) Food Preservatives: Definition, Preservation methods (Temperature control, Moisture control), Organic/Inorganic Chemicals as a preservatives (Benzoic acid, Sorbic Acid, Parabens, Sulfites, Nitrates, Nitrites, Sodium Chloride, Hydrogen Peroxides)

ii) Food Emulsifiers: Algin, Alginates in foods, Detection of alginates in foods

iii) Food Adulterants: Definition, Adulteration of juice, soft drinks, milk.

iv) Food stabilizers: Definition, Extraction of gum from fruits and vegetable products.

v) Sweetners: Definition, Different artificial sweeteners (Saccharin, Aspertame, Cyclamate, Dulcin, Acesulfame-K, Sucralose)

Unit V: Fat Analysis in Food **05 Hrs.**

Introduction, General Classification of lipids, Solvent extraction methods (Continuous, Semicontinu- ous, Discountious), Nonsolvent Wet extraction methods.

Unit VI: Protein Analysis in Food **05 Hrs.**

Introduction, Analysis by Dumas method, Biuret method, Lowry method, Dye-binding method, Bicinchonic method

Unit VII: Carbohydrate Analysis in Food **05 Hrs.**

Introduction, Analysis of total Carbohydrates by Phenol-Sulfuric acid method, Total Reducing Sugar by Somogyi-Nelson method, Analysis of Total Starch.

Unit VIII: Vitamin Analysis in Food **05 Hrs.**

Importance of Analysis, Vitamin Units, Methods for Vitamin Assay (Bioassay, Microbiological assay, Physicochemical assay). Analysis of the following Vitamins: Vitamin A, Vitamin E (Toropherols and Torotrienols), Vitamin C by titrimetric and microfluorometric methods, Vitamin B_1 by thiochrome fluorometric method, Vitamin B_2 by fluorometric method.

Unit IX: Analysis of Pesticides **10 Hrs.**

i) Introduction and classification of pesticides

ii) Legislation & recent amendments with respect to the pesticides materials

iii) Application dosage of different pesticides

iv) Analysis of DDT, BHC, Gammexane, Endosulphan, Zinab, Ziram, Malathion, Thiram, Thiometon, Simazine and Chloridane.

Unit X: Oils and Fats **05 Hrs.**

Introduction to natural fats & oils, Components of Fats and Oils, Structure of triglycerides, Analysis of fats & oils: Smoke point, Flash point, Fire point, Cloud point, Acid Value, Saponification Value, Iodine Value, Peroxide Value, Unsaponifiable matter, Water Content, Phosphorus Content, Colorimetric Value, Hexane in extraction meal, Crude Fibre in meal, Protein in meal, Ash, Solid Fat content, Dilatation (Solid fat Index).

References Books

1. S. Suzanne Nielsen, Food Analysis, Springer Publications, 2009.
2. Handbook of Food Analytical Chemistry, Eds. By R.E. Wrostad, T.E. Acree, E.A. Decker, M.H. Penner, D.S. Reid, S.J. Schwartz, C.F. Shoemaker, D. Smith, P. Sporns, Wiley-Interscience Publs.
3. L. Amsel, L. Hirsch, Food Science and Security, Nova Science Publishers, 2009.
4. J.M. deMan, Principles of Food Chemistry, ASPEN Publications, 1999.
5. K.V. Ramesh, Food Microbiology, MJP Publishers.
6. S.N. Mahindru, Food Science and Technology, APH Publishing Corporation.
7. B. Ghosh, M.S. Ranganathan, S. Sridhar, Enzyme and Food Biotechnology, Wisdom Press.
8. M. Bennion, Introductory Foods, Prentice Hall, Inc.
9. M. Bockisch, Fats and Oils Handbooks, AOCS Publications, 1998.

S. Suzanne Nielsen, Food Analysis, Springer Publications, 2009.

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

PAPER 403 : PHARMACEUTICAL AND CLINICAL ANALYSIS

100 Marks **60 Hours**

Unit I: Quality Assurance **15 Hrs.**

i) Basic terminology: Quality, QA, QC, Good laboratory practices (GLP) and Good Manufacturing practices (GMP)

ii) Pharmacopeia standards: BP, IP, USP, NF, EP.

iii) Different Drug Regulatory Authorities: FDA, NIBSC, TGA, MCC

iv) Drug Development and Regulatory Process: Introduction, Identification of New Molecules, Preclinical Research, Formulation & Development, Regulatory issues, Clinical trials, New Drug Applications.

v) Official method of analysis: Sources of impurities in pharma/food products, Limit test of As, Pb, Fe, Cl, SO_4, Stability studies.

vi) Concept of online analysis: Raw material, Documentation, Finished product, Record keeping

Unit II: Microbiological Analysis **12 Hrs.**

i) Introduction to micro-organism: Bactria, Fungus.

ii) Isolation & identification of important group of Bactria by plate count method.

iii) Determination of cell mass by direct & indirect method.

iv) Microbial growth & Factor affecting it : Temperature, pH, Media & Humidity

v) Counting techniques:

Sterilization: definition, various methods (Chemical/thermal/Radiation)

Disinfection: definition & various methods, Evaluation of antimicrobial agent & disinfects

Aseptic condition & Sterling test (HEPA filter)

Pyrogen Test.

Unit III: Clinical Analysis **8 Hrs.**

i) Introduction of blood : Composition, collection & Preservation of blood samples

ii) Analysis of blood sample for the followings :Glucose (Follin-Wu method), Urea (Diacetyl monoxime method & modified Diacetyl monoxime thiosemicarboxime method), Blood urea nitrogen, Serum uric acid, Total Proteins (Albumin ,Globulin, & A.G. Ratio), Biuret method,

specific gravity method, Serum Barbiturates, Spectroscopic method, Serum alkaline phosphate

Serum acid phosphate

Unit IV: Blood Gas Analysis **10 Hrs.**

i) Introduction

ii) Processes of obtaining arterial blood sample

iii) Blood gas symbols

iv) Blood gas instrumentation

v) Arterial blood gases

vi) Determination of Partial pressure of CO_2 (P CO_2), Oxygen saturation (SO_2), Oxygen contents (O_2), Partial Pressure Of Oxygen (PO_2), CO_2 contents Or total CO_2 contents, Blood p^H

Unit V: Forensic Analysis **15 Hrs.**

Special features for forensic analysis, Sampling, Sample storage, Sample dissolution, Classification of poisons, Lethal dose, Significance of LD50 & LC50

Toxicology: Isolation, Identification and determination of followings

Narcotics: Heroin, Morphine

Stimulants: Caffeine, cocaine, Amphetamines

Depressant: Barbiturates, Benzodiazepine pines.

Reference Books

1. P. Konieczka, J. Namiesnik, Quality Assurance and Quality Control in the Analytical Chemical Laboratory, CRC Press, 2009.

2. Quality Assurance of Pharmaceuticals, WHO, 2007.

3. B.W. Wenclawiak, M. Koch, E. Hadjicostas, Quality Assurance in Analytical Chemistry, Springer Publications, 2010.
4. J.B. Crippin, Explosive and Chemical Weapons Identification, Taylor & Francis Publications, 2006.
5. M.M. Houck, Forensic Science: Modern Methods of Solving Crime, Library of Congress Publications, 2007.
6. A. Mozayani, C. Noziglia, The Forensic Laboratory Handbook Procedures and Practice, Springer-Humana Press, 2011.
7. S. Suzanne Nielsen, Food Analysis, Springer Publications, 2009.

M. Sc. Second Year (*Fourth Semester*) Analytical Chemistry

PAPER 404 : APPLIED ANALYTICAL CHEMISTRY–III

(Nanomaterials, Polymers and Catalysis)

100 Marks **60 Hours**

Unit I: Chemistry of Nanomaterials **30 Hrs.**

a) General Introduction, Historical background

b) Synthesis

Chemical Methods include Reduction method for Metal Nanoparticles, Solvothermal method, Photochemical Synthesis, Electrochemical Synthesis, Arrested Precipitation, Sol-gel, Langmuir-Blodgett, Micelles-Microemulsions.

c) Characterization Techniques

Electron Microscopy (TEM & SEM), Probe Microscopy (STM & AFM), Diffraction Techniques (XRD & NRD), UV-Visible-NIR spectroscopy.

d) Properties of Nanoparticles

Mechanical, Optical, Magnetic, Electronic properties

e) Examples of Nanomaterials

Carbon nanostructures include Carbon Nanotubes and graphene, Mesoporous materials include Metal oxides (Titania and ZnO) and Zeolites, Carbon-based Composites, Smart materials.

f) Applications

Electronics, Energy, Automobiles, Sports & toys, Textile, Cosmetics, Domestic appliances, Sensors, Biotechnology & medical field, Space & Defence, Catalysis, Nanotechnology & environment

Unit II: Polymer Chemistry **15 Hrs.**

i) Introduction (Monomer, Co-monomer, Mesomer, Homopolymer, Hetropolymer, Co-polymer)

ii) Classification of polymers, Different types of polymerizations (Condensation polymerization, Addition polymerization-Cationic/Ionic/Free radical/Co-ordination, Chain polymerization, Coordination polymerization, Ring opening polymerization, Group transfer polymerization) & their mechanism, Chain transfer reaction, Ionic copolymerization.

iii) Molecular weight of polymers and their determination by end group analysis, Osmometric, Viscometric, Light Scattering & Sedimentation method.

iv) Synthesis, Properties & Applications of following Polymers:

Polyethylene, polypropylene, polystyrene, polyvinyl chloride, polyacruly nitride, polyester, polyethylene glycols, polyvinyl alcohol, polyetrafluoroethylen, silicone polymer, urea-formaldehyde resin, polyurethanes, epoxy resins.

Unit III: Catalysis **15 Hrs.**

Introduction, Catalyst and its types, General features of Catalysts (Catalytic efficiency, Catalytic cycles, Selectivity, Energetic, Life time).

Homogeneous Catalysis:

Various catalytic steps (Ligand co-ordination & dissociation, Insertion & elimination, Nucleophilic attack of co-ordinated ligands, Oxidation & reduction, Oxidative addition & reductive elimination), Illustrative examples include Hydrogenation of alkene, hydroformylation of alkenes, Oxidation of alkenes (Wacker process), Carbonylation of methanol to acetic acid (Monsanto process).

Heterogeneous Catalysis:

Nature of heterogeneous catalysts (Surface area, Porosity, Surface acidic and basic sites, Surface metal sites), Various catalytic steps such as chemisorption and desorption surface migration, Illustrative examples include hydrogenation of alkene, Ammonia synthesis, SO_2 oxidation, Interconversion of aromatic Zeolites, Photocatalysis by TiO_2.

Reference Books

1. G.B. Sergeev, Nanochemistry, Elsevier Publications, 2006.
2. Nanomaterials Chemistry: Recent Developments and New Directions, Edited by C.N.R. Rao, A. Muller and A.K. Cheetam, Wiley-VCH, 2007.
3. C.N.R. Rao, P.J. Thomas, G.U. Kulkarni, Nanocrystals: Synthesis, Properties and Applications, Springer-Verlag Berlin Heidelberg, 2007.
4. Nanoparticles: From Theory to Applications, Edited By G. Schmid, Wiley-VCH, 2010.
5. G. Cao, C. J. Brinker Annual Review of Nano Research, Vol.1, World Scientific Publishing.
7. V.R.Gowarikar, N. V. Vishwanathan & J. Sreedhar, Polymer Science, Wiley Eastern.
8. D.D. Deshpande, Physical Chemistry Polymers, Tata McGraw Hill.
9. P.J. Flory, Principles of Physical Chemistry, Cornell University Press.
10. R.B. Seymour, Introduction to Polymer Chemistry by McGraw Hill.
11. E.K. Ridder & H.S.Taylor Catalysis: Theory and Practices.

M. Sc. Second Year (*Third Semester*) Drug Chemistry

PAPER 301: APPLICATIONS OF SPECTROSCOPY

100 Marks **60 Hours**

Unit I: Nuclear Magnetic Resonance (^{1}H-NMR) **10 Hrs.**

Elementary Ideas (Recapitulation)

Spin-spin coupling, Different types of coupling, Factors affecting coupling constant, Karplus equation, Spin system (AB, AX, ABX, AMX, etc), Rate processes, Spin decoupling, Shift reagents, Nuclear over Hauser effect (NOE).

Unit II: C^{13}-NMR Spectroscopy **7 Hrs.**

Elementary Ideas, Instrumental aspects, chemical shift (Aliphatic, Olefinic, Alkyne, Aromatic, Heteroaromatic & carbonyl carbon), Effects of constituents on chemical shifts. Two dimensional (2D) NMR techniques: COSY, NOESY, DEPT, APT, INEPT & INADQUATE.

Unit III: Mass Spectrometry **7 Hrs.**

Introduction, Ion production (EI, CI, FD & FAB), Ion analysis, Ion abundance, Factors affecting fragmentation, Fragmentation of different functional groups, Molecular ion peaks, Metastable peaks Nitrogen rule, McLafferty rearrangement, Retro-Diels Alder reaction.

Unit IV: Problems based on joint application of UV, IR, NMR & Mass spectroscopy **6 Hrs.**

Unit V: Mossbauer Spectroscopy **10 Hrs.**

Principle of Mossbauer spectroscopy, Instrumentation, Isomer shift and its factors affecting, Quadrupole splitting, Temperature Dependence of MB parameters, Zeeman Splitting (Six fingered MB lines), MB spectra of iron and tin compounds, Applications, Numericals.

Unit VI: Electron Spin Resonance Spectroscopy **12 Hrs.**

Introduction, Principle of ESR Spectroscopy, Instrumentation, Presentation of spectrum, Hyperfine splitting in some simple systems, Hyperfine splitting in various structure (Naphthalene anion radical, Pyrazine anion radical, Isomers of Xylene anion radicals, VO^{2+}, Quinoline radical, Isoquinoline radical, Quinoxaline radical, Anthracene radical, Phenanthracne radical, Pyrene radical, Alkyl halide radicals, Quinone & Isoquinone anion radicals, nitrogen/deuterium containing radicals), Hyperfine splitting diagram, 'g' value, g-marker, Factors affecting the magnitude of 'g' values, Determination of g-value, Zero field splitting, Karmers's degeneracy, Applications, Numericals.

Unit VII: IR & Raman Studies of Complexes **8 Hrs.**

Origin of Molecular Spectra, Origin of Infrared and Raman Spectra, Modes of vibrations, Selection Rules for Infrared and Raman Spectra, Normal modes of vibrations in AB_2 (Linear/Bent), AB_3, AB_4, AB_5, Octahedral AB_6 molecules with factors affecting band frequencies.

Reference Books

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein- 6th Edition
2. Spectroscopy of Organic Compounds, V.M. Parikh.
3. Organic Spectroscopy, P.S. Kalsi
4. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.L. Nelson.
5. Mass Spectroscopy, K.G. Das & James.
6. Physical Methods in Chemistry, IInd Edition, R. S. Drago.
7. P.H. Rieger, Electron Spin Resonance: Analysis & Interpretation, RSC Publishing, 2007.
8. B. Simovic, Introduction to the Technique of ESR Spectroscopy. 2004.
9. A. Lund, M. Siotani, S. Shimada, Principles and Applications of ESR Spectroscopy, Springer.
10. P. Gutlich, E. Bill, A.X. Trautwein, Mossbauer Spectroscopy & Transition Metal Chemistry, Springer Publications, 2011.
11. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A & Part B, John Wiley & Sons Publishers.
12. Mossbauer Spectroscopy: Principles and Applications of the Techniques, A.G. Maddock.
13. An introduction to Electron Paramagnetic Resonance, *M. Bersohn & J.C.Baired,* W.A.Benjamin, Inc N.Y.
14. High resolution ESR Spectroscopy, F.Gerson (John Wiley & sons)
15. An introduction to Electron Paramagnetic Resonance, M. Bersohn & J.C. Baired, W.A. Benjamin, Inc N.Y.

M. Sc. Second Year (*Third Semester*) Drug Chemistry
PAPER 302: BIO-ORGANIC AND GREEN CHEMISTRY

100 Marks **60 Hours**

1. Enzyme **4 Hrs**

Introduction, Active sites, Mechanism of enzyme action, Inhibition, Isolation and purification of enzyme, enzyme kinetics, co-enzyme, enzyme models, chemical use of enzymes, Therapeutic application of enzymes, recombinant DNA technology

2. Carbohydrates **10Hrs**

Confermation of monosaccharides; structures and function of important derivatives of monosaccharides like Glycosides, Deoxy sugars, Myoinositol, amino sugars, N-aceylmuranic acid and sialic acid, disaccharides and polysaccharides. Structural polysaccharides: Cellulose and Chitin. Storage polysaccharides: Starch and Glycogen. Structure and biological function of Glucosaminogycans or mucopolusaccharides. Carbohydrates of glycoproteins and glycolinides. Role of sugars in bio;logical recognition. Blood group substances, Ascorbic acid. Carbohydrate metabolism: Kreb's cycle, Glycolysis, Glyvogenolusis, Gluconeogenesis and Pentose phosphate pathways.

3. Lipids **6 Hrs**

Fatty acids, essential fatty acids, structures and function of triglycerides, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins and function, role in antherosclerosis. Properties of lipid aggregates-Micelles, Bilayers, liposomes

and their possible biological functions. Biological membranes, Fluid mosaic model membrane structure. Lipid metabolism: Beta oxidation of fatty acids

4. Amino acids, Peptides and Proteins

Chemical and enzymatic hydrolysis of prteins to peptides, amino acid sequencing. Secondary structure of protein, forces responsible for holding of secondary structure a helix, beta-sheets, super secondary structure, triple helix structure of collagen.

5. Nucleic Acids **10 Hrs**

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible or Holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an Overview of replication of DNA, Transcription, translation and genetic code. Chemical synthesis of mono and dinucleosides.

6. Green Chemistry **10 Hrs**

Introduction, Ideal synthesis, theoretical and functional details of following eco-friendly synthetic protocols with suitable examples ad applications.

6.1 Neat synthesis (solvent free synthesis)

6.2 Non-volatile organic media and water as green media in organic transformations like ionic liquid, PEG and water.

6.3 Microwave irradiation as alternative energy source for the chemical transformations.

6.4 Heterogeneous catalysis / Immobile catalysis.

6.5 Ultrasound assisted synthesis.

Reference:

1. Bioorganic chemistry By Hermann Dugas.
2. Biotransformation in organic chemistry By K. Faber.
3. Enzyme structure and Mecahanism By Alan Faber
4. Enzyme Catalysis in organic synthesis Vol. 1 By Karlheinz Drauz and Herbert Waldmann.
5. Bioorganic, Bioinorganic and Supramolecular chemistry By P. S. Kalsi and J. P. Kalsi.
6. Organic Chemistry IV Edn G.Marc Loudon.
7. Green Chemistry By Paul T. Anastas and John C. Warner
8. Green Chemistry By Rashmi Sanghi and M. M. Srivastav

M. Sc. Second Year (*Third Semester*) Drug Chemistry
PAPER 303: ORGANIC REACTIONS & REARRANGEMENTS

100 Marks **60 Hours**

1. Name Reactions

Reaction, Mechanism and applications of following reactions: Gabriel synthesis, Streker amino acid synthesis, Ullmann, Mitsnobu, Favorski, Hofmann-Loffler-Freytag, Shapiro, Dakin, Von Richter, Henery, Mukaiyama reaction, Sonogishira reaction.

2. Rearrangement

Introduction

(A) Migration to Electron deficient Carbon: i) Pinacol-Pinacolone, ii) Wagner-Meerwein, iii) Demjanov, iv) Wolf, v) Benzil-Benzilic acid rearrangement.

(B) Migration to Electron deficient Nitrogen: i) Beckmann, ii) Hoffmann, iii)Curtius, iv) Lossen, v) Schimidt rearrangement.

(C) Migration to Electron deficient Oxygen: i) Favorskii, ii) Neber, iii) Dakin rearrangement.

(D) Electrophilic Rearrangement: i) Stevens, ii) Wittig, iii) Smile rearrangement.

3. Pericyclic Reaction

Introduction, Classification, Molecular Orbital Conservation Approach

(A) Cycloaddition reaction: Cycloaddition reactions and their stereochemical aspects, Woodward-Haffman rule, Selection rule for cycloaddition reaction, Details with examples of Diels-Alder reaction, (2+2) cycloaddition, (1, 3) polar cycloaddition, Cycloaddition of alkenes with OsO_4 and ozone, Cheleotropic reactions, Analyses of cycloaddition by FMO, Mobius-Huckel and Corrlaion diagram methods.

(B) Electrocyclic Reaction: Electrocyclic reactions and their stereochemical aspects, Selection rule of electrocyclic reaction, Con-rotations and dis-rotations, Methods of analyses of the electrocyclic reactions: FMO, Mobius-Huckel and Correlation diagram approaches.

(C) Sigmatropic rearrangements: Sigmatropic rearrangements and their stereochemistry, Rules for Sigmatropic rearrangements, Examples on (1, 3), (1, 5), (1, 7), (3, 3), (2, 3) Sigmatropic shifts, Claisen, Cope, Oxy-cope, Aza-cope, Sommelet-Hauser rearrangements, Ene reaction, Methods of analyses of the rearrangements: FMO, Mobius-Huckel and Correlation diagram approaches.

4. Photochemical Reaction

(A) Photochemistry of Alkenes: Intermolecular reactions of the Olefinic Bond-Geometrical Isomerism, Cyclization reactions, Rearrangement of 1, 4- and 1, 5-dienes.

(B) Photochemistry of Carbonyl compounds: Intermolecular reactions of the Carbonyl compounds-saturated, Cyclic and acyclic, β, γ-gamma unsaturated and α, β-unsaturated compounds, Cyclohexadienones, Intermolecular Cycloaddition reactions, Dimerizations and Oxetane formation.

(C) Photochemistry of Aromatic Compounds: Isomerization, Additions and Substitutions.

5. Protecting Groups

Introduction, Principle, Protecting groups for alcohols, carbonyl, carboxylic acids, amino groups.

Reference Books:

9. Designing Organic Synthesis: S. Warren, Wiley.
10. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers
11. Protective Groups in Organic Synthesis: T. W. Greene, G. M. Wuts.
12. Organic Syntheis: Jagdama Singh and L. D. S. Yadav
13. Advanced organic Chemistry: Part A & B, Reactions and Synthesis, F. A. Carey and R. J. Sundberg.
14. Organic Synthesis: M. B. Smith.
15. Principle of organic synthesis: Norman and Coxon
16. Advanced organic chemistry: Jerry March
17. Organic Photochemistry: Robert Kan

M. Sc. Second Year (*Third Semester*) Drug Chemistry

PAPER 304: APPLIED ORGANIC CHEMISTRY

100 Marks **60 Hours**

1. Organometalic Reagents

Principle, Preparation, Properties and applications of the mechanistic details: Li, Mg, Hg, Cd, Zn, Ce, Cu, Pd, Ni, Fe, Co, Rh, Sn, Cr, Ti, Si, and B compounds.

3. Ylides and Enamines

Phosphorus, Nitrogen and Sulphur ylides: Methods of generation, reactivity and applications.

3. Free Radical Reactions

Types of radical reaction, Free radical substitution mechanism, mechanism at an aromatic substrate, Neighbouring group assistance, Reactivity for aliphatic and aromatic substrates at a bridgedhead, reactiviy in the attacking radicals, The effect of solvents on reactivity.

Allylic halogenations (NBS), Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazoniu salts, Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction.

4. Polynuclear Hydrocarbons

Introduction, Comparative study of the aromatic character of linear and nonlinear Ortho fused Polynuclear Hydrocarbon. General methods of preparation of fluorine, anthracene and phenanthrene.

5. Heterocyclic Compounds

Nomenclature and familiarity with the heterocyclic ring (3-7 members containing up to 3 heteroatoms. Detailed chemistry of Pyrozole, imidazole, oxazole, thiazole, thiazine, pyrimidines, pyrazines and zepines.

6. Retrosythetic Analysis

Creative Chemistry, Retrosynthetic backwards, Disconnection must correspond to known, reliable reactions, Choosing a disconnection, Multi step syntheses: avoid chemoselectivity problems, Functional group interconversion, two group disconnections are better than one, C-C disconnections, Donor and acceptor synthons, Two group C-C disconnections, Natural reactivity and Umploung.

Reference Books:

1. Designing Organic Synthesis: S. Warren, Wiley.
2. Organic Chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers
3. Principles of Organic Synthesis: R. Norman and J. M. Coxon, Blackie Academic and professional.
4. Advanced organic Chemistry: Part A & B, Reactions and Synthesis, F. A. Carey and R. J. Sundberg.
5. Organic Synthesis: M. B. Smith.
6. Principle of organic synthesis By Norman and Coxon
7. Advanced organic chemistry By Jerry March
8. Organic synthesis By W. Carruther

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
PAPER 401: INTRODUCTION TO MEDICINAL CHEMISTRY

100 Marks **60 Hours**

1. Introduction to Drug **30**

What are Drugs? Definition, Characteristics of ideal drugs, Why do you need drugs? Examples of old and new drugs.

(A) Classification of Drugs: i) Based on the chemical structures; examples of each class; ii) Based on the Pharmacological action; examples of each class

Physiological action, Pro-drug; definition, requirement, mode of action

(B) Sources of Drugs: i) Plant sources; examples of methods of isolation; ii) Marine sources; examples of methods of isolation; iii) Micro-organism sources; examples of methods of isolation

(C) Historical development of Medicinal Chemistry, Genetic engineering

(D) Development of drugs: Lead discovery, lead development; Pharmacological / Microbiological / Biochemical evaluation of drugs; Toxicological evaluation of drugs (Pre-clinical studies); Clinical trials; Pharmacokinetic: i) Absorption, ii) Distribution, iii) Metabolism, iv) Elimination

(E) Dosage forms; Need and Benefits; Mode of administration of drugs; Types, Advantages; Disadvantages.

2. Alkaloids: **15**

Introduction, Occurrence, Functions of alkaloids in plants, Nomenclature, Isolation, Structure determination and synthesis of papavarine, morphine, quinine, nicotine, atropine, cocaine, ephedrine, adrenaline, piperine.

3. Terpenoids: **15**

Introduction, Classification, Isolation, Structure elucidation and synthesis of Monoterpenoids, Sesquiterpenoids, Diterpenoids, Triterpenoids, Carotenes.

Reference books

1) Medicinal chemistry (Vol. I and II)-Burger.
2) The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
3) Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
4) Medicinal Chemistry- Ashutosh Kar
5) Medicinal Chemistry- Balkishen Razdan
6) Natural Products: Chemistry and Applications- S.V. Bhat, B.A. Nagasampagi, S. Meenakshi

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
PAPER 402: DRUG SYNTHESIS

100 Marks **60 Hours**

Chemical synthesis of different classes of drugs:

1. Anti-Infective **08Hr**

Introduction, Different classes, Mode of action examples of synthesis of each class e.g. Penicillin, Cephalosporins (semi-synthetic), Chloramphenicol, Ciprofloxacin, Sulphonamides, Metronidazoie, Clotrimazole, Griseofulvin

2. Psychoactive Drugs **10Hr**

Introduction, neurotransmitters, CNS depressant, general anaesthetics, mode of action of hypotics sedatives, anti-anxiety drugs, synthesis of some psychoactive drugs e.g. Diazepam, Barbiturates, Fluoxetine, Alprazolam.

3. Cardiovascular drugs **08Hr**

Introduction, Cardiovascular diseases, Drug inhibitors of peripheral sympathetic function, central intercention of cardiovascular output, direct acting anterior dilators, synthesis of some cardiovascular drugs e.g. Atenelol, Captopril, Diltiazem, Reserpine, Prostaglandins.

4. Anti-neoplastic agent **08Hr**

Introduction, cancer chemotherapy, special problems; Role of alkylating agent and anti-metabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibiters, synthesis of some antineoplastic agent-e.g. Taxol.

5. Analgesics and Anti-inflammatory **08Hr**

Introduction, Synthesis of some: Analgesis and Anti-inflammatory compounds e.g. Ibuprofen, Indomethacin, Diclofenac, Rofecoxib, Steroids: Introduction, Nomenclature, Structure elucidation Cholesterol, Bile acids, Estrogens, Gestogens, Androgens, Cortisone, Vitamins: A, D, E, K, Vitamin B, Complex, B_1, B_2, B_6, B_{12}, C, H.

6. Antiacids / Antiulcer **08Hr**

Introduction, synthesis: Omeprazole, Ranitidine.

7. QSAR Method **10Hr**

Introduction, Methods used in QSAR studies, Hansch method, Free-Wilson method, Advantage and disadvantage of free approach, Computer based methods of QSAR related to receptor binding, Physico-Chemical properties, Lipophilicity, Electronic parameters, Steric substituent constants, Experimental determination of partition coefficints.

References

1. Synthesis of Essential Drugs- R. S. Vardanyan and V. J. Hruby, *Elsevier.*
2. Contemporary Drug Synthesis- J. J. Li, D. S. Johnson, D. R. Sliskovic, B. D. Roth, *John Wiley.*
3. Natural Products Chemistry- J. Singh, S. M. Alia and J. Singh, *Pragati Prakashan.*

4. Principals of Organic Synthesis- R. O. C. Norman and J. M. Coxon, *CRC Press.*
5. Advanced Organic Chemistry *Part B: Reactions and Synthesis*- F. A. Carey and R. J. Sundberg, *Springer.*
6. Natural Products: Chemistry and Applications- S.V. Bhat, B.A. Nagasampagi, S. Meenakshi.
7. Medicinal chemistry (Vol. I and II)-Burger.
8. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
9. Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
10. Medicinal Chemistry- Ashutosh Kar
11. Medicinal Chemistry- Balkishen Razdan

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
PAPER 403: DRUG ACTION AND DEVELOPMENT

100 Marks **60 Hours**

1. **Drug Design- A Rational Approach**
   Introduction, Analogus and prodrugs, Concept of lead, Factors governing drug-design, Rational Approach to drug-design, Drug design-methods of variations, Drug design and development, Molecular hybridisation, rigidity and flexibility *vs* Drug-design.

2. **Physical-Chemical Factors and Biological Activities**
   Introduction, Physical properties, Factors governing ability of drugs, Dissociation constants, Isosterism and bio-isosterism, Stereochemistry and drug action, Chemical properties.
3. **Target of action of drugs**
4. **Receptors**
   Definition, mode of action: agonists, antagonists (description): Families of receptors
5. **Cell**
   Definition, types, structure
6. **Nucleus**
   Definition, types, nucleic acid, DNA (structure, drug, that work on DNA); RNA (structure, that work on RNA) Drugs related to nucleic acid and building blocks.
7. **Mode of action and development of following classes of drugs**
   7.1 Cancer and anticancer drugs: Mechloroethamines hydrochlorides, Chloroambucil, Methotrexate, Daunorubicin, Colchicine.
   7.2 Analgesics and anti-inflammatory: Indomethacin, Ibuprofen, Ibufenac, Indoprofen, Naproxen.
   7.3 Antibiotic-Historical development and semi synthesis e.g. Penicillin,Cephalosporin's, Macrolides, Quinolones, Sulplhonamides and sulphones
   7.4 Anti-malerials: Chloroquine phosphate, Pamaquine, Pyrimethamine, Dapsone, Trimethoprim.
   7.5 Anti-virals and AIDS: Amantidine hydrochloride, Idoxuridine, Acyclovir, Ribavirin, Vitrasert, foscarnet.
   7.6 Anti-fungals: Griseofulvin, Chlormidazole, Naftifine, Flucytosine.
   7.7 Cardiovascular disorders and managements: Hypertension, Myocardial infraction, angina, Arrythemia: Hydralazine, Clonidine, Diazoxide, Sodium nitroprusside, Propranolol.
   7.8 Antidiabetics: Chlorpropamide, Metformin, Nateglinide, Rosiglitazone, Pioglitazone
   7.9 Central nervous system and disorder managements Anticonvulsant, Antidepressant, Sedatives: Caffenie, Theobromine, Pemoline, Phentermine, Bemegride.

Reference:

7) Medicinal chemistry (Vol. I and II)-Burger.
8) The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
9) Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
10) Medicinal Chemistry- Ashutosh Kar
11) Medicinal Chemistry- Balkishen Razdan

M. Sc. Second Year (*Fourth Semester*) Drug Chemistry
PAPER 404: PHARMACEUTICAL & INDUSTRIAL PRACTICES

100 Marks **60 Hours**

1) Various departments in a Pharmaceutical Industry **30**

Information about each section-their organization, work carried out, monitoring, interactions with various departments.

Overall idea of each department: Drug discovery, Process development, Pharmaceutical formulation, Production (Bulk drugs & Fine chemicals), Analysis (Intermediates, Finished goods & formulations), Regulatory affairs: (Product protection, Patenting, Regulated-non regulated markets), Packaging: (Designing & Stability), Distribution: (Local & Overseas), Selling: (Local & Overseas), Advertising: (Local & Overseas), Waste disposal: An environment protection

2) Agents for organ imagine OR Diagnostic agents. **15**

Introduction, Classification, Radiopagues agents (contrast media), Water soluble and Water insoluble contrast media. Synthesis of Metrizamide, Iopanoic acid and Pyropylidone. Diognostic chemicals: i) Drugs used to test kidney functions, ii) Drugs used to test liver functions, iii) Agents used to test gastric function, iv) Agents used to test cardiac function, v) Miscellaneous diagnostic chemicals.

3) Drug acting on Gastrointestinal tract (Drug acting on GIT) **15**

Introduction a) Gastric antacid: i) Treatment of gastric hyperacidity, ii) H2-receptor antagonists-Synthesis of Ranitidine (Zantac) and Famotidine. b) Ulcerative colitis. c) Antispansmodics agents (Spasmolytic agents), d) Anthelmintic agents: Introduction, anthelmintic agents, synthesis of mebendazole.

Reference books

1. Medicinal chemistry (Vol. I and II)-Burger.
2. The organic chemistry of drug design and drug action-R. B. Silverman (Academic Press)
3. Strategies for organic drug synthesis and designing - D. Lednicer Wiley.
4. Medicinal chemistry-William O. Foye
5. T. B. of Organic medicinal and pharmaceutical chemistry-Wilson and Gisvold's (Ed. Robert F. Dorge)
6. An introduction to medicinal chemistry-Graham L. Patrick.
7. Principles of medicinal chemistry (Vol. I and II)-S. S. Kadam, K. R. Mahadik and K. G. Bothara (Nirali prakashan)
8. An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international)
9. Pharmacological basis of therapeutics-Goodman and Gilman's (McGraw Hill)
10. Manual of patent practice and procedure-Patent office, India (2005)