DEPARTMENT OF CHEMISTRY

M.Sc. (CHEMISTRY)

(Students admitted during 2020-2021 Onwards)

(Under CBCS with Outcome Based Education (OBE) Pattern)

SYLLABUS

I & II SEMESTER

GOBI ARTS & SCIENCE COLLEGE

(Govt. Aided Autonomous Co-educational Institution, Affiliated to Bharathiar University, Coimbatore, Accredited with 'A' Grade by NAAC (4th cycle) and Recognised as a STAR College by DBT, Government of India)

KARATTADIPALAYAM POST,

GOBICHETTIPALAYAM - 638453

ERODE DISTRICT.

GOBI ARTS & SCIENCE COLLEGE (Autonomous)

Vision

Social and Economic upliftment of the people of this area through value based quality Education.

Mission

Committed to serve the society with humility and trust, devoid of exploitation; to impart value based higher education, particularly to the socially and economically deprived sections of this area; to make students of this institution worthy citizens of our glorious motherland.

DEPARTMENT OF CHEMISTRY

Vision

We strive to contribute to a chemically literate society through teaching and research.

Mission

The chemistry department is committed to prepare competitive and professional graduates to compete globally and to produce a better society for all.

GOBI ARTS & SCIENCE COLLEGE (AUTONOMOUS): GOBICHETTIPALAYAM
SCHEME OF EXAMINATIONS - M.Sc. CHEMISTRY (20 BATCH)

No.	Course Code	Course	Total Hours	Hrs/ Exam	Maximum Marks		Total Marks	Credits
					CIA	EOS		
		SEMESTER - I						
1	19P3CH01	INORGANIC CHEMISTRY - I	75	3	40	60	100	4.0
2	19P3CH02	ORGANIC CHEMISTRY - I	75	3	40	60	100	4.0
3	19P3CH03	PHYSICAL CHEMISTRY - I	75	3	40	60	100	4.0
4	19P3CH04	ELECTIVE - I : PHYSICAL METHODS IN CHEMISTRY	60	3	40	60	100	4.0
		SEMESTER - II						
5	19P3CH05	INORGANIC CHEMISTRY - II COORDINATION CHEMISTRY	75	3	40	60	100	4.0
6	19P3CH06	ORGANIC CHEMISTRY – II	75	3	40	60	100	4.0
7	19P3CH07	PHYSICAL CHEMISTRY - II	75	3	40	60	100	4.0
8	19P3CH08	ELECTIVE - II : MOLECULAR SPECTROSCOPY	60	3	40	60	100	4.0
9	19P3CHP1	PRACTICAL - I : INORGANIC CHEMISTRY - I	90	6	40	60	100	3.0
10	19P3CHP2	PRACTICAL - II : ORGANIC CHEMISTRY - I	90	6	40	60	100	3.0
11	19P3CHP3	PRACTICAL - III : PHYSICAL CHEMISTRY - I	90	6	40	60	100	3.0
		SEMESTER - III						
12	19P3CH09	INORGANIC CHEMISTRY – III ORGANO METALLIC CHEMISTRY	75	3	40	60	100	4.0
13	19P3CH10	ORGANIC CHEMISTRY – III	75	3	40	60	100	4.0
14	19P3CH11	PHYSICAL CHEMISTRY – III	75	3	40	60	100	4.0
15		SUPPORTIVE PAPER :	90	3	40	60	100	4.0
		SEMESTER – IV						
16	19P3CH12	INORGANIC CHEMISTRY - IV	75	3	40	60	100	4.0
17	19P3CH13	ORGANIC CHEMISTRY - IV	75	3	40	60	100	4.0
18	19P3CH14	ELECTIVE - III : ANALYTICAL CHEMISTRY	75	3	40	60	100	4.0
19	19P3CHP4	PRACTICAL - IV : INORGANIC CHEMISTRY - II	90	6	40	60	100	4.0
20	19P3CHP5	PRACTICAL - V : ORGANIC CHEMISTRY - II	90	6	40	60	100	4.0
21	19P3CHP6	PRACTICAL - VI : PHYSICAL CHEMISTRY - II	90	6	40	60	100	5.0
22	19P3CHV1	PROJECT WORK AND VIVA VOCE			40	60	100	8.0

TOTAL CREDITS: 90

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

K1-Remember; **K2**- Understanding; **K3**- Apply; **K4**-Analyze; **K5**- Evaluate

I. END OF SEMESTER (EOS) EXAMINATIONS:

1. Theory: 60 Marks

Knowledge Level	Section	Marks	Description	Total
K1	A (Answer All)	10 × 1 = 10	MCQ	60
K2	B (Either or Pattern)	5 × 4 = 20	Short answers	
K3 & K4	C (Answer 3 out of 5)	3 × 10 = 30	Descriptive/Detailed	

2. Practical Examinations: 60 Marks

Knowledge Level	Section		Total
	Practical	Record work	
K3	50	10	60
K4			
K5			

II. CONTINUOUS INTERNAL ASSESSMENT (CIA):

1. Test – I & II: 30 Marks (Theory)

Knowledge Level	Section	Marks	Description	Total
K1	A (Answer All)	10 × 1 = 10	MCQ	30
K2	B (Answer 2 out of 3)	2 × 5 = 10	Short answers	
K3 & K4	C (Answer 1 out of 2)	1 × 10 = 10	Descriptive/Detailed	

2. Test –III: (Model Exam)

Knowledge Level	Section	Marks	Description	Total
K1	A (Answer All)	10 × 1 = 10	MCQ	60 Marks converted to 40 Marks
K2	B (Either or Pattern)	5 × 4 = 20	Short answers	
K3 & K4	C (Answer 3 out of 5)	3 × 10 = 30	Descriptive/Detailed	

3. Practical Internal Assessment: 40 Marks

Knowledge Level	Components		Calculation	Lab Performance	Total
K3, K4, K5	Test 1	30	$\frac{\text{Test 1 + Test 2}}{2}$	10	40
	Test 2	30			

Components of Continuous Internal Assessment (CIA)

Components		Calculation	CIA Total
Test 1 & Test 2	30	$30 + 40 + 30 = \frac{100 \times 40}{100} = 40$	40
Test 3	40		
Assignment+ Seminar+ Quiz / GD / Poster Presentation / Book Review / Field Visit Report	10+10+10 = 30		

Programme Specific Objectives

The students will be able to do, on successful completion of programme,

1. Obtain employment in industry/academia and will possess skills to identify, critically access, analyze and solve problems related to chemistry.
2. Flourish in their career through continual learning pursue higher education and research.
3. Strive to contribute for the development of the country by participating in industry/academic area.
4. Acquire morale value, kinship and the spirit of compassion and committed to ethical society and the environment.
5. Vividly portrays the knowledge in the subject of chemistry and exercise the principles of chemistry to the needs of the academic institution/industry/own business (or) other enterprise/society.
6. Exhibit professional skills in ethical way and demonstrate community living and cherish nation building initiatives.

Programme Specific Outcomes (PSO)

PSO1: Apply the knowledge of chemistry in energy, environment, material science and medicine fields.

PSO2: Apply the domain expertise in chemistry to participate effectively as an individual (or) a leader in the society.

PSO3: Effectively communicates to share their views with regards to theoretical concepts, experimental aspects and impacts of chemistry on environment and society to the fellow human being.

PSO4: Using state of art techniques, and current tools to solve the problems in society with an understanding of societal, environmental, legal, and cultural impacts of the solution.

PSO5: Acquire analytical skills and coherent thinking in the field of chemistry.

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH01	Course Title:	Batch:	2019
Total Hours:	75	Inorganic Chemistry - I	Semester:	I
			Credits:	4.0

Course Objective

The course aims

- To know about the inorganic chains, rings, cages and clusters.
- To study the concept of acids and bases and bonding models.
- To learn the fundamentals of nuclear chemistry and its applications.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K2	CO1	Discuss the chemistry of inorganic chains, rings, cages and clusters.
K1	CO2	Compute the concepts of acids-bases and theories involved in it.
K3	CO3	Apply the acid-base concept in non-aqueous media and reactions in non-aqueous media.
K4	CO4	Explain the bonding models in inorganic chemistry.
K2, K3	CO5	Predict the types of Nuclear reactions and applications of radioisotopes.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Structure-Inorganic chains-rings-cages and cluster:** catenation - heterocatenation-intercalation chemistry- one dimensional conductor- isopolyanions- heteropolyanions-borazines- phosphazenes- phosphazene polymer- ring compounds of sulphur and nitrogen- homocyclic inorganic system- cages- boron cage compound – metal cluster - dinuclear cluster- trinuclear cluster-tetranuclear cluster- hexanuclear cluster-structure predation of organometallic clusters.	15
II	**Acids and Bases:** Acid-base concepts: Bronsted-Lowry, Lux-Flood, Usanovich, Lewis, solvent system and generalized acid base concepts – Measures of acid-base strength – steric effect and solvation effects F-strain and B-strain. **lonic bond:** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.	15
III	**Hard and soft acids and bases:** Classification- Acid base strength - hardness and softness – symbiosis–Theoretical basis of hardness and softness, electronegativity and hardness and softness. Solvents- Classification- Properties- types of reactions – autoionisation, neutralisation, precipitation, solvation, solvolysis and complex formation. Liq. SO_2, HF and H_2SO_4 as solvents - Liq. NH_3, alkali metals in liq. NH_3.	15

IV	**Covalent bond:** Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Formal charge, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. **Metallic bond:** Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.	**15**
V	**Nuclear chemistry:** The nucleus- subatomic particles and their properties- nuclear forces- Liquid drop model and shell model, Modes of radioactive decay- Types of nuclear reactions- Theories of fission- Fission product distribution- Fissile and fertile isotopes- stellar energy- synthetic elements. **Detectors and Particle Accelerators:** Cloud chamber, bubble chamber, Scintillation counter, Proportional counter, G.M counter and Cherenkov counter. Linear accelerator-cyclotron, synchrotron, betatron and bevatron. Uses of radioisotopes in structure and mechanistic studies- Carbon dating- Hot atom chemistry- Nuclear waste disposal.	**15**

<* Self study: Catenation, Structure predation of organometallic clusters>.

Text Books:

1. Huheey J E, Keiter E A and Keiter R L, Inorganic Chemistry Principles of Structure and Reactivity, 4th Ed., Harper Collins College Publishers, New York, 1993.
2. Cotton F A and Wilkinson G, Inorganic Chemistry, A Comprehensive Text, 3rd Ed., Interscience Publishers, New York, 1972.
3. Lee J D, Concise Inorganic Chemistry, 6th Ed., ELBS, London, 1998.
4. Arniker H J, Essentials of Nuclear Chemistry, New Age International Publishers, New Delhi, 2005.
5. Gurudeep Raj, Advanced Inorganic Chemistry, Vol. I, Krishna Prakasam Media (P) Ltd., Edn. 25 (1999).

Reference Books:

1. Miessler G L, Fischer P J and Tarr D A, Inorganic Chemistry, 5th Ed., Pearson Education, Inc., New York, 2014.
2. Glasstone S, Source Book on Atomic Energy, Affiliated East West Press Pvt. Ltd. New Delhi, 1967.
3. Purcell K F and Kotz J C, Inorganic Chemistry, W B Saunders Company, Philadelphia, 1977.
4. Shriver D, Weller M, Overton T, Rourke J and Armstrong F, Inorganic Chemistry, 6th Ed., W H Freeman and Company, New York, 2014.
5. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.

E-references:

1. http://www.easynotes4u.com/pdf/Inorganic_Chemistry.pdf
2. http://www-ucjf.troja.mff.cuni.cz/dolezal/teach/accel/talks /empp.pdf

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	H	M	M	H
CO2	S	M	H	H	S
CO3	S	M	H	M	H
CO4	H	S	S	H	S
CO5	S	S	H	M	H

S - Strong; **H** - High; **M** - Medium; **L** - Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH02	Course Title:	Batch:	2019
Total Hours:	75	Organic Chemistry - I	Semester:	I
			Credits:	4.0

Course Objective

The course aims

- To learn about the basic concepts of aromaticity.
- To know the basic concepts of reaction mechanism of organic compounds.
- To understand the concepts of substitution reactions of aliphatic and aromatic compounds.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K3	CO1	Identify aromatic, anti aromatic and non aromatic compounds.
K3, K2	CO2	Give mechanisms of nucleophlic and electrophlic reactions.
K2, K3	CO3	Evaluate aliphatic substitution reactions which are occurring through the nucleophile and electrophile.
K2, K3	CO4	Explain addition reaction to double, triple bonds and carbonyl compounds
K2 ,K3	CO5	Create an outline about elimination reactions and with some specific examples.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Aromaticity:** Benzenoid and non benzenoid aromatics, ferrocene, azulene and annulenes **(synthesis not required)**. Alternant and non-alternant hydrocarbons-homoaromaticity-antiaromaticity. Kinetic and non-kinetic methods of determining reaction mechanism: isotopic effect, study of intermediates, isotopic labeling and cross over experiments. Hammond's postulates. Linear free energy relationship- Hammet equation.	**15**
II	**Aromatic electrophilic substitution reactions:** Arenium ion mechanism orientation and reactivity of mono and disubstituted benzenes. Aromatic electrophilic substitution reactions: Vilsmier reaction, Fries rearrangement, Diazonium coupling, Hoesch Reaction, Fischer-Hepp rearrangement, Orton rearrangement, Hoffmann Maritus and Jacobsons reactions. **Aromatic nucleophilic substitution reactions:** Intermediate complex mechanism, Benzyne mechanism, -Structure reactivity relationship. Ziegler alkylation and Chichibabin reaction.	**15**
III	**Aliphatic nucleophilic substitution reactions:** S_N^1, S_N^2, S_N^i, $S_N^1{}_{CB}$ $S_N^{1'}$, $S_N^{2'}$ and $S_N^{i'}$ mechanisms, substitution at vinyl carbon, stereo chemistry of nucleophilic substitution reaction, effect of substrate structure, solvent, leaving group and nucleophilicity. Ambident nucleophiles and substrates-neighbouring group participation. **Aliphatic electrophilic substitution reactions:** S_E^1, S_E^2 and S_E^i mechanisms, structure reactivity relationship.	**15**

IV	**Addition Reactions:** Electrophilic, nucleophilic and free radical addition reactions to double and triple bonds, hydration, hydroboration, Michael addition, epoxidation and hydroxylation. **Addition reactions to carbonyl compounds:** Mannich reaction, aldol condensation. Perkin reaction, Tollen's reaction, Dieckmann, Stobbe, prins reaction, Darzen, Wittig, Thorpe and Ritter reactions.	**15**
V	**Elimination reactions:** E_1, E_2, E_i, E_{1CB} mechanisms, stereo chemistry of elimination reactions, effect of substrate structure, attacking base, leaving group, medium. Typical cis elimination reactions: Chugaev reaction, Hofmann exhaustive methylation, Cope elimination and dehydration of alcohols. Carbens and nitrenes–Structure, generation and reactions.	**15**

<* Self study: Meerwein-ponndorf-Verely reduction, Claisen, Benzoin reactions, Saytzeff rule, Hofmann rule, eliminations Vs substitution>.

Text Books:

1. Michael B. Smith, March's Advanced organic chemistry: Reaction Mechanism and structure, Wiley& sons, Edn VII (2013).
2. John MC.Murry, Organic chemistry, cengage Learning, Edn VIII, (2011).
3. I.L.Finar, Organic chemistry, ELBS, Vol 1, Edn IV, (1963).
4. G.M.Badger, Aromatic Character and Aromaticity, Cambridge university press, (1969).
5. P.S.Kalsi, Organic Reactions and their mechanisms, New age international (P) Ltd, Edn III (2010).

Reference Books:

1. Dr.Jagdamba singh and L.D.S.Yadav, Advanced organic chemistry, Pragati Prakashan, Edn XIV, (2017).
2. S.K.Mukherjee and S.P.Singh, Reaction mechanism in organic chemistry, Macmillan publishers India (1984).
3. Dr.Jagdamba singh and L.D.S.Yadav, organic synthesis, pragati prakashan, (2011).
4. V.K.Ahluwalia, Rakesh Kumar, Parashar, Organic Reaction Mechanisms, Alpha Science International, Edn IV, (2011).
5. C.K.Ingold, Structure and Mechanisms in organic Chemistry, Cornell University Press (1953).

E-references:

1. www.vanderbilt.edu/.../Rizzo/chem220a/Ch11slides.pdf
2. www.chem.ualberta.ca/~vederas/Chem_164/handouts/pdf/sub

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	S	H	M
CO2	S	S	H	H	S
CO3	S	H	S	M	H
CO4	S	H	M	S	S
CO5	S	S	H	H	S

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH03	Course Title:	Batch:	2019
Total Hours:	75	Physical Chemistry - I	Semester:	I
			Credits:	4.0

Course Objective

The course aims

- To know the third law of thermodynamics.
- To understand the concept of statistical thermodynamics.
- To get the basic concepts of group theory.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K2	CO1	Formulate the concepts of fugacity and activity.
K2	CO2	Demonstrate irreversible thermodynamic process.
K3	CO3	Apply different types of statistics for different particles.
K2	CO4	Evaluate the thermodynamic properties.
K3	CO5	Construct the character table for C_{2V}, C_{3V} and C_{2h} point group.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Chemical thermodynamics:** Thermodynamic Quantities at Absolute Zero – Helium at Low Temperature – Negative Absolute Temperature. Entropy of Gases – Entropy at Absolute Zero – Entropy and Probability (Boltzmann Expression) – Planck Equation – Significance of Thermodynamic Probability – Entropy of Expansion of Ideal Gas. Konowaloff's law, Excess thermodynamic functions. The concept of Fugacity and Activity: definition of fugacity - determination of fugacity - variation of fugacity with temperature and pressure Fugacity of liquids and solids. Fugacity of mixtures of gases. Lewis Randall rule. Activity and Activity coefficients. Determination of activity and activity coefficients –vapour pressure method, solubility method, freezing point method, and emf method.	**15**
II	**Thermodynamics of Irreversible process:** Simple examples of irreversible process, general theory - Conservation of mass and energy- Entropy production in open system by (i) heat (ii) matter and (iii) current flow, transformation properties of fluxes and forces , the phenomenological relations, Principle of Microscopic reversibility and Onsager reciprocal relations, Verification of the Onsager relations, applications to the theory of diffusion, electro- kinetic effects, the Glandorf-Prigogine equation. . Application of irreversible thermodynamics to biological and non-linear systems.	**15**

III	**Statistical thermodynamics - I:** Objectives of statistical thermodynamics - concept of thermodynamics and mathematical probabilities Permutation and combination. - Laws of probability. Distribution laws. Gaussian distribution. Distribution of distinguishable and non-distinguishable particles. Maxwell - Boltzmann distribution law - Fermi - Dirac and Bose - Einstein statistics - comparison with Maxwell -Boltzmann distribution law and their applications.	**15**
IV	**Statistical thermodynamics - II:** Partition function – Definition – Justification & Nomenclature – Barometric Distribution Law – Boltzmann Distribution – Relation between Total Partition Functions & Translational, Rotational Vibrational & Electronic Partition Functions – Ortho & para Hydrogen – Evaluation of Thermodynamic Properties (E, H, A and G, C_V and C_P).	**15**
V	**Group Theory and its Applications:** Symmetry elements and symmetry operations. Matrix representation of symmetry operations. Character of a matrix. Point groups. Multiplication of operations. Group multiplication table. Similarity transformation and classification of symmetry operation, Matrix representation of point group. Reducible and Irreducible representations. The Great Orthogonality theorem. Rules derived from GOT. Character table of C_{2v}, C_{3v} and C_{2h} point groups only. Molecular symmetry and optical activity. Symmetry selection rules of infra-red and Raman spectra.	**15**

<* Self study: Nernst heat theorem, Gibbs free energy, Gibbs- Helmholtz equation>.

Text Books:

1. S.Glasstone, Thermodynamics for Chemists, Affiliated East-WestPress (P) Ltd, New Delhi, (1993).
2. P.W.Atkins, J.De.Paula, Atkin's Physical Chemistry, Oxford University press, oxford, Edn VIII, (2006).
3. John F.Lee, Francis W. Sears & Donald L.Turcotte, Statistical Thermodynamics, Reading, Mass Addition –Wesley Pub. Co, (1963).
4. F.W.Sears and G.L.Salinger, Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Narosa Publishing House, (1998).
5. K.V.Raman, Group theory and its applications to chemistry, Tata McGrowHill, (1990).

Reference Books:

1. B.R.Puri, L.R.Sharma, M.S.Pathania, Principles of Physical Chemistry, Vishal Publishing Co, Jalandr, Edn 41, (2006).
2. W.J.Moore, Physical Chemistry, Longmans, (1962).
3. M.C. Gupta, Statistical Thermodynamics, New Age International (P) Limited publisher, New Delhi, (2007).
4. V.Ramakrishnan and M.S.Gopinathan, Group theory in chemistry, Vishal Publishing Co, (1988).
5. K.Veera Reddy, Symmetry and Spectroscopy of molecules, New Age International Ltd Publishers, (2014).

E-references:

1. farside.ph.utexas.edu/teaching/sm1/statmech.pdf
2. www.bhojvirtualuniversity.com/slm/mscche1p4.pdf

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	H	M
CO2	H	H	H	S	S
CO3	S	S	H	S	H
CO4	S	S	H	H	M
CO5	S	H	S	H	S

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH04	Course Title:	Batch:	2019
Total Hours:	60	Elective - I: Physical Methods in Chemistry	Semester:	I
			Credits:	4.0

Course Objective

The course aims

- To study the instrumentation and principles of analytical instruments.
- To aware the various applications of instruments in chemistry.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K4	CO1	Analyse the radioactive elements using various methods of activation analysis.
K1, K2	CO2	Predict the thermo gram of various compounds by using thermal methods.
K3	CO3	Apply the concept of ORD and CD to determine the absolute configuration and conformation of organic compounds.
K2	CO4	Identify the metals and non metals using AAS and FES.
K1	CO5	Apply the chromatographic principles and techniques to separate and purify various organic compounds.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Nuclear methods and analysis**: Statistical in measurement of radioactivity-coincidence correction-preparation and mounting of samples-tagging compounds-analysis with labelled reagents-isotope dilution analysis-liquid scintillation counting-activation analysis-absolute method-comparator method-limitations of activation analysis-application of activation analysis-isotope dilution method-applications of isotope dilution method-Radiometric titrations.	12
II	**Thermal methods of analysis**: Introduction- different types of thermo analytical methods. Thermogravimetry-principle, factors influencing thermograms- instruments-precautions in the use of thermo balance. Derivative thermogravimetry-principle-factors influencing thermograms. Differential thermal analysis- principle instrumentation and applications -DTA of calcium oxalate monohydrate. Differential scanning calorimetry and Refractometry - theory, Abbe's refractometer and applications of refractometry.	12
III	**Polarimetry** – Plane polarised light – optical activity of molecules – polarimeter and its uses. ORD and CD spectrometry, circular birefringence, circular dichroism, optical rotatory dispersion, plain curves, anomalous curves – Cotton effect – axial haloketone rule and octane rule – application. Nephelometry and Trubidimetry – Principle, instrumentation and applications. voltametry and cyclicvoltametry, electrogravimetry.	12
IV	**Atomic Absorption Spectrometry:** Principle – instrumentation – detection of metals & non-metals, interference, detection limit & sensitivity and applications.	

	Flame Emission Spectrometry: Principle, instrumentation and applications. Comparison between AAS and FES. Molecular fluorescence and phosphorescence: Instrumentation and applications. Chemiluminescences: Introduction, principle, types. Measurement of Chemiluminescences instrumentation and titrations.	**12**
V	**Chromatography** – Introduction - definition – types- Adsorption and partition principles. Paper chromatography - principle - RF concept - types and applications. Thin layer chromatography - principles–Experimental Techniques. Superiority over other chromatographic techniques and applications - isolation of alcohols, alkaloids, amino acids, separation of inorganic ions only. Column chromatography- principle, theory of development, factors affecting column chromatography and applications. Gel chromatography, ion exchange chromatography and paper electrophoresis. **Advanced techniques:** HPLC - principle - instrumentation - column efficiency & selectivity – applications. GC - principle - instrumentation and applications. HPLC-GC and GC-MS.	**12**

<* Self Study: Basic concepts of optical activity and Amprometric titrations>.

Text Books:

1. Gurdeep R.Chatwal & S.K.Anand, Instrumental methods of Chemical Analysis, Himalaya Publishing House, 5th Edition, (2003).
2. B.K.Sharma, instrumental methods of chemical analysis, Goel Publishing House, 23rd Edition, (2004).
3. R. Gopalan, P.S. Subrmanian and K. Rangarajan, Elements of Analytical chemistry, Sultan Chand and Sons, 2nd Edition, (1994).
4. V. K. Srivastava and K. K. Srivastava, Introduction to Chromatography, Holden Day, New York, 2nd Edition, (1985).
5. Shoba Ramakrishnan Banani Mukhopadhyay, Essentials of Analytical chemistry, Pearson Education, First edition, (2017).

Reference Books:

1. R. S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East-West Press Pvt. Ltd., New Delhi, (2012).
2. D.A. Skoog, D.M. West, F.J.Holder and S.R.Grouch, Analytical chemistry an introduction, Saunders college publishing, 9th Edition, (2004).
3. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, Chennai, 6th Edition, (1986).
4. S.M. Khopkar, Basic concepts of Analytical chemistry, New age international publishers, 3rd Edition, (2009).
5. A. I. Vogel, Text Book of Quantitative Inorganic Analysis, Longman, New Delhi, 6th Edition, (2000).

E-references:

1. https://www.slideshare.net/JayshreeUpadhyay/tga-and-dsc-ppt
2. https://www.slideshare.net/sharmasuriti/atomic-absorption-spectroscopy-15185397

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	H	S	H	M
CO2	H	S	H	S	H
CO3	S	H	H	S	M
CO4	H	S	S	H	S
CO5	S	H	S	S	H

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH05	Course Title:	Batch:	2019
Total Hours:	75	Inorganic Chemistry - II Coordination Chemistry	Semester:	II
			Credits:	4.0

Course Objective

The course aims

- To learn the various theories of coordination compounds.
- To study the various reaction of coordination compounds.
- To acquire the knowledge about bioinorganic chemistry.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K1	CO1	Compare the various theories of coordination compounds.
K2 & K3	CO2	Interpret electronic spectra and magnetic properties of coordination compounds.
K3	CO3	Apply the various reactions and mechanism of coordination complexes.
K3	CO4	Utilize the chemistry of transition metal complexes to understand the functions of biological systems.
K2	CO5	Identify the applications of various non-essential elements in chemotherapy.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Theories of coordination compounds**: CFT-Splitting of d orbital in ligand field and different symmetries-CFSE-Factors affecting the magnitude of 10 DQ-Evidence for crystal field stabilization - Spectro chemical series – Site selection in spinels - tetragonal distortion from octahedral symmetry-John Teller distortion - Nephelauxetic effect-Mo theory octahedral-tetrahedral and Square planar complexes-pi bonding and molecular orbital theory-experimental evidence for pi-bonding.	15
II	**Electronic and Magnetism**: Microstates, terms and energy levels for d^1–d^9 ions in cubic and square field-selection rules-band intensities and band widths-orgel and tanabe-sugano diagram-evolution of 10DQ and â for octahedral complexes for cobalt and nickel-charge transfer spectra -change in magnetic properties of complexes in terms of spin orbit coupling – temperature independent pare magnetism-spin cross over phenomena.	15
III	**Reactions:** The rate law for Nucleophilic substitution in square planar complexes-the trans effect-theories of trans effect-mechanism of Nucleophilic substitution in square planar complexes-kinetics of octahedral substitution –ligand field effect and reaction rate-mechanism of substitution in octahedral complexes –reaction rate influenced by acid and bases – racemization and isomerization-mechanism of redox reactions-outer	15

	sphere mechanism-excited outer sphere electron transfer reactions-inner sphere mechanisms-mixed valence complexes.	
IV	**Bio inorganic chemistry**: Metalloporphyrins - chlorophyll, hemoglobin and myglobin-structure and functions of heamoglobin cytochromes. Metalloenzymes- enzyme action, inhibition and restoration-carboxy peptidase-A and carbonic anhydrase-vitamin B_{12} and B_2 co-enzymes. Metalloproteins: non heme iron proteins-rubredoxin and ferrodoxin-copper proteins and their classification-Nitrogenase, their structure and function-metal sodium ion pump-metal poisons and chelating agents in medicines.	**15**
V	**Chemotheraphy**: Chemotherapy with compounds of certain non-essential elements: Cisplatin and its mode of action – cyto toxic compounds of other metals-Gold containing drugs as anti-rheumatic agents and their mode of action-Lithium in pschyco pharmological drugs. Compounds of arsenic -arsenous anhydride, sodium arsenate and aromatic arsenicatls – Iron- ferrous gluconate and ferric ammonium citrate-Mercury - mercurous chloride ammoniate mercury and grew powder-Biological role of I_2, Cu and Zn.	**15**

<* Self Study: Basic concepts of coordination compounds and VB theory>.

Text Books:

1. J.E Huheey, Inorganic chemistry, Principles of structure and reactivity, Pearson Education in India, 4th Edition, (2002).
2. Wahid U. Malik, G.D. Tuli and R.D. Madan, Selected topics in inorganic chemistry Sultan Chand and Co, New Delhi, Revised Edition, (1999).
3. J.D. Lee, Concise of inorganic chemisty, Wiley-Blackwell, 5th Edition, (1999).
4. R. Gopalan and V. Ramalingam, Concise coordination chemistry, Vikas publishing house, New Delhi, 1st Edition, (2014).
5. Asim K Das, Bioinorganic chemistry, books& allied (P) Ltd, (2013).

Reference Books:

1. F.A. Cotton and Wilkinson Advanced inorganic chemistry, Wiley Easter Pvt. Ltd, New Delhi, 2nd Edition, (1969).
2. B.N. Figgis, Introduction to ligand field theory and applications, John wiley & Sons Ltd, (2000).
3. F.Basclo and R.G. Pearson, Mechanism in inorganic reactions, Wiley, New York, 2nd Edition, (1967).
4. B.R.Puri, L.R. Sharma and K.C Kalia, Principles of inorganic chemistry, Milestone Publishers & Distributors, New Delhi, (2008).
5. W.Keim, B. Schewederski, Bio inorganic chemistry, inorganic elements in the chemistry of life, John Wiley & Sons, Ist Edition, (1994).

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1. https://www.studocu.com/en-ca/document/university-of-leeds/chemotherapy/lecture-notes/lecture-i-introduction-and-key-concepts-in-chemotherapy-lecture-notes-lectures-1-18/582788/view
2. https://nptel.ac.in/courses/104105031/

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	S	S	S
CO2	S	H	S	H	M
CO3	H	S	H	M	S
CO4	S	H	S	H	H
CO5	H	S	H	S	M

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH06	Course Title:	Batch:	2019
Total Hours:	75	Organic Chemistry - II	Semester:	II
			Credits:	4.0

Course Objective

The course aims

- To understand the basic concepts of pericyclic reactions.
- To put on expertise in the progress of photochemistry.
- To learn about the molecular rearrangements.
- To learn various organic reactions and reagents used in them as tools applied in the art of organic synthesis.
- To know about the conformational analysis and stereochemistry of organic compounds.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K2, K3	CO1	Predict the product due to pericyclic reaction mechanism at thermal and photochemical conditions.
K1, K2	CO2	Identify the products of various organic compounds by using photochemical process.
K2	CO3	Construct the mechanism of various named molecular rearrangements.
K3	CO4	Utilize different reagents for oxidation and reduction reactions.
K3, K4	CO5	Examine stereochemistry of organic compounds and conformational analysis of five and six membered rings.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Pericyclic reactions:** Electrocyclic reactions, molecular orbital correlation diagram and frontier molecular orbital (FMO) theory applicable to the electrocyclic conversion of 1,3-dienes and 1,3,5-trienes, [2+2] cycloadditions and [2+4] cycloadditions. Sigmatropic rearrangements: [1, 5] sigmatropic rearrangement, Claisen, Cope di-π methane rearrangements. The perturbation theory of pericyclic reactions. Ene reactions and 1,3-dipolar additions.	**15**
II	**Photochemistry:** Introduction theory of light absorption – Jablonski diagram. Photochemistry of alkene, cis-trans isomerization, photo cycloaddition reactions of alkene, photochemical electrocyclic and sigmatropic reactions, di-pi-methane rearrangement. Photochemistry of aromatic systems, electron transfer and nucleophilic substitution reactions. Photo fragmentation reactions – Barton, Hofmann-Loffler - Freytag.	**15**
III	**Molecular rearrangements:** Wagner-Meerwein, Sommelet-Hauser, Brook, Von Richter, Favorskii, Neber, Wittig, Wolf, Dakin, Stevens, Baeyer-Villiger, Dienone-phenol and benzidine.	**15**

IV	**Oxidation:** Metal based and non-metal based oxidations of alcohols (chromium, manganese, silver and DMSO). Peracids oxidation of alkenes and carbonyls. Alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation and selenium based allylic oxidation). Asymmetric epoxidations (Sharpless, Jacobsen and Shi epoxidations). **Reduction:** Hydride transfer reagents – $NaBH_4$, Luche reduction, Red-Al, DIBAL-H, trialkylsilanes and trialkylstannane. Enantio selective reduction (chiral boranes, Corey-Bakshi-Shibata).	**15**
V	**Stereochemistry:** The concept of prochirality, topicity, prostereo isomerism, stereotopic and stereoheterotopic ligands. Stereochemistry of allenes, biphenyls, binaphthyls, spiranes, ansa and cyclophanic compounds. Stereoselective and stereospecific reactions. **Conformational analysis:** Introduction, conformational analysis of cyclohexane, Conformation and reactivity of mono & di-substituted cyclohexanes.	**15**

<***Self Study: Photooxidation and photoreduction reactions***>.

Text Books:

1. Jagdamba Singh, Jaya Singh, Photochemistry and Pericyclic Reactions, NEW AGE Publications, 3rd edition, 2009.
2. V.K. Ahluwalia and Rakesh K. Parashar, Organic Reaction Mechanisms, Narosa Publishing House; 4th edition, 2010.
3. Robert T. Morrison, Robert N. Boyd, Organic Chemistry, Prentice Hall, 6th edition (1992).
4. S.M. Mukhaerji, Reaction Mechanism in Organic Chemistry, Laxmi Publications; 3rd edition (2007).
5. Ernest L. Eliel, Samuel H. Wilen, Stereochemistry of Organic Compounds, Wiley, 1st edition (2008).

Reference Books:

1. Michael B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Wiley; 7th edition (2015).
2. Dr. G.R. Chatwal, Organic Photochemistry and Pericyclic Reaction, Himalaya Publishing House (1998).
3. Dr. G.R. Chatwal, Organic Photochemistry, Himalaya Publishing House, Revised edition (2010).
4. R. Hoffmann and S. Sankararaman, Pericyclic Reactions - A Textbook: Reactions, Applications And Theory, Wiley India, Revised edition (2015).
5. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, New Age International Publishers, 3rd edition (2018).

E-references:

1. https://nptel.ac.in/courses/104105038/
2. https://schoolbag.info/chemistry/organic/47.html
3. http://courses.washington.edu/medch562/pdf/MEDCH400_Stereochem.pdf

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	H	M
CO2	H	S	H	S	S
CO3	S	M	H	S	S
CO4	H	H	S	S	H
CO5	S	S	H	M	S

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH07	Course Title:	Batch:	2019
Total Hours:	75	Physical Chemistry - II	Semester:	II
			Credits:	4.0

Course Objective

The course aims

- To acquire the basic knowledge of quantum mechanics and its applications.
- To understand the concept of chemical kinetics.
- To learn about the enzyme catalysis and different isotherm models.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K2, K3	CO1	Identify the basic concept of quantum mechanics.
K1, K2	CO2	Analyze the application of quantum mechanics in atomic & molecular structure.
K2	CO3	Compare the theories of reaction rates.
K3	CO4	Explain the kinetics of complex & fast reactions.
K3, K4	CO5	Identify non-catalytic and catalytic reactions and evaluate the best adsorption model.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS

Unit	Content	No. of Hours
I	**Quantum mechanics I:** Functions and operators- Eigen functions, Eigen values. Failure of Classical Mechanics and the need for QM- Postulates of QM-The time-dependent and time-independent Schrodinger wave equations-Application to simple systems. Solution of Schrodinger wave equation for a particle in one dimensional box, particle in 3D box, separation of variables, degeneracy. One dimensional Harmonic oscillator- Complete solution.The Hydrogen atom: Solution to Hydrogen wave equation. Stern-Gerlach experiment.	15
II	**Quantum mechanics II:** Born Oppenheimer approximation- Approximate methods in quantum mechanics-need for the approximation methods - Perturbation and variation methods applicable to Hydrogen and Helium atom. Quantum mechanical treatment of MO theory. LCAO-MO methods-HMO treatment of simple and conjugated ð-electron systems-ethylene system-delocalization energy - directional character – determination of bond angles. SALC procedure (Symmetry Adapted Linear Combination)-Simple Huckel Theory to linear conjugated systems-Applications of SALC procedure-Butadiene-Benzene.	15
III	**Chemical Kinetics I**: Theories of Reaction rates – Arrhenius theory. Hard - sphere collision theory of gas – phase reactions. Absolute reaction rate theory (ARRT) for ideal gas reactions (in terms of partition functions). Relation between activated - complex theory and hard - sphere collision theory. Thermodynamic formulations of activated	15

	complex theory –potential energy surfaces – Kinetic isotopic effects- significance of volume of activation and entropy of activation (Perin's theory). Unimolecular reactions – Lindemann's theory –limitations –Hinshelwood theory – KRR theory (Kassel, Rice and Ramsperger theory) –Slater's treatment to diatomic molecule (only).	
IV	**Chemical Kinetics II:** Kinetics of complex reactions - consecutive reactions, parallel reactions, opposing reactions (Unimolecular steps only). Semenoff-Hinshelwood mechanism of chain reactions and explosion. Kinetics of fast reactions: Relaxation method, flow method, shock method, field jump method, pulse method and flash photolysis method. Reactions in solution: Diffusion controlled reactions in solution-Debye Smoluchowski equation- Effect of solvent on the reaction rates (ARR theory approach only) - influence of ionic strength on rates of reactions (Bronsted-Bjerrum equation).	**15**
V	**Catalysis and Adsorption:** General characteristics of catalytic reactions -Specific and general acid - base catalysis. Bronsted catalysis law. Hammett acidity function-Zucker-Hammet hypothesis – Bunnett criterion. Enzyme catalysis – mechanism and kinetics of enzyme catalyzed reactions (single substrate reaction only)-Michaelis-Menten equation-Turn over number. Influence of pH and temperature. **Adsorption:** Adsorption and free energy relation– Gibbs adsorption isotherm – potential energy diagram and Lenard-Jones plots –Heterogeneous adsorption – BET isotherm. Role of surface in catalysis - semiconductor catalysis – Langmuir-Hinshelwood and Langmuir-Rideal-Eley mechanisms of heterogeneous catalysis by adsorption- Hydration of ethylene on Cu surface and decomposition of ammonia on Tungsten surface.	**15**

<* Self Study: Comparison of Slater's and KRR theory>.

Text Books:

1. R.K.Prasad, "Quantum Chemistry" - New Age International (P) Ltd., Publishers,4thEdn. (2010).
2. A.K.Chandra, "Introductory Quantum chemistry", McGraw Hill, (1974).
3. P.W. Atkin's, J. De. Paula, "Atkin's Physical Chemistry" - Oxford University Press, 8thEdn. (2006).
4. Keith J.Laidler, "Chemical Kinetics"–Dorling Kindersley (India) Pvt. Ltd., 3rd Edn.
5. Samuel Glasstone, Keith James Laidler, Henry Eyring, "The Theory of Rate Processes" McGraw-Hill Book Company Publishers (2008).

Reference Books:

1. D.A.McQuarrie, "Quantum Chemistry" - University Science Books, California, 2nd Edn. (2008).
2. I.Levine, "Quantum Chemistry" - Allyn Bacon, 2nd Edn.,(1974).
3. Michael J. Pilling, "Reaction Kinetics"–OxfordUniversity Press Publishers, 2nd Edn.
4. B.R. Puri, L.R. Sharma, M.S. Pathania, "Principles of Physical Chemistry"-Vishal Publishing &Co., Jalandar, 41st Edn., (2006).
5. A. A Pearson, R. G Frost, "Kinetics & Mechanism"John Wiley and Sons Publishers.

E-references:

1. http://chemistry.st-andrews.ac.uk/staff/rs/teaching
2. http://www.lth.se/fileadmin/fm/Education/Courses/Combustion/lect3_kinetics.pdf

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	H	M
CO2	H	S	H	S	H
CO3	S	M	H	S	S
CO4	H	H	S	S	H
CO5	S	S	H	M	S

S - Strong; **H -** High; **M -** Medium; **L -** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CH08	Course Title:	Batch:	2019
Total Hours:	60	Elective - II: Molecular Spectroscopy	Semester:	II
			Credits:	4.0

Course Objective

The course aims

- To learn about the various spectroscopic techniques.
- To understand the basic knowledge of spectroscopic techniques.
- To learn about the instrumentation and applications of different spectroscopic techniques.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K1	CO1	Apply UV-visible spectroscopic principles to calculate maximum absorption in organic molecules.
K2	CO2	Interpret the various organic compounds IR spectroscopy in research fields.
K4	CO3	Identify various fragmentation of small organic molecules.
K2, K3	CO4	Use ESR spectroscopic principles to characterize inorganic and organometallic compounds.
K3	CO5	Apply the concept of chemical shift and spin-spin coupling in NMR spectroscopy.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
I	**Ultraviolet and Visible Spectroscopy**- Basic principle- process of electronic excitations n-π and π -π transitions – Transition probability- solvent effects- factors affecting position and intensity of absorption bands, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes, enones and carbonyl compounds, Fischer Kuhn rules for calculating absorption maximum in polyenes, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls- Applications of UV- Visible spectroscopy –Study of keto-enol tautomerism- geometrical isomerism- equatorial & equatorial axial conformers and hydrogen bonding- empirical rules, Photometric titrations.	**12**
II	**IR Spectroscopy:** Molecular vibrations – vibrational frequency- Hooke's equation, Number of fundamental vibrations – Modes of vibrations of polyatomic molecules, force constant, –factors influencing vibrational frequencies of a molecule- IR Spectrometer- preparation of samples- correlation charts and tables. Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds- ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and	**12**

	conjugated carbonyl compounds. Overtones, combination bands and Fermi resonance-FT IR-application of IR to simple organic molecules.	
III	**Mass spectrometry**: Principle, working of mass spectrometer (double beam). – sample inlet system, ion source, mass analyser and ion detectors. Determination of molecular formula – nitrogen rule – isotopic abundance – metastable ions – Retro Diels – Alder rearrangement – Mclafferty rearrangement, ionization techniques, fragmentation processes of organic molecules, fragmentation associated with functional groups – aliphatic compounds, aldehydes – ketones – carboxylic compounds ester – amides – alcohols and halides, high resolution MS, soft ionization methods- ESI-MS and MALDI-MS, studies of inorganic/coordination and organometallic compounds. **Mossebauer spectroscopy** - Principle, Doppler effect, Instrumentation. Isomer shift – Quadrupole interactions – nuclear Zeeman splitting and applications.	**12**
IV	**NMR spectroscopy:** Magnetic properties of nuclei – theory of NMR - FT NMR, chemical shift – factors affecting chemical shifts, chemical shift values and correlation for protons bonded to carbon -aliphatic, olefinic, aldehydic and aromatic and other nuclei -alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), Chemical equivalent and spin – spin coupling – shielding and deshielding mechanisms – chemical exchange – applications of NMR to simple organic molecules, Nuclear magnetic double resonance technique – NDMR and INDOR. Two dimension NMR spectroscopy – COSY, NOESY, and DEPT, INEPT, APT and INADEQUATE techniques.	**12**
V	**Electron Spin Resonance Spectroscopy (ESR):** Theory- factors affecting the 'g' value. Isotropic and Anisotropic systems, Hyperfine splitting- Zero field splitting and Krammer's degeneracy spin Hamiltonian, spin densities, application to structure determination of inorganic complexes and study of free radicals. **NQR:** Introduction-theory-EFG-QCC-Splitting in NQR- applications of NQR.	**12**

<* Self Study: Basic principles of Raman and IR and Mutual Exclusion principle>.

Text Books:

1. C.N.Banwell, Fundamentals of Molecular spectroscopy, Mc Graw Hill, New York, 3rdEdition, (1972).
2. William Kemp, Organic spectroscopy, Macmillan London, 3rd Edition, (2016).
3. S.K Dewan, Organic spectroscopy, NMR, IR UV and Mass, CBS publishers & Distributors, 1st Edition, (2010)
4. J.R. dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall of India Pvt.Ltd, Ist Edition, (1929).
5. Donald L.pavia, Gary M.Lampman and George s. Kriz, Introduction to spectroscopy, cengage publisher, 5th Edition, (2015).

Reference Books:

1. R.M. Silverstein and G.C. Basler, Spectroscopic identification of organic compounds, John Wiley and Sons, New York, 6th Edition, (1967).
2. R.S. Drago Physical methods in inorganic chemistry, Wiley Eastern, 4th and 5th Editions, (1992).
3. R.V. Parish, NMR, NQR, EPR and Mossbauer spectroscopy in inorganic chemistry, Ellis Horwood Ltd, 1st Edition, (1991).
4. M.L Martin, J.J.Depeuch and G.J. Martin, Practical NMR spectroscopy, Heyden London, (1980).
5. R.J. Abraham, J.Fisher and P. Loftus, Introduction to NMR spectroscopy-Wiley-Blackwell, Reprint edition, (1988).

E-references:

1. https://www.slideshare.net/solairajananant/nmr-spectroscopy
2. http://chem.ch.huji.ac.il/nmr/techniques/1d/row2/c.html

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	S	H	S	H
CO2	H	H	M	H	M
CO3	S	H	H	S	S
CO4	H	S	H	M	H
CO5	S	H	S	H	M

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CHP1	Course Title:	Batch:	2019
Total Hours:	90	Practical - I: Inorganic Chemistry - I	Semester:	II
			Credits:	3.0

Course Objective

The course aims

- To know the semi micro qualitative analysis in Inorganic chemistry.
- To analysis the various rare earth elements qualitatively.
- To know the various inorganic complex preparations and principles of colorimetry.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K4	CO1	Analyze the rare earth elements qualitatively.
K4	CO2	Create procedures for the synthesis of inorganic complexes.
K5	CO3	Estimate the amount of metals by colorimetric method.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
	Qualitative Analysis Analysis of at least four inorganic mixtures containing two common cations and two less common cations using semi micro method. Less common cations: Thallium, Tungsten, Tellurium, molybdenum, Cerium, Thorium, Titanium, Zirconium, Vanadium, Beryllium, Uranium and Lithium minimum four mixtures. **Preparations** Preparations of any five of the following complexes: Lead tetraacetate, Dipyridinium hexa chloro plumbate, Hydroxyl amine hydrochloride, ortho and para Hydoxy phenyl mercuric chloride, Potassium cupric chloride, Chromalum, Tris thio urea copper(I), Potassium tri oxalate aluminate(III), Potassium trioxalato chromate(III). **Colorimetric Estimations (Nessler's method)** Copper, Iron, Nickel, Manganese, Chromium and Lead.	**90**

Text Books:

1. V. Venkateswaran, R. Veeraswamy and A.R. Kulandaivelu, Principles of practical chemistry, Sultan chand& sons, 2nd Edition, (2013).
2. V.V. Ramanujam, Semi micro Qualitative inorganic analysis, The national publishing company, 3rd Edition, (1974).

Reference Books:

1. J.Bassart, R.C. Denny, G.H. Jeffery Vogel and Mendham, Text book of Qualitative inorganic analysis, 4th Edition, (1978).
2. S.Giri, D.N. Bajpai and O.P Pandy, Practical chemistry Vol I& II, Sultan Chand Publishing, Revised Edition, (2013).

E-references:

1. http://www.iscnagpur.ac.in/study_material/dept_chemistry/4.1_MIS_and_NJS_Manual_for_Inorganic_ semi-micro_qualitative_analysis.pdf
2. https://archive.org/stream/laboratorymanual00vultrich/laboratorymanual00vultrich_djvu.txt

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	H	S	H	M
CO2	H	S	H	S	H
CO3	S	H	S	H	S

S - Strong; **H** - High; **M** - Medium; **L** – Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CHP2	Course Title:	Batch:	2019
Total Hours:	90	Practical - II: Organic Chemistry - I	Semester:	II
			Credits:	3.0

Course Objective

The course aims

- To understand the separation and analysis procedure of organic mixture.
- To learn the single stage preparations of organic substances.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K4	CO1	Separate and purify products in organic reactions
K5	CO2	Create knowledge in the synthesis of organic compounds

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
	Analysis of two component mixtures (about five mixture): Separation and Characterization of compounds. **Any five single stage preparations involving the following reactions:** Nitration, acylation, halogenations, diazotization, rearrangement, hydrolysis, alkylation, reduction and oxidation and preparations illustrating the following: Benzoin condensation, Cannizzaro reaction, Perkin reaction, Reimer – Tiemann reaction, Sandmeyer reaction, Fries rearrangement, Skraup synthesis – recrystallisation of product, melting point determination and calculation of percentage yield.	**90**

Text Books:

1. Gnanapragasam and Ramamurthy, Organic chemistry lab manual, Viswanathan S. Printers and publishers Pvt, Ltd. (2009).
2. V. Venkateswaran, R. Veerasamy and A.R. Kulandaivelu, Basic principles of Practical Chemistry, Sultan Chand and Sons, 2nd edition (1997).
3. D.N. Bajpai, O.P. Pandey and S. Giri, Practical Chemistry, S. Chand and Sons, Revised edition (2006).

Reference Books:

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th edition, Pearson Education Ltd. Singapore (2004).
2. V.K. Ahluwalia, S. Dhingra, A. Gulati, College Practical Chemistry, Universities Press (India) Limited (2012).
3. N K Vishnoi, Advanced Practical Organic Chemistry, Vikas Publishing, 3rd edition (2009).
4. Arthur I. Vogel, A Text Book of Practical Organic Chemistry, Longman Science & Technology, 4th edition (1978).

E-references:

1. http://wwwchem.uwimona.edu.jm/lab_manuals/c1901exp8.html
2. https://www.thinkiit.in/iit-qrp/english/theory/chemistry/organic/practical-organic-chemistry/

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	H	M
CO2	H	S	S	H	S

S - Strong; **H -** High; **M -** Medium; **L –** Low

Programme Code:	M.Sc.	Programme Title:	Chemistry	
Course Code:	19P3CHP3	Course Title:	Batch:	2019
Total Hours:	90	Practical - III: Physical Chemistry - I	Semester:	II
			Credits:	3.0

Course Objective

The course aims

- To develop the practical knowledge in physical chemistry.
- To develop skills and to understand the underlying principles in acid-base titrimetric analysis.
- To develop the experimental skills in Potentiometric titrations.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

Knowledge Level	CO Number	Course Outcome
K5	CO1	Carry out scientific experiments.
K3	CO2	Use the modern instrumentation and classical techniques, and to properly record the results of their experiment.
K4	CO3	Analyze and apply the results of their experiments as analytical tool.

K1 - Remember; **K2 -** Understanding; **K3 -** Apply; **K4 -** Analyze; **K5 –** Evaluate

SYLLABUS		
Unit	**Content**	**No. of Hours**
	1. Potentiometric experiments - 6 Nos. i) Acid – Base Titration (strong acid Vs. strong base). i) Acid – Base Titration (weak acid Vs. strong base). iii) Acid – Base Titration (mixture of acids Vs. Strong base) iv) Redox Titration ($KMnO_4$Vs. $FeSO_4$). v) Redox Titration ($K_2Cr_2O_7$Vs. FAS). vi) Determination of pH of Buffer solution Potentiometrically usingquinhydrone electrode. **2. Phase rule studies and Surface chemistry – 2 Nos.** i) Two component system - Simple eutectic formation. ii) Verification of Freundlich Adsorption Isotherm. **3.** Determination of Molecular Weight by Rast's Macro method. **4.** Determination of Arrhenius Parameter.	**90**

Text Books:

1. V. Venkateswaran, R.veeraswamy & A.R. Kulandaivelu, "Principles of Practical Chemistry" –Sultan Chand & Sons Publishers.
2. B. Viswanathan & P.S. Raghavan, "Practical Physical Chemistry"–Viva Books Publishers, (2009).
3. J.B.Yadav, "Practical Physical Chemistry" –Goel Publishing House.

Reference Books:

1. S.R. Palit & S.K. De, "Practical Physical Chemistry" – "Science Book Agency".
2. David P.Shoemaker & Carl W. Garland, "Experiments in Physical Chemistry"–McGraw-Hill Inc., US; 5th Revised Edn.

E-references:

1. https://www.elsevier.com/books/experiments-in-physical-chemistry/wilson/978-0-08-023798-5
2. https://www.phywe.com/en/chemistry/university/physical-chemistry/

Mapping with Programme Specific Outcomes

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	S	S	M	S
CO2	S	H	M	S	H
CO3	H	H	S	S	H

S - Strong; **H -** High; **M -** Medium; **L –** Low

Question Paper Pattern - P.G. Courses

(Common for Major and Supportive Papers)

For EOS Examinations: 60 Marks

The Question Paper is to be divided into THREE Sections.

Section-A Carries 10 Marks, Section-B Carries 20 Marks and Section-C Carries 30 Marks.

Section-A Contains 10 Multiple Choice Questions. (10 x 1 = 10)

Two Questions from each unit. (Q. No: 1 to 10)

Section-B Contains 5 Either or Choice Questions. (5 x 4 = 20)

Each Question carries 4 Marks. Both (a) and (b) from the same unit.

Q. No.: 11 (a) or (b) to 15(a) or (b)

Section-C Contains 5 Questions, out of which 3 Questions are to be answered. (3 x 10 = 30)

Each Question carries 10 Marks. One Question from each unit. Q. No.: 16 to 20

For CIA Examinations: 40 Marks

CIA Test I and II Question Paper Pattern: (30 Marks)

Section-A: 10 Multiple Choice Questions. (10 x 1 = 10)

Section-B: Two Questions out of Three. (2 x 5 = 10)

Section-C: One Question out of Two. (1 x 10 = 10)

Components of Continuous Internal Assessment (CIA)

Components		Calculation	CIA Total
Test 1 & Test 2	30	$30 + 40 + 30 = \frac{100 \times 40}{100} = 40$	40
Test 3 (Model Exam)	40		
Assignment + Seminar + Quiz / GD / Poster Presentation / Book Review / Field Visit Report	10+10+10 = 30		