MANONMANIAM SUNDARANAR UNIVERISTY,
TIRUNELVELI-12

SYLLABUS

PG - COURSES – AFFILIATED COLLEGES

Course Structure for M.Sc. Botany
(Choice Based Credit System)

(with effect from the academic year 2021-2022 onwards)

Semester-III				
Part	**Subject Status**	**Subject Title**	**Subject Code**	**Credit**
3	Core	ORGANIC SPECTROSCOPY AND REARRANGEMENTS	ZCHM31	4
3	Core	SPECTRAL METHODS – I, ORGANO METALIC AND ANALYTICAL METHODS	ZCHM32	4
3	Core	GROUP THEORY AND CHEMICAL THERMODYNAMICS	ZCHM33	4
3	Core	SCIENTIFIC RESEARCH METHODOLOGY	ZCHM34	4
3	Practical	ORGANIC CHEMISTRY PRACTICAL - III	ZCHL31	2
3	Practical	INORGANIC CHEMISTRY PRACTICAL - III	ZCHL32	2
3	Practical	PHYSICAL CHEMISTRY PRACTICAL - III	ZCHL33	2

Total Marks: 100 Internal Exam: 25 marks + External Exam: 75 marks

A. **Scheme for internal Assessment**:
Maximum marks for written test: **15 marks**
3 internal tests, each of **I hour** duration shall be conducted every semester.
To the average of the **best two** written examinations must be added the marks scored in. The **assignment** for 5 marks and Seminar for 5 marks

The break up for internal assessment shall be:
Written test- 15 marks; Assignment -5 marks; Seminar-5 Marks Total - 25 marks

B. Scheme of External Examination
3 hrs. examination at the end of the semester
A – Part : 1 mark question two - from each unit
B – Part : 5 marks question one - from each unit
C – Part : 8 marks question one - from each unit

- **Conversion of Marks into Grade Points and Letter Grades**

S.No.	Percentage of Marks	Letter Grade	Grade Point	Performance
1	90 - 100	O+	10	Outstanding
2	80 - 89	O	9	Excellent
3	70 - 79	A+	8	Very Good
4	60 - 69	A	7	Good
5	55 - 59	B+	6	Above Average
6	50 - 54	B	5	Pass
7	0 - 49	RA	-	ReAppear
8	Absent	AA	-	Absent

- **Cumulative Grade Point Average (CGPA)**

$$\mathbf{CGPA} = \frac{\Sigma\,(\mathbf{GP} \times \mathbf{C})}{\Sigma \mathbf{C}}$$

- **GP** = Grade point, **C** = Credit
- CGPA is calculated only for Part-III courses
- CGPA for a semester is awarded on cumulative basis

- **Classification**
  a) First Class with Distinction : CGPA $\geq$ 7.5*****
  b) First Class : CGPA $\geq$ 6.0
  c) Second Class : CGPA $\geq$ 5.0 and $<$ 6.0
  d) Third Class : CGPA$<$ 5.0

ORGANIC SPECTROSCOPY AND REARRANGEMENTS

Objectives:

- To study the concept of UV, IR, NMR spectroscopy, Mass spectrometry and their applications in organic systems.
- To interpret the spectral data of organic molecules.
- To understand the mechanism of Rearrangement reactions.

UNIT I - ULTRAVIOLET, INFRA – RED SPECTROSCOPY, ORD AND CD

UV-Visible: The absorption laws – Types of electronic transitions – effect of solvents and Hydrogen bonding on λmax values. – Woodward – Fieser rules to calculate λmax values of conjugated dienes and α,β - unsaturated ketones.

IR: Molecular Vibrations – Vibrational frequencies - Characteristic IR absorptions of different functional groups – Fermi resonance and Finger print region - factors influencing absorption of carbonyl and hydroxyl groups – electronic effect and effect of hydrogen bonding.

ORD and CD: Optical rotatory dispersion (ORD): Cotton effect - Octant rule and axial - halo ketone rule – Conformation and Configuration determination of simple systems -Circular Dichroism.

UNIT II - NMR SPECTROSCOPY

Nuclear spin – magnetic moment of a nucleus – nuclear energy levels in the presence of magnetic field – relative populations of energy levels – macroscopic magnetization - Basic Principle of NMR experiments – CW and FT NMR.

1H NMR: Chemical shift - number of signals - Factors influencing proton chemical shift (Electronegativity, Anisotropic effects and Vander walls' deshielding) and vicinal proton - Spin–spin coupling – proton coupling constants - Geminal, Vicinal and long range coupling constants - 1H NMR spectrum of simple organic molecules such as CH3CH2Cl, CH3CHO etc. - Classification of spin systems – First order and Second order spectra - analysis of AX, AMX and ABX systems – spin decoupling – Nuclear Overhauser Effect – Chemical exchange.

13C NMR: Principle of proton decoupled and OFF- resonance 13C NMR spectra - comparison with H1NMR – factors affecting ^{13}C chemical shifts – 13C NMR spectra of simple organic molecules (aliphatic, olefinic, alkynic, aromatic and carbonyl compounds).

UNIT III - MASS SPECTROMETRY

Basic Principles– Base peak – molecular ion – nitrogen rule – metastable ions – isotopic peak - daughter ions – Mc–Lafferty rearrangement – RDA – General rules for fragmentation pattern – Fragmentation pattern of simple compounds of hydrocarbons, alcohols, amines, aldehyde, ketone, ether, acids, phenols ,nitro compounds, alicyclic compounds .

Alternative electron impact ionization technique – CI, FAB, ESI – MS, MALDI –MS, MALDI-TOF, ICP- MS.

UNIT IV - 2D NMR AND INTERPRETATION OF SPECTRUM

2D NMR spectroscopy: H^1–H^1 COSY, H^1 –C^{13} COSY, NOESY, DEPT and INADEQUATE spectra.

Applications of combined spectroscopic techniques in elucidating the structure of organic molecules – One conjunction problem based on UV, IR, H^1 NMR, ^{13}C NMR and Mass spectroscopic techniques is compulsory under section – C. Problems shall be based on the reference books.

UNIT V - REARRANGEMENT REACTIONS

Types of rearrangements: Nucleophilic, electrophilic and free radical and protrophic reactions.

Mechanism: Nature of migration – migrating aptitude and memory effects, ring enlargement and ring contraction rearrangements.

Reactions: Carbon to carbon migration: Pinacol – Pinacolone, Benzil – Benzilic acid, Arndt – Eistert synthesis, Demjanov and dienone-phenol rearrangements.

Carbon to oxygen migration – Brook, Cumene Hydro-peroxide and Dakin rearrangements. Carbon to Nitrogen migration – Lossen, Neber and curtius rearrangements.

Miscellaneous: Von – Richter and Sommelet-Hauser rearrangements.

PRESCRIBED BOOKS

1. William Kemp, Organic Spectroscopy, Third Edition, MacMillan, Indian edition, 2019.
2. R.M. Silverstein, F.X. Webster and K.J. Kiemle, Spectrometric identification of organic compounds, John Wiley and Sons, Inc., 2005.
3. L.D. S. Yadav, , Organic Spectroscopy, Springer, 2005.
4. L.D. Field, S. Sternhell and J.R. Kalman, Organic Structures from Spectra, 4th edition, John Wiley and Sons, 2007.
5. Karen-Feinstein, Guide to Spectroscopic Identification of Organic compounds, 1st edition, CRC Press, 1994.

6. B.P.Mundy, M.G.Ellerd and F.G.Favaloro, Name Reactions and Reagents in Organic Synthesis, 2nd Ed., 2005.
7. Dr Jagdamba Singh & Dr. L.D.S Yadav, Orgnic Synthesis: Design, Reagents, Reactions and Rearrngements, A Pragati Second Revised Edition, 2007.
8. Raj K. Bansal, Organic Reaction mechanisms, Tata Mc Graw Hill, Third Editon, 2007.
9. A. Hassner & I. Namboothiri. Organic Syntheses Based Name Reactions, Elsevier , 2012.
10. Sanyal & Sanyal, Reactions, Rearrangements and Reagents, 4th edition, Bharati Bhawan Publishers and Distributors, 2003.

REFERENCE BOOKS

1. R.M. Silverstein, F.X. Webster, K.J. Kiemle and D.L. Bryce, Spectrometric identification of organic compounds, 8th edition Wiley Publications, 2014.
2. Ian Fleming and Dudley Williams, Spectroscopic methods in organic chemistry, 7th edition, Springer Publications, 2019.
3. William Kemp, Organic Spectroscopy, Third Edition, MacMillan, 1994.
4. E. Pretsch, P. Buhlmann and M. Badertscher, Structure Determination of Organic Compounds: Tables of Spectral Data, 4th revised and enlarged edition, Springer Publications, 2009.
5. F. A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Part B: Reaction and Synthesis, 5th edition, Springer, 2007.
6. W. Carruthers, and I. Coldham, Modern Methods of Organic Synthesis, 4th edn, Cambridge University Press, 2015.
7. L. Kurti and B. Czako, Strategic Applications of Named Reactions in Organic Synthesis, Elsevier 2005.

SPECTRAL METHODS-I, ORGANO METALLIC AND ANALYTICAL METHODS

Objectives:

- To study the applications of electronic and photo electronic spectroscopic techniques in coordination compounds.
- To study the applications of ORD and CD to determine absolute configuration of chelate complexes.
- To introduce organometallic compounds and to study their catalytic applications in homogeneous and heterogeneous systems.
- To understand the basic principles and applications of thermo and spectro analytical techniques.

UNIT I - ELECTRONIC SPECTROSCOPY, ORD AND CD

Electronic spectroscopy: Selection rules for electronic transitions - Hole formalism - LS Coupling and determination of term symbols – Hund's Rules - Splitting of terms – Orgel and Tanabe Sugano diagrams – Electronic spectra of 1st row transition metal complexes - Evaluation of 10 Dq, β and B' for octahedral d^2 and d^8 systems. Charge transfer spectra – types – Effect of solvent polarity on CT spectra - Effect of tetragonal distortion and spin - orbit coupling on spectra – Electronic spectra of lanthanide and actinide complexes.

ORD and CD - Optical isomerism in octahedral complexes – absolute configuration of chelate complexes from ORD and CD.

UNIT II - PHOTO ELECTRON SPECTROSCOPY

Theory – types of PES – origin of fine structures – adiabatic and vertical transitions – PE spectra of homonuclear diatomic molecules (N_2, O_2) – hetero nuclear diatomic molecule (CO) – polyatomic molecules (H_2O, NH_3) - Koopman's theorem – application and limitation of the theorem. XPS (ESCA): structure of N_3^- ion, N (1s) spectrum of $[Co(en)_2(NO)_2]NO_3$, C(1s) spectrum of $C_2H_5COOCF_3$. Shake-up and shake-off processes – Structural and bonding information in metal carbonyls – Auger electron spectroscopy.

UNIT III - ORGANOMETALLIC CHEMISTRY–I

The 18 e− and 16 e− rules and its correlation to stability – Synthesis, structures and bonding of metal carbonyls, metal nitrosyls and dinitrogen complexes – Identifications of bridging and terminal CO groups by IR – Structure of Mononuclear, dinuclear [$Mn_2(CO)_{10}$, $Co_2(CO)_8$, $Fe_2(CO)_9$], Trinuclear [$M_3(CO)_{12}$ (M = Fe, Ru, Os)] and Tetranuclear [$M_4(CO)_{12}$ (M = Co, Rh, Ir)] Carbonyls. Synthesis, properties and

structural features of metal complexes with alkene, alkyne and allyl systems. Metallocenes – synthesis, properties, structure and bonding with particular reference to ferrocene and berryllocene – covalent versus ionic bonding in beryllocene.

UNIT IV - ORGANOMETALLIC CHEMISTRY–II

Organometallic compounds as catalysts and the requirements: Agostic interaction – Oxidative addition and reductive elimination - insertion and elimination reactions – nucleophilic and electrophilic attack of coordinating ligands.

Homogeneous catalysis: Wilkinson's catalyst and hydrogenation reactions, Tolman catalytic loop; hydroformylation (oxo) reaction, Wacker and Monsanto acetic acid processes.

Heterogeneous catalysis: synthesis gas and water gas shift reactions; Fischer Tropsch process and synthetic gasoline, Ziegler-Natta polymerization and mechanism of stereoregular polymer synthesis.

Hybrid Catalysis: Cluster compounds in catalysis, polymer-supported and phase-transfer catalysis-biphasic-systems.

UNIT V - THERMOANALYTICAL AND SPECTROANALYTICAL METHODS

Theory and principles of thermogravimetric analysis, differential thermal analysis and differential scanning colorimetry – characteristic features of TGA and DTA curves – factors affecting TGA and DTA curves – complementary nature of TGA and DTA – applications of thermal methods in analytical chemistry – thermometric titrations – the study of minerals and metal compounds. Principle and applications of spectrophotometry, spectrofluorimetry, atomic absorption spectroscopy and atomic emission spectroscopy based on plasma sources.

PRESCRIBED BOOKS

1. James E. Huheey, Ellen A. Keiter and Richard L. Keiter, Inorganic chemistry: principles Structure and Reactivity, 4th Edition, Pearson Education, 2006.
2. D.F. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, ELBS, Oxford University Press, 1994.
3. B.K.Sharma, Instrumental Methods of Chemical Analysis, Meerut Krishna Prakashan, 2012.
4. P. Powell, Principles of Organometallic Chemistry, 2nd edition, Springer, 1998.
5. D.N. Satyanarayana , Electronic Absorption Spectroscopy , University Press, 2000.
6. P. Atkins, T. Overton, J. Rourke, M. Weller and F.Armstrong, Inorganic

Chemistry, 5th edition, Oxford University press, 2010.
7. Russell S. Drago, Physical Methods in Inorganic Chemistry, Chapman and Hall Ltd., London, 1965.
8. Russell S. Drago, Physical Methods for Chemists, Surfside Scientific Publishers, 2nd Edition, 1977.
9. E.A.V. Ebsworth, David W.H. Rankin and Stephen Credock, Structural Methods in Inorganic Chemistry, ELBS, 1988.
10. B.P. Lever, Inorganic Electronic Spectroscopy, 2nd Sub Edition, Elseveir Science, 1986.

REFERENCE BOOKS

1. C. Elschenbroich and A. Salzer, Organometallics – A Concise Introduction, 2nd Edition, VCH Publication, 1992.
2. R. C. Mehrotra and A. Singh, Organometallic Chemistry: A Unified Approach, 2nd Edition, New Age International Publishers, 2005.
3. B.D.Gupta and A.J. Elias, Basic Organometallic Chemistry: Concepts, Synthesis and Applications of Transition Metals , 1st edition , University Press, CRC Press, 2010.
4. R.H.Crabtree, Organometallic Chemistry of the Tranistion Metals, Wiley, Newyork, 1988.
5. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, Saunders, 1992.
6. D.A. Skoog, D. M. West, F.J. Holler and S.R. Grouch, Fundamentals of Analytical Chemistry, Thomson Asia Pvt.Ltd., 8th Edition, Third Reprint, 2005.
7. H.H. Willard, L.L. Merritt and J.A. Dean, Instrumental Methods of Analysis, CBS Publishers, 6th Edition, 1986.
8. F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Marilo and Manfred Bochman, Advanced Inorganic Chemistry, Wiley Interscience Publication, 6th Edition, Reprint, 2012.

GROUP THEORY AND CHEMICAL THERMODYNAMICS

Objectives:

- To understand the basic concepts of group theory.
- To understand the inter linking of quantum chemistry and group theory.
- To explain various concepts of thermodynamics.
- To apply the concepts of statistical thermodynamics for the study of equilibrium reactions and reaction rates.
- To understand the inter linking of quantum chemistry and statistical thermodynamics.

UNIT I - GROUP THEORY-I

Symmetry elements and operations - Group Postulates and types of groups. Identification of Point groups of molecules and Schoenflies symbols. Construction of multiplication table for C_{2v}, C_{3v} and C_{2h}. Sub-groups and classes of symmetry operations. Rule of similarity transformations. Matrix representations of symmetry operations. Use of atomic wave functions as bases for point group representations. Reducible and irreducible representations. The Great Orthogonality theorem. Properties of Reducible and irreducible representations. Construction of character tables for C_{2v}, C_{3v}, C_{4v}, C_{2h} and D_2 point groups by using the Great Orthogonality theorem.

UNIT II - GROUP THEORY-II

Standard Reduction Formula -Vibrational modes as bases for group representations- Normal mode analysis for non linear molecules H_2O, $POCl_3$, trans-N_2F_2 and $PtCl_4$. Symmetry selection rules for infrared and Raman spectra. Mutual exclusion principle. Determination of Hybridisation of atomic orbitals in non-linear molecules (CH_4, XeF_4, and PF_5). Electronic spectra of ethylene and formaldehyde molecules. Construction of Projection operators and Molecular orbitals by Symmetry Adapted Linear Combinations. Simplification of HMO calculations using group theory. Calculation of delocalization energy for ethylene, trans-1,3-butadiene and benzene systems.

UNIT III - CHEMICAL THERMODYNAMICS

A general review of enthalpy, entropy and free energy concepts. Maxwell relations. Genesis of third law and its limitations - Thermodynamics of systems of variable compositions - partial molar quantities and their determination - chemical potential - Gibbs-Duhem equation - Duhem-Margules equation - Fugacity and its determinations - choice of state - Activity and activity coefficients - electrolytes and non-electrolytes. Determination of activity and activity coefficients for electrolytes and non-electrolytes. Excess Thermodynamic functions.

UNIT IV - STATISTICAL THERMODYNAMICS

Thermodynamic probability and most probable distribution - Ensemble averaging, postulates of ensemble averaging, Canonical, Grand canonical and microcanonical ensembles. Maxwell-Boltzmann statistics – Partition functions – thermodynamic properties from partition function - translational, rotational, vibrational and electronic partition functions. Partition function and equilibrium constant. Quantum statistics - Fermi-Dirac and Bose-Einstein statistics - photon gas and electron gas. Heat capacities of diatomic gases. Einstein and Debye's theory of heat capacity of solids - population inversion - negative Kelvin temperature.

UNIT V - IRREVERSIBLE THERMODYNAMIC PROCESSES

Affinities and fluxes, reversible and irreversible processes, entropy production for some important irreversible processes, entropy flow due to exchange of matter and energy, entropy changes due to chemical reaction, affinity and coupling of chemical reaction, the phenomenological laws and equations and their applications in chemistry - Onsager reciprocal relations- validity and verification. Thermoelectric phenomena - Electro kinetic and thermo mechanical effects. Application of irreversible thermodynamics to biological and non-linear systems.

PRESCRIBED BOOKS

1. F.A. Cotton, Chemical Applications of Group Theory, 3rd Edn., Wiley, 2008.
2. G. Davidson, Introductory Group Theory for Chemists, Elsevier, 1971.
3. K.V. Raman, Group Theory and its applications to Chemistry, 3rd Edn., Tata Mc Graw- Hill Publishing Company, 1990.
4. M. S. Gopinathan and V. Ramakrishnan, Group Theory in chemistry, 2nd Edn., Vishal Publication, 2013.
5. K.V. Reddy, Symmetry and Spectroscopy of molecules, New Age International, 2007.
6. P.K. Bhattacharya, Group Theory and its Chemical Applications, Himalaya Publishing House, 2010.
7. K. Rajaram and J.C. Kuriacose, Thermodynamics For Students of Chemistry, 2ndEdition,S.L.N. Chand and Co, Jalandhar, 1986.
8. M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt., Ltd., New Delhi, 1995.

REFERENCE BOOKS

1. R.L. Carter, Molecular Symmetry and Group Theory, Wiley, 1997.
2. R.L. Flurry, Symmetry Groups: Theory and Chemical Applications, Prentice Hall, 1980.
3. I.M.Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A.Benjamin Publishers, California, 1972.
4. Lee, Sears and Turcotte, Statistical Thermodynamics, 2nd edition, Addison Wesley, 1973.
5. P.A.Rock, Chemical Thermodynamics, Oxford University press, 1983.
6. W.J. Morre, Physical Chemistry, 5th edition, Orient Longman, 1976.
7. G.W. Castellan, Physical Chemistry, 3rd edition, Addison Wesley, 1983.

SCIENTIFIC RESEARCH METHODOLOGY

Objectives:

- To introduce scientific research and to learn the survey for literature, chemical abstract, choosing a research problem, scientific writing of research papers, presentations and research proposal and funding agencies.
- To learn Plagiarism and Intellectual Property Rights.
- To introduce the basic principles, working and applications of Instrumental techniques like Surface Probe Microscopy.

UNIT I - INTRODUCTION TO SCIENTIFIC RESEARCH

Objectives of research – Types of research – Significance of research. Research methods versus methodology – Research and scientific method – Criteria of good research – Problems encountered by researchers in India.

Problem selection – Selection of research problem, sources of research problems, criteria/characteristics of a good research problem, errors in selecting a research problem - project proposal – funding agencies.

UNIT II - LITERATURE SURVEY

Sources of information, Primary, Secondary, Tertiary sources, Journals, Journal abbreviations, Abstracts – Beilstein - Compendia and tables of information – Reviews – Current titles – Textbooks – Current contents - General treatises – Monographs and treatises on specific areas - Literature search – Information about a specific compound – Science citation index – Box to locate journals.

Introduction to Chemical Abstracts. Online searching, Database, Scifinder, Scopus, Citation Index, Impact Factor.

UNIT III - WRITING OF RESEARCH REPORT

Format of the research report- style of writing the report- references and bibliography.
Research paper writing: Types of research papers – Structure of research papers – Research paper formats - Different formats for referencing – ways of communicating research paper – organizing a poster display, giving an oral presentation in seminars/conferences - Making effective presentations using Power Point and Beamer.
Research Proposal: Format of research proposal, individual research proposal and institutional proposal.

UNIT IV - PLAGIARISM AND INTELLECTUAL PROPERTY RIGHTS

Plagiarism - Introduction, Reason for plagiarism, Types of plagiarism - Plagiarism of words, Patchwork plagiarism, Self-plagiarism, Cyber and Digital plagiarism, Accidental plagiarism, Plagiarism of Authorship, Plagiarism of Ideas. Plagiarism policies - IEEE, Springer, Elsevier. Software used for identifying plagiarism. Techniques to avoid plagiarism - Referencing, Paraphrasing, Creative Common License.
Intellectual Property Rights - Introduction. Difference between Industrial Property and Intellectual Property, Significance of Intellectual Property Rights. Forms of IPR - Patents, Copyright, Trademarks, Collective marks, Industrial Design, Integrated Circuit, Geographical Indication. Valuation of IPR, IPR and licensing.

UNIT V - ADVANCED INSTRUMENTAL TECHNIQUES

Principles, techniques and applications:
Surface probe microscopy: Atomic force microscopy, Scanning tunnelling microscopy, Scanning electron microscopy, Transmission electron microscopy, HRTEM, Energy Dispersive X-ray analysis (EDX), X-ray photo electron spectroscopy. X-ray diffraction techniques - Powder and single crystal XRD, principle, techniques and applications.

PRESCRIBED BOOKS

1. Dr.C.R. Kothari, Research Methodology: Methods and Techniques, New Age International Publishers, 2nd Edition, New Delhi. 2014.
2. Ranjit kumar, Research Methodology: A Step by Step Guide for Beginners, Pearson Education; 2nd Edition, 2005.
3. Tanmoy Chakraborty and Lalita Ledwani, Research Methodology in Chemical Sciences: Experimental and Theoretical Approach, Apple Academic Press; 1st Edition, 2016.

4. Dr. N. Arumugam, Research Methodology, Saras Publication, First Edition, 2016.
5. Vinayak Bairagi and Mousami V. Munot, Research Methodology - A Practical and Scientific approach, CRC Press, 2019.
6. R. Gopalan, P. S. Subramanian and K. Rengarajan, Elements of Analytical Chemistry, Sultan Chand and Sons, New Delhi, 2005.
7. S. M. Khopkar, Basic concepts of analytical chemistry, New age international, third edition 2008.
8. Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch, Fundamentals of Analytical Chemistry, ninth edition, 2013.
9. Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Analytical Chemistry, John Wiley & Sons, seventh edition, 2013.
10. G.R. Chatwal and S.K. Anand, Instrumental Method of Chemical Analysis, Himalaya Publishing house, fifth Reprint, 2016.

REFERENCE BOOKS

1. M.D. Barbara Gastel and Robert A. Day, How to Write and Publish a Scientific Paper, Greenwood Publishing Group Inc, 8th Edition, 2016.
2. R. Gopalan, Thesis writing, Vijay Nicole Imprints Private Ltd., 2005.
3. D.G Peters, J.M. Hayes and G.M. Hefige, A brief introduction to Modern chemical analysis, Saunders, 1976.
4. R.A Day and A.L. Underwood, Quantitative analysis, Prentice Hall, 1999.
5. D.A. Skoog, F.J. Holler and T.A. Nieman, Principles of Instrumental Analysis, 5th Edition, Bangalore, 2005.
6. Anthony R. West, Solid state chemistry and its applications, second edition, student edition, Wiley and sons, 2014.

ORGANIC CHEMISTRY PRACTICAL - III

Objectives:

- To enable the student to develop analytical skill in organic quantitative analysis.
- To enable the students to understand the mechanism involved in t w o stage organic preparations.

Estimations and two stage preparations comprising oxidation, bromination, nitration, hydrolysis, dehydration, diazotisation, coupling and photochemical reactions have been included as the practical components.

Microscale preparations are recommended for the simple reason, as they are both economicfriendly
and eco-friendly.

A. List of Estimations

1. Glucose-Lane - Eynon and method
2. Glucose - Bertrand's method
3. Purity of Glucose
4. Determination of Percentage purity in an unsaturated acid.

B. List of Two stage preparations

1.	Benzaldehyde	→	Benzoic acid	→ m-nitrobenzoic acid
2.	Acetanilide	→	p-bromoacetanilide	→ p-bromoaniline
3.	Acetanilide	→	p-nitroacetanilide	→ p-nitroaniline
4.	Methyl Benzoate	→	m-nitro methylbenzoate	→ m-nitrobenzoic acid
5.	Benzophenone	→	Benzpinacol	→ Benzpinacolone
6.	Benzophenone	→	Benzophenone oxime	→ Benzanilide
7.	Phthalic acid	→	Phthalic anhydride	→ Phthalimide
8.	Aniline	→	Tribromoaniline	→ sym-tribromobenzene
9.	Aniline	→	Diazoaminobenzene	→ p-aminoazobenzene

Students are expected to submit the recrystallised samples of the final products, at the time of practical examination, for evaluation by the examiners.

PRESCRIBED BOOKS

1. A.I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis, Pearson Education, 2011.
2. F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th edn, Pearson Education India, 2009.
3. V.K. Ahluwalia, and R. Aggarwal, Comprehensive Practical Organic Chemistry, Universities Press, 2004.
4. Raj K. Bansal, Laboratory Manual of Organic Chemistry, Second Edition, Wiley Eastern Ltd., 1990.

REFERENCE BOOKS

1. R.G. Engel, D.L. Pavia, G.M. Lampman and G.S. Kriz, A Microscale approach to Organic Laboratory, 5th edition, Paperback – International Edition, 2012.
2. P.B. Cranwell, L.M. Harwood and C.J. Moody, Experimental Organic Chemistry, 3rd edn, Wiley-Blackwell, 2017.
3. J. Leonard, B. Lygo and G. Procter, Advanced Practical Organic Chemistry, 3rd edn, CRC Press, 2013.
4. Moore, Dalrympk and Rodig, Experimental methods in organic chemistry, 3rd edition, Saunders College publishing, The Oxford Press, 1982.

INORGANIC CHEMISTRY PRACTICAL - III

Objectives:

- To identify the methodology to separate and estimate mixture of metal ions quantitatively.
- To understand the principles for volumetric and gravimetric methods of estimation of cations present in a mixture.

I. Quantitative estimation of a mixture containing two or three metal ions (Volumetric and Gravimetric Estimations)

1. Estimation of mixture of Cu2+(V) and Ni2+(G)ions.
2. Estimation of mixture of Fe2+(V)and Cu2+(G)ions.
3. Estimation of mixture of Fe2+(V) and Ni2+(G)ions.
4. Estimation of Cu2+ (V), Ba2+ (G) and Ca2+ (G) ions in a mixture.
5. Estimation of Cu2+ (V), Ba2+ (G) and Zn2+ (G) ions in a mixture.
6. Estimation of Fe2+ (V), Cu2+ (G) and Ni2+ (G) ions in a mixture.

II. Analysis of ores and alloys (coursework)

PRESCRIBED BOOKS

1. Mounir A. Malati, Experimental Inorganic/Physical Chemistry - An Investigative, Integrated Approach to Practical Project Work, Woodhead Publishing Limited, Reprint, 2010.
2. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, Revised 5th edition, ELBS, 1989.
3. Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch,

Fundamentals of Analytical Chemistry, 8th Edition, Brooks/Cole-Thomson Learning, USA, 2004.

REFERENCE BOOKS

1. I.M. Kolthoff and V.A. Stenger, Volumetric Analysis, 2nd Edition, Interscience Publishers, New York, 1947.
2. W. G. Palmer, Experimental Inorganic Chemistry, Cambridge University Press, Reprint, 1970.

PHYSICAL CHEMISTRY PRACTICAL - III

Objectives:

- To learn and apply the Principles of Potentiometric Titrations.
- To understand the Principles and applications of Kinetics and Adsorption.

I. Potentiometric Titrations

(a) Acid alkali titrations.
(b) Determination of dissociation constant of weak acids
(c) Determination of pH of buffer Potentiometrically
(d) Redox Titrations
(i) Fe^{2+} vs Ce^{4+}
(ii) Fe2+ vs $Cr_2O_7^{2-}$
(iii) Fe^{2+} vs $KMnO_4$
(iv) I^- vs $KMnO_4$
(e) Precipitation Titrations
(i) Mixture of Cl^-& I^- vs Ag^+
(f) Solubility Product: Determination of solubility product of sparingly soluble silver salts.

II. Kinetics: Study of Kinetics of KI - $K_2S_2O_8$ system

III. Adsorption:

(a) Freundlich Adsorption isotherm:
(i) Adsorption of oxalic acid on charcoal.
(ii) Adsorption of acetic acid on charcoal.
(b) Langmuir Adsorption isotherm:
(i) Adsorption of oxalic acid on charcoal.
(ii) Adsorption of acetic acid on charcoal.

PRESCRIBED BOOKS

1. J. B.Yadav, Advanced Practical Physical chemistry, 20th Edn., GOEL publishing House, Krishna Pakashan Media Ltd., 2001.
2. B.C. Kosla, Senior Practical Physical Chemistry, Simla Printers, New Delhi, 1987.
3. R.C. Das and B. Behra, Experimental Physical Chemistry, Tata McGraw Hill, New Delhi,1983.
4. Saroj Kumar and Naba Kumar, Physical Chemistry Practical, New Central Book Agency, 2012.

REFERENCE BOOKS

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2. W.J. Popiel, Laboratory Manual of Physical Chemistry, ELBS, London, 1970.
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