To,

The Principal Secretary,
Raj Bhavan, Bihar,
Patna

Sub:- **Regarding submission of proposed course uniform syllabus of Chemistry for 3rd to 8th Semester of 4 - Year undergraduate Course, (CBCS)**

Ref.:- Letter No.-BSU (UGC) -02/2023-1457/ GS(I) dated 14.09.2023

Sir,

In compliance with your letter no. BSU(UGC)-02/2023-1457/GS(I), dated-14.09.2023, we are submitting the proposed course syllabus of **Chemistry** for 3rd to 8th semester of the 4 - year under graduate course (CBCS) as per UGC regulations.

Yours sincerely

1 **Dr. Shailendra**
Professor & Head, Dept. of Chemistry
Patna University, Patna
Email.-shailendra1966bnc@gmail.com
Mobile -8210739742

2 **Prof. Himanshu Shekhar**
Professor, P.G. Dept. of Chemistry
V K S University, Ara
Email.-hshe2503@rediffmail.com
Mobile -7857929565, 8877311180

3 **Dr. Rabindra Singh,**
Professor & Head
(Additional)
J P University, Chapra
Email.-rabindrasingh4u@gmail.com
Mobile -9431622879

4 **Prof. Kalpana Shahi**
Professor
Patliputra University, Patna
Email.-drkalpnashahi@gmail.com
Mobile -8789552077

5 **Prof. B.B. Sharma**
Professor & Head
(Additional)
Magadh University, Bodh Gaya
Email.-brijbiharisharma111259@gmail.com
Mobile -9431224668

6 **Sonu Ram Shankar**
Assistant Professor
(Additional)
L N M University, Darbhanga
Email.-sonuram@gmail.com
Mobile -7004197060

7 **Dr. Ashok Kumar Yadav**
Professor & Head
(Additional)
B N M University, Madhepura
Email.-yadavkrashok@yahoo.co.in
Mobile -7366062257

8 **Dr. Vijay Kumar**
Associate Professor
(Additional)
B RA Bihar University, Muzaffarpur
Email.-kumarvijchem@gmail.comil.com
Mobile -9430059732

9 **Dr. Rana Pratap Singh***
Ex-HOD (TMBU)
(Additional)
T M B University, Bhagalpur
Email.-singhrpchem@gmail.com
Mobile -8757164950

10 **Prof. Ramchandra Singh***
HOD
(Additional)
J P University, Chapra
Email.-ramchandrasursaria@gmail.com
Mobile -9631725272

Chemistry

(A)Major Core Courses

Sem	Type of Course	Name of Course	Credits	Marks
I	MJC-1 (T)	Inorganic Chemistry I: Atomic Structure & Chemical Bonding (T)	6	100
II	MJC-2 (T)	Physical Chemistry I: States of Matter & Ionic Equilibrium (T)	4	100
	MJC-2 (P)	Physical Chemistry I: States of Matter & Ionic Equilibrium (P)	2	100
III	MJC-3 (T)	Organic Chemistry: Cyclic Hydrocarbons and their Halogen Derivatives (T)	5	100
	MJC-4 (T)	Physical Chemistry: Chemical Thermodynamics and its Applications (T)	3	100
	MJC-4 (P)	Physical Chemistry: Chemical Thermodynamics and its Applications (P)	1	100
IV	MJC-5 (T)	Inorganic Chemistry: *s*-, *p*-, *d*- and *f*-block elements (T)	3	100
	MJC-5 (P)	Inorganic Chemistry: Qualitative Analysis of Inorganic Salt Mixture. (P)	2	100
	MJC-6 (T)	Organic Chemistry: Compound with OxygenContainingFunctionalGroups. (T)	3	100
	MJC-6 (P)	Organic Chemistry: identification of oxygen Containing Functional Groups (P)	2	100
	MJC-7 (T)	Physical Chemistry: Phase Equilibria, Conductance and Electrochemical Cells	5	100
V	MJC-8 (T)	Inorganic Chemistry: Coordination Chemistry (T)	3	100
	MJC-8 (P)	Inorganic Chemistry: Coordination Chemistry, preparation of complexes (P)	2	100
	MJC-9(T)	Organic Chemistry: Polynuclear hydrocarbons, nitrogen containing compounds, heterocyclic compounds, alkaloids and terpenoids (T)	5	100
VI	MJC-10 (T)	Physical Chemistry: Colligative Properties of Dilute Solutions, Chemical Kinetics and Photochemistry (T)	3	100
	MJC-10 (P)	Physical Chemistry: Colligative Properties of Dilute Solutions and Chemical Kinetics (P)	1	100
	MJC-11 (T)	Organic Chemistry: Biomolecules (T)	3	100
	MJC-11 (P)	Organic Chemistry: Biomolecules (P)	2	100
	MJC-12 (T)	Physical Chemistry: Quantum Chemistry & Spectroscopy (T)	5	100
VII	MJC-13 (T)	Inorganic Chemistry: Organometallic Chemistry symmetry and Group theory (T)	5	100
	MJC-14 (T)	Research Methodology (T)	5	100
	MJC-15 (T)	Organic Chemistry: Spectroscopy (T)	6	100
VIII	MJC-16 (T)	Analytical Methods in Chemistry (T)	4	100

Sub Total = 80

SEMESTER- III

MJC-3 (T): Organic Chemistry: Cyclic Hydrocarbons and their Halogen Derivatives (T)

Course Outcomes

After completion of the course, students will be able to understand:

CO1: the aromatic character of the molecules.

CO2: the idea to design some organic synthesis.

MJC-3: Organic Chemistry: Cyclic Hydrocarbons and their Halogen Derivatives. (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Reaction intermediates:** Carbenes, nitrenes and benzynes: Generation, structure, stability and reactions.	12
2	**Chemistry of Cyclic Hydrocarbons:** Nomenclature of monocyclic and bicyclic compounds, Baeyer's strain theory, conformation of cyclohexane, relative stability of chair, boat and twist boat forms of cyclohexane with their energy level diagram, relative stability of mono- and disubstituted cyclohexanes, Aromaticity and Huckel rules with reference to benzenoids, cyclocarbocations and cyclocarbanions, mechanism of electrophilic aromatic substitution in benzene-halogenation, nitration, sulphonation, Friedel -Crafts alkylation/acylation, energy profile diagrams of these reactions, reactivity of mono-subsituted benzene, directive influence of functional groups.	12
3	**Chemistry of Halogen Derivatives of alkanes:** General methods of preparation, properties and uses of mono- and dihalo derivatives of alkanes. Mechanism of substitution and elimination reactions *viz.* S_N1, S_N2, S_N^i, E1, E2 and E1CB mechanism.	12
4	**Halogen derivatives of arenes:** General methods of preparation, properties and uses of halogen derivatives of arenes. Mechanism: ArS_N2, ArS_N1, elimination-addition mechanism (benzyne mechanism).	12
	TOTAL	48

Suggested Readings:

1. Reaction Mechanism in Organic Chemistry - S. M. Mukherjee and S.P. Singh
2. Organic Chemistry, vol.-1, I. L. Finar
3. Organic Chemistry – Morrison & Boyd
4. Organic Chemistry: Graham Solomons
5. Oranic Chemistry: Paula Yurkanis Bruice
6. Stereochemistry in Organic Chemistry: D. Nassipuri

7. Stereochemistry- Conformation and Mechanism: P.S.Kalsi.
8. Advanced Organic Chemistry, Fourth Edition, J. March, Wiley, India (2006)
9. Greeves, N., Clayden, J.; Warren, S., Organic Chemistry, 2nd Ed., Oxford University, Press India (2014).
10. Sykes, P., A Guidebook to Mechanism in Organic Chemistry, 6th Ed., Pearson Education India (2003)

Semester-III
MJC-4: Physical Chemistry: Chemical Thermodynamics and its Applications (T)

Course Outcomes

After completion of the course, students will be able to understand:

CO1: various thermodynamic terms.

CO2: various enthalpies of transformations and Kirchoff's law.

CO3: entropy changes, Gibbs free energy change, partial molar quantities, spontaneous and non- spontaneous processes.

CO4: second and third law of thermodynamics.

MJC-4: Physical Chemistry: Chemical Thermodynamics and its Applications (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Thermodynamics-I:** Definition of thermodynamic terms: system, surroundings, types of systems, intensive and extensive properties, state and path functions, thermodynamic processes, concept of heat and work, First law of Thermodynamics-Statements, definition of internal energy and enthalpy, Heat capacities at constant volume and constant pressure with their relationship, Joule's law, Joule-Thomson coefficient and inversion temperature, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible and irreversible processes.	12
2	**Thermochemistry:** Standard state, enthalpy of reaction, standard enthalpy of formation, Hess's law of constant heat summation and its applications, enthalpy of combustion, enthalpy of neutralization, bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy, Kirchoff's equation.	12
3	**Thermodynamics-II:** Second law of thermodynamics, need of the law, different statements of the law, Carnot theorem, Carnot cycle and its efficiency, concept of entropy, entropy as a function of V&T, P&T, entropy change in ideal gases and mixing of ideal gases, free energy and spontaneity, variation of Gibbs free energy (G) and Helmholtz free energy(A) with P,V and T, Maxwell's relations, Thermodynamic equation of state, Nernst heat theorem, third law of thermodynamics, statement, evaluation of absolute entropy from third law of thermodynamics, concept of residual entropy .	12
4	**Systems of Variable Composition:** Partial molar quantities, chemical potential, dependance of chemical potential with temperature and pressure, chemical potential of a gas in ideal gas mixture, Gibb's Duhem equation.	12
	TOTAL	48

Suggested Readings:

1. Peter, A. & Paula, J. de., Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. &Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6. Levine, I.N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
7. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).

Semester-III
MJC-4 (P): Chemical Thermodynamics and its Applications (P)

Course Outcomes

After completion of this practical course, students will be skilled in determining:

CO1: different types of enthalpy changes.

CO2: the heat capacity of calorimeter.

CC-4: Chemical Thermodynamics and its Applications (Practical: 2 credits)
Practical: **Chemical Thermodynamics and its Applications** 1. Determination of water equivalent of calorimeter. 2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Determination of enthalpy of ionization of ethanoic acid. 4. Determination of the basicity of a polybasic acid against standard sodium hydroxide solution. 5. Determination of heat of displacement of Cu by Zn from Cu^{2+} salt solution. 6. Determination of enthalpy of hydration of copper sulphate. 7. Determination of solubility of benzoic acid in water and ΔH for the process. 8. Determination of heat capacity of the calorimeter and integral enthalpy of solution of salts.

Suggested Readings:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry, New Age International, New Delhi (2001).

SEMESTER – IV

MJC-5 (T): Inorganic Chemistry: *s*-, *p*-, *d*- and *f*-block elements (T)

Course Outcomes

After completion of the course, the students will be able to understand: -

CO1: different oxidation states of elements with their relative stability and complex forming properties.

CO2: the ring, cage and polymers of B, Si & P.

CO3: to carry out the preparation of inorganic compounds.

CO4: the important properties of transition metals such as their oxidation states, colour, magnetic and spectral, use of Latimer diagrams in identifying oxidizing, reducing and disproportionating species.

CO5: the concepts related with noble gases, their compounds, shapes, properties and applications.

***s*-, *p*-, *d*-and *f*-block elements (Theory: 4 credits)**		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Periodic Table and Periodicity of Elements:** *s*-, *p*-, *d*- and *f*-block elements, the long form of periodic table, detailed discussion of the following periodic properties of the elements with reference to *s*- and *p*-block: (a) shielding or screening effect, Slater's rules, effective nuclear charge (b) atomic radii (covalent, metallic and van der Waals) (c) ionization enthalpy, successive ionization enthalpies, factors affecting ionization enthalpy and applications of ionization enthalpy. (d) electron gain enthalpy. (e) electronegativity: Pauling's, Mullikan, Allred Rochow's scales, group electronegativity, variations of electronegativity with bond order and partial charge. General electronic configuration of *s*- and *p*- block elements, inert pair effect, relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group, allotropy and catenation properties, complex forming tendency of *s*- and *p*- block elements,	10
2	**Compounds of *p* block elements:** Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses:- Boric acid, borates, borazines, borohydrides, calcium carbide, silicon carbide, aluminium carbide, silicates, silanes, siloxanes, silcon halides, silicones, NH_3-manufacture (Haber's process), oxides, oxy-, peroxy acids of nitrogen, phosphorus and sulphur, inter-halogen compounds, polyhalides and pseudohalides.	10
3	**Chemistry of noble gases:** Occurrence and isolation, rationalization of inertness of noble gases, nature of bonding in noble gas compounds, shape and structure of noble gas compounds using VSEPR theory, preparation and properties of XeF_2, XeF_4 and XeF_6. Clathrates.	5

4	**Chemistry of d-block elements:** General electronic configuration of d-block metals and their group trends, variable oxidation states and their relative stabilities, magnetic and catalytic properties of metals, colour, complex forming ability of metals, difference between 1st, 2nd and 3rd transition series, Chemistry of Cr, Mn, Fe and Co in various oxidation states with special reference to their following compounds: peroxo compounds of Cr, potassium dichromate, potassium permanganate, potassium ferrocyanide and ferricyanide, sodium nitropruside and sodium cobaltinitrite.	10
5	**Chemistry of f-block Elements:** General electronic configuration of f- block elements (inner transition elements - 4f and 5f series), position of lanthanides and actinides in periodic table, group trends with special reference to electronic configuration, ionic radii and lanthanide contraction, consequences of lanthanide contraction, complex forming ability of lanthanides, occurrence and isolation of lanthanides, compounds of lanthanides, sources of actinides, chemistry of actinides, separation of Np and Pu from spent fuel .	10
	TOTAL	45

Readings:

1. Lee, J. D., Concise Inorganic Chemistry, 5th Ed., Wiley India (2008).
2. Housecroft, C. E.; Constable, E. C. Chemistry-An Introduction to Organic, Inorganic and Physical Chemistry, 4th Ed., Pearson Education (2010).
3. Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., Shriver Atkins's Inorganic Chemistry, 6th Ed., Oxford University Press India (2015).
4. Miessler, G.; Tarr, D. A., Inorganic Chemistry, 3rd Ed., Pearson Education India (2008).
5. Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., Inorganic Chemistry: Principles of Structures and Reactivity, 4th Ed., Pearson Education India (2006).
6. Cotton, F. A.; Wilkinson, G.; Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley India (2007).
7. Puri, B. R.; Sharma, L. R.; Kalia, K. C., Principles of Inorganic Chemistry, 33rd Ed., Vishal Publishing (2017).

Semester-IV

MJC-5 (P): Qualitative Analysis of Inorganic Salt Mixture Containing Four Radicals (P)

Course Outcomes

After the end of this practical course students will be skilled in: -

CO1: identification of basic radicals from known and unknown salts.

CO2: identification of acid radicals from known and unknown salts.

Qualitative Analysis of inorganic salt mixture containing Four Radicals. **(Practical:2 credits)**
1. Identification of known cations (basic radicals) and anions (acid radicals) from the supplied salt.
2. Identification of cation (basic radicals) and anions (acid radicals) from unknown salt.
3. Identification of cation (basic radicals) and anions (acid radicals) from binary mixture of inorganic salts.

SuggestedReadings:

1. Raj, G., Advanced Practical Inorganic Chemistry, Krishna Prakashan, Meerut (2013).
2. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., Vogel's Quantitative Chemical Analysis, 6th Ed., Pearson Education India (2009).

Semester-IV

MJC-6 (T): Organic Chemistry: Compounds with Oxygen Containing Functional Groups (T)

CourseOutcomes

After the completion of the course, students will be able to understand:

CO1: preparation, properties and reactions of compounds with oxygen containing functional groups.

CO2: to draw plausible mechanisms for reactions involving these functional groups.

CO3: the knowledge of various named organic reactions associated with these functional groups.

CO4: chemistry of epoxides.

CO5: the detection of *O*-containing functional groups like alcohols, phenols, carbonyl and carboxylic acid groups.

CO6: the preparation of various organic compounds by functional group transformations and other common organic reactions.

CO7: the green practices in Organic syntheses.

Compounds with Oxygen Containing Functional Groups (Theory:4credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Alcohols, Phenols, Ethers and Epoxides** **Alcohols:** Classification and nomenclature. Preparation of 1^{o}, $2^{o}$and 3^{o}alcohols using substitution reaction, addition reactions, Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acids and esters. **Reactions:** With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation. **Diols:** Oxidation of diols. Pinacol-Pinacolone rearrangement. **Glycerol:** Preparation, properties and uses. **Phenols:** Classification, nomenclature and properties **Preparation:** Cumene hydroperoxide method, from diazonium salts. **Reactions:** Electrophilic substitution: Nitration, halogenation and sulphonation. Fries and Claisen Rearrangements, Kolbe's–Schmidt Reaction, Lederer-Manasse reaction, Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten–Baumann Reaction. **Ethers and epoxides (aliphatic and aromatic):** Classification, nomenclature, preparation and properties. **Reactions:** Cleavage of ethers with HI. Syntheses of epoxides, Acid and base–catalyzed ring opening of epoxides, orientation of ring opening, reactions of Grignard and organolithium reagents with epoxides. Concept of crown ethers.	20

2	**Aldehydes and ketones (aliphatic and aromatic):** Structure, reactivity and preparation; nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives and their mechanisms; mechanisms of Aldol and Benzoin condensation, Knoevenagel condensations, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reactions, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions,oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV and PDC). Addition reactions of unsaturated carbonyl compounds: Michael addition. Active Methylene Compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	10
3	**Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of monocarboxylic acids. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acid. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.	09
4	**Carbohydrates** Classification and general properties of carbohydrates, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose).	09
	TOTAL	48

Suggested Readings:

1. Greeves, N.; Clayden, J.; Warren, S., Organic Chemistry, 2nd Ed., Oxford University, Press India (2014).
2. Sykes, P., A Guide book to Mechanism in Organic Chemistry, 6th Ed., Pearson Education India (2003)
3. Ghosh, S. K., Advanced General Organic Chemistry, Part-I & Part-II, 3rd Ed., New Central Book Agency (2010).
4. Bhal, B. S.; Bhal, A., A Textbook of Organic Chemistry, 22nd Ed., S. Chand and Company (2016).
5. Sengupta, S., Basic Stereochemistry of Organic Molecules, 2ndEd., Oxford University Press India (2018).
6. Finar, I. L. Organic Chemistry (Volume1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Semester-IV

MJC-6 (P): Organic Chemistry: Compounds with Oxygen Containing Functional Groups (P)

Course Outcomes:

When the students will finish this practical course, they will be skilled in: -

CO1: acetylation and benzoylation of various functional groups present in organic compounds.

CO2: oxime formation, hydrazone formation, semi-carbazone formation, iodoform test and in the bromination of phenols.

CO3: oxidation of alcohols and reduction of nitro compounds.

CO4: Aldol Condensation by conventional and green methods.

Compounds with Oxygen Containing Functional Groups (Practical:2 credits)
(a) Acetylation of one of the following compounds: phenols (β - naphthol, vanillin, salicylic acid) by any one method: Using conventional method/Using green approach. (b) Benzoylation of one of the following amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and one of the following phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction. (c) Preparation of Oxime and 2,4-dinitrophenylhydrazone of aldehydes and ketones (d) Oxidation of ethanol and isopropanol (Iodoform reaction). (e) Preparation of semicarbazone of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde. (f) Aldol condensation using either conventional or green method. (g) *S*-Benzylisothiouronium chloride from thiourea and benzyl chloride. (h) Reduction of *p*-, *m*-nitrobenzaldehyde by sodium borohydride. (i) Bromination of Phenol. (j) Hydrolysis of amides and esters.

Suggested Readings:

1. Agarwal, O. P., Advanced Practical Organic Chemistry, Krishna Prakashan, Meerut (2014).
2. Ahluwalia, V. K.; Aggarwal, R., Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Universities Press (2000).
3. Furniss, B. S.; Hannafold, A. J.; Smith, P. W. G.; Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Pearson Education India (2003).
4. Clarke, H. T., A Handbook of Organic Analysis: Qualitative and Quantitative, 4th Ed., CBS Publishers India (2007).
5. Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J. & Smith, P. W. G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
6. Mann, F.G. & Saunders, B. C. Practical Organic Chemistry Orient-Longman, 1960.
7. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry. R. Chand & Co.: New Delhi(2011).

Semester-IV

MJC-7: Physical Chemistry: Phase Equilibria, Conductance and Electrochemical Cells (T)

Course Outcomes

After completion of the course, students will be able to understand: -

CO1: the degree of ionization, pH and salt hydrolysis.
CO2: the different types of Buffer solutions.
CO3: the concepts of solubility product.
CO4: the conductivity, specific conductivity, equivalent conductivity and molar conductivity, application of conductance measurement in determining various physical parameters.
CO5: the standard electrode potential of half cells and calculate the EMF of a cell using Nernst equation.
CO6: EMF measurements in determining various parameters like free energy, enthalpy, entropy, equilibrium constants, etc.
CO7: the concentration cells with and without transference.
CO8: the principle of potentiometric titrations.

MJC-7:Physical Chemistry: Ionic Equilibria, Conductance and Electrochemical Cells (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Phase Equilibria:** Phases, components and degrees of freedom of systems, criteria of phase equilibria, Gibbs Phase Rule and its thermodynamic derivation, derivation of Clausius - Clapeyron equation and its importance in phase equilibria, phase diagram of one component system (water/sulphur) and two component system involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-water and Na-K only), Nernst distribution law and its thermodynamic derivation, limitations of Nernst distribution law, modification of the distribution law in cases of association and dissociation of solutes, application of the law in the process of solvent extraction.	12
2	**Conductance:** Conductance, specific conductance (conductivity), equivalent and molar conductance, their variation with dilution for weak and strong electrolytes, Kohlrausch law of independent migration of ions, transference number and its experimental determination using Hittorf and Moving Boundary Methods, ionic mobility, applications of conductance measurements, determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt, conductometric titrations (only acid-base).	12
3	**Electrochemical cells :** Electrode and electrode potential, reference electrodes (Standard hydrogen electrode and Calomel	12

	electrode), standard electrode potential, type of electrodes, galvanic cells, electrochemical series and its significance, Nernst equation and its importance, types of electrochemical cells – chemical cells and concentration cells, concept of EMF of a galvanic cell, measurement of EMF of a cell, construction and working of a Galvanic cell, liquid junction potential and salt bridge, EMF of a concentration cell with and without transference.	
4	**Applications of EMF measurements** Determination of equilibrium constant, ΔG, ΔS and ΔH of cell reactions, calculation of solubility product of a sparingly soluble salt, the valency of ions, determination of pH using hydrogen electrode and quinhydrone electrode. Potentiometric titrations: qualitative treatment (acid-base and oxidation-reduction only).	12
	TOTAL	48

Suggested Readings:

1. Atkins, P. W.; de Paula, J.; Keeler, J., Physical Chemistry, 11th Ed., Oxford University Press India (2018).
2. Bahl, A.; Bahl, B. S.; Tuli, G. D., Essentials of Physical Chemistry, S. Chand and Company (2014).
3. Negi, A. S.; Anand, S. C., Physical Chemistry, New Age International Publishers (2007).
4. Puri, B. R.; Sharma, L. R.; Pathania, M. S., Principles of Physical Chemistry, 47th Ed., Vishal Publishing (2017).
5. Silbey, R. J.; Alberty, R. A.; Bawendi, M. G., Physical Chemistry, 4th Ed., Wiley India (2006).
6. Rakshit, P. C., Physical Chemistry, Revised Ed. Sarat Book House (2014).
7. Kapoor, K. L., A Textbook of Physical Chemistry: States of Matter and Ions in Solution, Vol. I, 6th Ed., McGraw Hill Education India (2019).

SEMESTER – V
MJC-8 (T): Co-ordination Chemistry (T)

Course Outcomes:

After completion of the course, students will be able to understand: -

CO1: ligand, denticity of ligands, chelates, coordination number and nomenclature coordination of compounds.

CO2: isomerism in coordination compounds.

CO3: Valence Bond Theory to predict the structure and magnetic behavior of metal complexes.

CO4: pairing energy, CFSE and its effects, high spin and low spin complexes.

CO5: magnetic properties and colour of complexes on the basis of Crystal Field Theory.

CO6: properties of transition metal complexes, variable oxidation states, colours, magnetic and catalytic properties.

Co-ordination Chemistry (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction:** Molecular or addition compounds, double salts and coordination compounds, coordination sphere, coordination number (C.N), oxidation state (O.S.) of the central metal atom/ion, ligands and their classification, chelating ligands, chelates and their stability. Werner's theory of coordination compounds, limitations of Werner's theory, effective atomic number (EAN) rule, nomenclature of coordination compounds, isomerism in coordination compounds.	12
2	**Valence bond theory:** Valence bond theory of complex compounds, different octahedral, square planar and tetrahedral complexes of Cr, Fe, Co, Ni, Cu and Zn, strength of ligands and stability of complexes, outer and inner orbital complexes. Limitations of valence bond theory (VBT).	12
3	**Crystal field theory:** Crystal field theory, crystal field splitting of d-orbitals in octahedral, tetrahedral, tetragonal and square-planar complexes, HS and LS complexes, factors affecting the crystal field splitting energy, spectrochemical series, magnetic properties of complexes, colour of the complexes, crystal field stabilization energy (CFSE) and its calculation. variation of octahedral ionic radii. Crystal structure of spinels. Jahn-Teller effect and distortion in octahedral and tetrahedral complexes, charge transfer spectra (LMCT) and (MLCT), heat of hydration, lattice energy of bivalent metal ions of transition metals.	12
4	**Magnetic properties of transition metal complexes:** Types of magnetic behaviour, methods of determination of magnetic susceptibility, L-S coupling, correlation of the magnetic moment (spin only formula) and effective magnetic moment values, quenching of orbital contribution to magnetic moment, applications of magnetic moment data for 3d series.	12
	TOTAL	48

Suggested Readings:

1. Selected Topics in Inorganic Chemistry- Malik, Madan and Tuli
2. Chemistry for degree students- R. L. Madan.
3. Inorganic Chemistry – Gary L. Miessler and Donald A.Tarr.
4. Advanced Inorganic chemistry- F.A. Coton andWilkinson.
5. Concise Inorganic Chemistry – J.D.Lee.
6. Inorganic Chemistry - P.W.Atkins.
7. Advanced Inorganic Chemistry – Kalia, Puri andSharma

Semester-V
MJC-8 (P): Co-ordination Chemistry (P)

Course outcomes

After completion of this practical course, students will be skilled in:-

CO1: preparation of complex compounds.

CO2: complexometric titrations and colorimetric analysis.

Co-ordination Chemistry (Practical: 2 credits)
Practical **1.Preparation of inorganic compounds/ complexes.** a) Preparation of potash alum [$K_2SO_4.Al_2(SO_4)_3\ 24H_2O$] b) Preparation of potassium tris(oxalato) ferrate (III), $K_3[Fe(C_2O_4)_3]$ c) Preparation of potassium tris(oxalato) chromate (III), $K_3[Cr(C_2O_4)_3]$ d) Preparation of hexammine nickel (II) chloride, $[Ni(NH_3)_6]Cl_2$. e) Preparation of tetramminecopper(II) sulphate,$[Cu(NH_3)_4]SO_4$. f) Preparation of sodium nitropruside, $Na_2[Fe(CN)_5(NO)]$. **2.Complexometric titrations and colorimetry** a) Estimation of copper sulphate/copper ion from a given solution colorimetrically. b) Estimation of phosphate ion, $(PO_4)^{3-}$ in a given sample of water/soil colorimetrically. c) Complexometric titrations by EDTA (i) Estimation of Ca^{2+}/ Mg^{2+} in the supplied sample of water. (ii) Estimation of total hardness from the supplied sample of water.

Suggested Readings:

1. Qualitative inorganic chemistry – A. I .Vogel
2. Advance practical inorganic chemistry – Gurdeep Raj

Semester-V

MJC-9 (T): Polynuclear hydrocarbons, nitrogen containing compounds, heterocyclic compounds, alkaloids and terpenoids (T)

Course Outcomes

After completion of the course, students will be able to understand:

CO1: the chemistry of polynuclear hydrocarbons.

CO2: the named reactions related to amines nitriles, isonitriles and diazo compounds.

CO3: the chemistry of some common heterocyclic compounds.

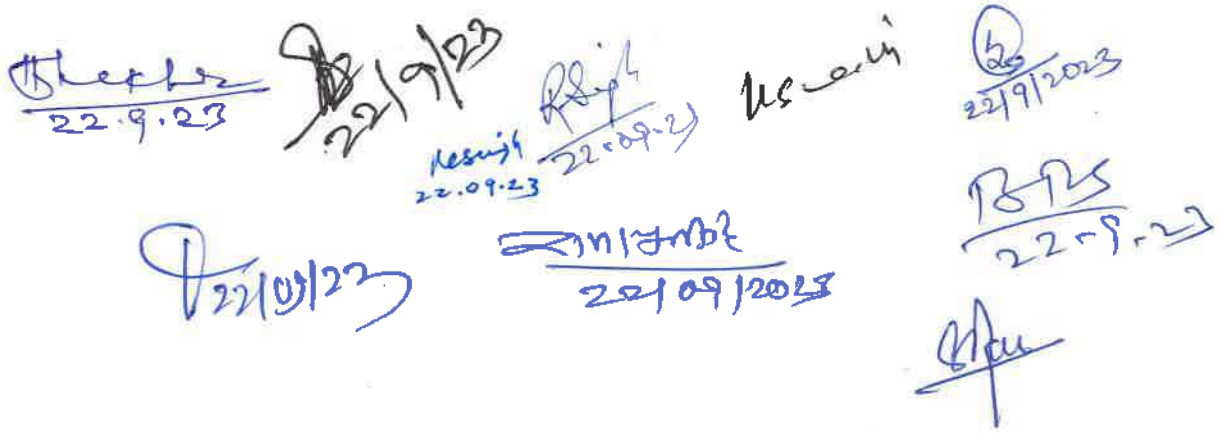
CO4: the general methods involved in structural elucidation of alkaloids and terpenoids.

Polynuclear hydrocarbons, nitrogen containing compounds, heterocyclic compounds, alkaloids and terpenoids (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Polynuclear Hydrocarbons:** Nomenclature of polynuclear hydrocarbons, preparation and properties and constitution of naphthalene, anthracene and phenanthrene.	12
2	**Nitrogen containing Compounds: Amines, Nitriles, Isocyanides and diazonium compound:** Reduction of nitro compounds under different conditions, von Richter reaction, preparation and separation of primary, secondary and tertiary amines, relative basic strength of amines, distinctions among primary, secondary and tertiary amines, preparation of diazonium salts and their synthetic applications, diazo- coupling reactions, Gomberg reaction, preparation and properties of nitriles and isonitriles.	15
3	**Heterocyclic Compounds:** Classification and nomenclature of heterocyclic compounds, aromaticity in 5- & 6-membered rings with one heteroatom, syntheses of pyrrole(Knorr-Pyrrole synthesis, Paal-Knorr synthesis, Hantzsch synthesis), Reaction synthesis and constitutions of furan, thiophene, pyridine (Hantzsch synthesis), reactions of pyrrole, furan, thiophene and pyridine. **Quinoline and isoquinoline:** Reactions, syntheses and constitution of quinoline and isoquinoline. (Skraup synthesis, Friedlander's Synthesis, Knorr Quinoline Synthesis, Bischler Napieralski Synthesis)	12
4	**Alkaloids and Terpenoids:** Natural occurrence, classification and isolation of alkaloids and terpenoids, isoprene. Isoprene and Special Isoprene rule, reactions used in general methods involved in structural elucidation of alkaloids and terpenoids.	09
	TOTAL	48

Suggested Readings:

1. Morrison R.T., Boyd R.N., (2007) Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar I.L., (2014) Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Finar I.L., (2014) Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson R.M., (1976), Introduction to the Chemistry of Heterocyclic compounds, John Wiley & Sons.
5. Graham Salomons T.W., Organic Chemistry, John Wiley & Sons, Inc.
6. Kalsi P.S., (2010), Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.



Semester-VI

MJC-10 (T): Colligative Properties of Dilute Solutions, Chemical Kinetics and Photochemistry (T)

Course Outcomes

After completion of the course, studentswill be able to understand:-

CO1: Colligative properties of dilute solutions and determination of these properties.

CO2: Abnormal colligative properties and molar mass.

CO3: Azeotropes, maximum and minimum boiling azeotropic mixture.

CO4: Kinetics of simple and complex reactions.

CO5: Jablonski diagram and laws of photochemistry.

Colligative Properties of Dilute Solutions, Chemical Kinetics and Photochemistry (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1.	**Colligative Properties of Dilute Solutions:** Colligative properties of solutions, Henry's law, Raoult's law (thermodynamic derivation), ideal and non-ideal solutions, azeotropes, thermodynamic derivation and experimental determination of relative lowering in vapour pressure, elevation in boiling point, depression in freezing point and osmotic pressure, abnormal colligative properties due to association and dissociation of solutes in solutions, van't Hoff's factor, abnormal molar mass, applications of colligative properties in determining molar mass of solutes, degree of dissociation and association.	15
2.	**Kinetics of Elementary Reactions:** Rate laws of first, second, third and zero order reactions, methods of determination of order of reactions, temperature dependance of reaction rate, Arrhenius equation, Activation energy, Collision theory and transition state theory of reaction rates. **Catalysis:** Theory and applications.	12
3.	**Kinetics of Complex Reactions:** Steady state approximation, integrated rate expression (first order only) for the 1. Opposing reactions 2. Parallel reactions and 3. Consecutive reactions.	12
4.	**Photochemistry:** Introduction, consequences of light absorption, Lambert-Beer's law, laws of photochemistry, Grotthus-Draper law, Stark-Einstein law of photochemical equivalence, quantum yield, photochemical reactions ($H_2 + Cl_2$, $H_2 + Br_2$, decomposition of HI), photochemical rate laws, energy transfer in photochemical reactions, Jablonski diagram, photosensitization, fluorescence, phosphorescence and chemiluminescence.	09
	TOTAL	48

Suggested Readings:

1. Physical Chemistry: P.W. Atkins (ELBS)
2. Comprehensive Physical Chemistry: Hemant Snehi
3. Theoretical Physical Chemistry: Gladstone

4. Physical Chemistry: G.M. Barrow.
5. Modern Electrochemistry: JOM Bakris and A.K.N. Reddy
6. Text Books of Polymer Science: F.W. Billmayer Jr.
7. Advanced Physical Chemistry: Gurdeep Raj

Semester-VI
MJC-10 (P): Physical Chemistry: Colligative Properties of Dilute Solutions and Chemical Kinetics (P)

Course Outcomes

After completion of this practical course, students will be skilled in:

CO1: determination of molecular mass by elevation in boiling point and depression in freezing point methods.

CO2: determination of the velocity constants of hydrolysis of esters and inversion of cane sugar.

Properties of Dilute Solutions and Chemical Kinetics (Practical: 2 credits)
Practical: **Solutions:** 1. Determination the molecular weight of non-volatile solute by Landsberger's method. 2. Determination of molecular mass of non-volatile solutes by Beckmann method. **Chemical Kinetics:** 1. Determination of the rate constant of hydrolysis of ethyl/methyl acetate catalyzed by HCl. 2. Determination of the rate constant of inversion of cane sugar. 3. Determination of the rate constant of hydrolysis of ethyl/methyl acetate with NaOH (saponification).

Suggested Readings:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).

SEMESTER – VI

MJC-11: Organic Chemistry: Biomolecules (T)

Course Outcomes

After completion of the course, students will be able to understand the:

CO1: genetic materials involved in living biosystems.

CO2: physicochemical properties of amino acids, peptides and proteins.

CO3: enzymes and their activity as well as some basic idea about lipids.

CO4: basics of energetics in biosystems and introduction to some synthetic and naturally occurring pharmaceuticals.

Biomolecules (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Amino Acids, Peptides and Proteins:** Classification of α-Amino Acids, General methods of synthesis, ionic properties and reactions, Zwitterions, pK_a values, isoelectric point and electrophoresis, study of peptides: Oligo and polypeptides, features of peptide bonds, syntheses of peptides using *N*-protecting, *C*-protecting and *C*-activating groups, solid-phase synthesis,elementary idea of primary, secondary, tertiary and quaternary structures of proteins.	10
3	**Nucleic Acids:** Components of nucleic acids, nucleosides and nucleotides, Structure and syntheses of Adenine, Guanine, Cytosine, Uracil and Thymine, structure of polynucleotides and DNA double helix.	10
2	**Enzymes and Lipids:** Introduction, classification and characteristics of enzymes, mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action specificity of enzyme action, enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition), Introduction to oils and fats, classification of lipids, phospholipids, hydrogenation and iodine number, saponification value.	10
4	**Concept of energy in Biosystems and Pharmaceutical compounds:** Role of ATP in glycolysis during phosphorylation of glucose, conversion of glucose-6-phosphate to fructose-6-phosphate, phosphorylation of fructose-6-phosphate, cleavage of fructose-1,6-biphosphate, oxidation of glyceraldehyde-3-phosphate to 1,3-biphosphoglycerate, phosphoryl transfer from biphosphate to ADP, Conversion of 3-phosphoglycerate to 2-phosphoglycerate, dehydration of 2-phosphoglycerate, transfer of the phosphoryl group from phosphonyl pyruvate to ADP and overall energy balance sheet for ATP. Structure, syntheses and therapeutic uses of aspirin, paracetamol, and ibuprofen, medicinal values of curcumin (haldi), azadirachtin (neem) and vitamin C.	18
	TOTAL	48

Suggested Readings:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

Semester-VI
MJC-11: Organic Chemistry: Biomolecules (P)

After completion of this practical course, students will be skilled in: -
CO1: tests of amino acids and proteins.
CO2: experiments related to enzymes, oils and fats.

Biomolecules (Practical: 2 credits)
Practical: **Tests of amino acids and proteins:** 1. Estimation of glycine by Sorenson's formalin method. 2. Study of the titration curve of glycine. 3. Test of proteins. **Experiments related to enzymes, oils and fats:** 1. Study of the action of salivary amylase on starch at optimum conditions. 2. Effect of temperature on the action of salivary amylase. 3. Saponification value of an oil or a fat. 4. Determination of Iodine number of an oil/ fat. **Experiment related to pharmaceutical compounds** 1. Synthesis of salicylic acid and aspirin.

Suggested Readings:

1. Manual of Biochemistry Workshop, 2012, Department of Chemistry, Universityof Delhi.
2. Arthur, I. V. *Quantitative Organic Analysis*, Pearson.
3. Any other laboratory manual available in departmental library as advised by the instructor.

Semester-VI
MJC-12 (T): Physical Chemistry: Quantum Chemistry &Spectroscopy (T)

Course Outcomes

After completion of the course, students will be able to understand:

CO1: the postulates of quantum mechanics, Schrödinger's wave equation and its applications

CO2: the concepts related to electronic and rotational spectra.

CO3: the concepts related to vibrational and Raman spectra.

Quantum Chemistry & Spectroscopy (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Elementary Quantum Mechanics:** Postulates of Quantum Mechanics, quantum mechanical operators, properties of operator, Hermitian operator, Schrödinger wave equation and its importance, physical interpretation of wave function, probability distribution function, nodal properties, particle in one dimensional box, particle in three dimensionalbox, concept of degeneracy and zero point energy, Schrödinger wave equation for hydrogen atom, separation of variables, hydrogen like wave functions.	12
2	**Valence Bond Theory and Molecular Orbital Theory:** Basic ideas of VBT and MOT, valence bond model of H_2, construction of MO's by LCAO for H_2^+ ion, physical picture of bonding and antibonding wave functions, concept of σ, σ^*, π, π^* non-bonding orbitals, comparison between VBT and MOT. Hybrid orbitals *sp*, sp^2 and sp^3 and calculation of coefficients of atomic orbitals used in these hybrid orbitals.	12
3	**Rotational and Electronic Spectra:** Electromagnetic radiation, Energy levels of a rigid rotor, selection rules, intensity of spectral lines using population distribution and degeneracy, effect of isotopic substitution, determination of bond length and atomic mass from rotational spectra,description of non-rigid rotor, Franck-Condon principle and intensity of spectral lines, pre-dissociation and dissociation, calculation of bond dissociation energy, electronic transitions, singlet and triplet states, concept of potential energy curves for bonding and anti-bonding molecular orbitals.	12
4	**Vibrational and Raman Spectroscopy** Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, determination of force constant and bond length, relation of force constants with bond energy, effect of anharmonic motion, idea of vibrational frequencies of different functional groups, overtones, combination bands and Fermi resonance, modes of vibration, vibrational-rotational spectrum, P, Q and R branches, Raman spectrum : concept of polarizability, vibrational Raman spectra, Stokes and anti-Stokes lines, their relative intensity, principle of mutual exclusion.	12
	TOTAL	48

Suggested Readings:

1. Banwell C. N., Mc Cash E. M., (2006). Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi.
2. Chandra A. K., (2001). Introductory Quantum Chemistry Tata McGraw-Hill.
3. House J. E., (2004). Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA.
4. Lowe J. P., Peterson K., (2005). Quantum Chemistry, Academic Press.
5. Kakkar R., (2015). Atomic & Molecular Spectroscopy, Cambridge University Press.

SEMESTER – VII

MJC-13: Inorganic Chemistry: Organometallic Chemistry, Symmetry and Group theory (T)

Course Outcomes

After completion of the course, students will be able to understand the:

CO1: nomenclature and classification of Organometallic compounds.
CO2: properties of metal carbonyls including their structures.
CO3: methods of preparation of Organometallics.
CO4: concept of symmetry and group theory.

Organometallic Chemistry (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction** Definition, nomenclature and classification of organometallic compounds,concept of hapticity, classification, preparation, properties and bonding of metal carbonyls, EAN rule and 18-electron rule applied to metal carbonyls, π-acceptor behaviour of CO, synergic effect, use of IR spectra in determining structure of metal carbonyls, structure of mono-, bi- and poly-nuclear metal carbonyls.	12
2	**σ- complexes** Preparation, properties, bonding and applications of Alkyls and aryls of Li, Al, Hg, Sn and Ti. Concept of multicentred bonding.	12
3	**π-Complexes** A brief account of metal-ethylene and Metal-acetylene complexes. **Zeise's salt:** Preparation, properties, bonding and synergic effect. **Ferrocene:** Preparation, reactions, structure and aromaticity, comparison of aromaticity and reactivity with that of benzene.	12
4	**Symmetry and Group Theory** Concept of symmetry, symmetry elements and symmetry operations, point groups, determination of point groups of simple molecules. Multiplication table of C_{2v} and C_{3v} point groups, group, characteristics of a group and subgroups.	12
	TOTAL	48

Suggested Readings:

1. Organometallic Chemistry: Gurdeep Chatwal and M. S. Yadav – Himalaya Publishing House.
2. Selected Topics in Inorganic Chemistry, by Dr. Wahid U. Malik, Dr. G. D. Tuli and Dr. R. D. Madan, S. Chand Publication.
3. Organometallic Chemistry – R. C. Mehrotra and A. Singh – New Age International Publication.
4. Chemistry for Degree Students – B. Sc. Third Year – by Dr. R. D. Madan- S Chand Publication.

5. General Inorganic Chemistry (Vol-II) – by Bidhan Chandra Roy and Satyanarayan Das – NCBA
6. Miessler, G.; Tarr, D. A., Inorganic Chemistry, 3rd Ed., Pearson Education India
7. Cotton F. A. Chemical applications of group theory, 3rd Ed. Interscience (Wiley), New York,
8. Gurdeep Raj, Group Theory & Symmetry in Chemistry, Krishna Prakashan Media.

Semester-VII
MJC-15: Organic Chemistry: Spectroscopy (T)

Course Outcomes

After completion of the course, students will be able to understand: -

CO1: different types of electronic transitions in organic molecules.

CO2: the principles related to ultraviolet spectroscopy.

CO3: different types of vibrations in organic molecules and the principles related to infrared spectroscopy.

CO4: the nuclear spin, shielding and deshielding effects and the principles of NMR

CO5: the principles of ESR spectroscopy.

Organic Spectroscopy (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Ultraviolet (UV)Absorption Spectroscopy:** Origin and spectrum of electromagnetic radiations, absorption and emission spectra, Lambert- Beer's law, types of electronic transitions, molar absorption coefficient, selection rules, recording and analysis of UV spectra, chromophore, auxochrome, bathochromic-, hypsochromic-, hyperchromic- and hypochromic-shifts, Woodward-Fieser rules for calculating $\lambda_{max.}$, UV spectra of conjugated enes and enones.	12
2	**Infrared (IR)Absorption Spectroscopy:** Degree of freedom, Hooke's law, different types of bond vibrations in organic molecules, IR, near IR and far IR regions, selection rules for IR spectroscopy, functional group characteristic vibrations in IR, fingerprint region, factors affecting the position and intensity of IR bands, recording of IR spectra, interpretation of IR spectra of simple organic molecules.	12
3	**Nuclear Magnetic Resonance (NMR) Spectroscopy:** Principle of Nuclear magnetic resonance (^{1}H-NMR) spectroscopy, shielding and deshielding effects, chemical shift, splitting of signals, spin-spin coupling and coupling constant, number, position, area and intensity of NMR signals, interpretation of NMR spectra of simple organic molecules.	12
4.	**Electron Spin Resonance (ESR) Spectroscopy:** Introduction, principle of ESR spectroscopy, types of species taken for investigation through ESR, relaxation processes, spin-lattice relaxation, spin-spin relaxation, effect of relaxation time on line width, presentation of ESR spectra, the g–factor, hyperfine structure (electron spin and nuclear spin coupling), number and intensity of lines, ESR spectra of some simple species ($H^{\cdot}$, $CH_3^{\cdot}$, $C_2H_5^{\cdot}$, $C_6H_6^{\cdot-}$), Applications of ESR spectroscopy.	12
	TOTAL	48

Suggested Readings:

1. Organic Chemistry –Morrison and Boyd
2. Organic spectroscopy: Y.R. Sharma.
3. Organic spectroscopy -William Kemp (MacMillan)
4. Spectroscopy of Organic Compounds – P.S. Kalsi.
5. Physical methods in inorganic chemistry – Russell S. Drago.

Semester-VIII
MJC-16(T): Analytical Methods in Chemistry (T)

Course Outcomes

After completion of the course, students will be able to: -

CO1: understand accuracy and precision.
CO2: develop methods of analysis for different samples independently.
CO3: test contaminated water samples.
CO4: understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer.
CO5: learn separation of analytes by chromatography.
CO6: apply knowledge of geometrical isomers and keto-enol tautomers to analysis.
CO7: determine composition of soil.
CO8: estimate macronutrients using Flame photometry.

MJC-16 (T): Analytical Methods in Chemistry (Theory:4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Qualitative and Quantitative Aspects of Analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression. Normal law of distribution of indeterminate errors, statistical test of data, F, Q and t test, rejection of data, and confidence intervals.	12
2	**Optical Methods of Analysis:** **UV-Visible Spectrophotometry:** Basic principle of instrumentation (choice of source, monochromator and detector) for single and double beam instrument, Transmittance. Absorbance. Basic principles of quantitative analysis: Estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. **Flame Atomic Absorption and Emission Spectrometry:** Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs). Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal, Techniques for the quantitative estimation of trace level of metal ions from water samples.	12
3	**Thermal Methods of Analysis:** Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser. Techniques for quantitative estimation of Ca and Mg from their mixture.	12
4	**Chromatography:** Classification, principle and efficiency of the technique, Mechanism of separation: adsorption, partition & ion-exchange, Development of chromatograms: frontal, elution and displacement methods.	12
	TOTAL	48

Suggested Readings:

1. Willard, H.H. (1988), Instrumental Methods of Analysis, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D. (2004), Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C. (2007), Quantitative Chemical Analysis, 6th Edition, Freeman.
4. Khopkar, S.M. (2008), Basic Concepts of Analytical Chemistry, New Age International Publisher.
5. Skoog, D.A.; Holler F. J.; Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd.

Course Structure

Chemistry

(B) Minor Courses to be offered by the department for students of other departments of science

Sem	Type of Course	Name of Course	Credits	Marks
I	MIC-1 (T)	Inorganic Chemistry I: Atomic Structure & Chemical Bonding	2	100
	MIC-1 (P)	Inorganic Chemistry Lab: volumetric analysis Organic Lab: detection, purification and separation of organic compounds	1	
II	MIC-2 (T)	Physical Chemistry: States of Matter & Ionic Equilibrium (T)	2	100
	MIC-2 (P)	Physical Chemistry: Determination of surfaces surface tension, viscosity and molecular weight (P)	1	100
III	MIC-3 (T)	Organic Chemistry: Hydrocarbons & Chemistry in everyday life.	3	100
IV	MIC-4 (T)	Chemical Thermodynamics and its Applications (T)	3	100
V	MIC-5 (P)	Chemical Thermodynamics and its Applications (P)	3	100
	MIC-6 (T)	*s*-, *p*- and d-block elements (T)	3	100
VI	MIC-7 (P)	Qualitative Analysis of Inorganic Salt Mixture Containing Four Radicals (P)	3	100
	MIC-8 (T)	Compounds with Oxygen Containing Functional Groups (T)	3	100
VII	MIC-9 (P)	Identification of Oxygen Containing Functional Groups (P)	2	100
	MIC-9 (T)	Colligative Properties of Dilute Solutions, Chemical Kinetics and Photochemistry	2	100
VIII	MIC-10 (T)	Physical chemistry: Phase Equilibria and Electrochemical cells	4	100
		Sub Total	**32**	

SEMESTER-III

MIC-3(T) : Hydrocarbons & Chemistry in everyday life

Course outcomes:

After completion of this course, student will be able to understand:

CO1: Chemistry of hydrocarbons.

CO2: applications of Chemistry in everyday life.

MIC-3(T) : Hydrocarbons & Chemistry in everyday life (Theory: 3 credits)		
Unit	**Name of Course**	**No. of Lectures**
	Aliphatic Hydrocarbons Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.	
1	**Alkanes:** (Upto 5 Carbons): Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.	11
2	**Alkenes:** (Upto 5 Carbons): Preparation: Elimination reaction, dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation,.	11
3	**Alkynes:** (Up to 5 Carbons): Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk, $KMnO_4$.	11
4	**Chemistry in everyday life:** Air Pollution, Water Pollution, Toxic Chemicals, Inorganic and Organic Chemicals in soil, Important Fertilizers Green Chemistry, essential constituents in foods, Important drugs food preservatives	12
	TOTAL	45

Suggested Readings:

1. Organic Chemistry-Graham Solomons
2. Organic Chemistry- Morrison & Boyd.

22/9/23 22.09.23 22.09.23 22.9.23 22/9/2023 22/09/2023 22/09/2023

Semester-IV
MIC-4: Physical Chemistry: Chemical Thermodynamics and its Applications (T)

Course Outcomes

After completion of the course, students will be able to understand:

CO1: various thermodynamic terms.

CO2: various enthalpies of transformations and Kirchoff's law.

CO3: entropy changes, Gibbs free energy change, spontaneous and non- spontaneous processes.

CO4: second law of thermodynamics.

MJC-4: Physical Chemistry: Chemical Thermodynamics and its Applications (Theory: 3 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Basic concepts and first law of thermodynamics:** Definition of thermodynamic terms: system, surroundings, types of systems, intensive and extensive properties, state and path functions, thermodynamic processes, concept of heat and work, First law of Thermodynamics-Statements, definition of internal energy and enthalpy, Heat capacities at constant volume and constant pressure with their relationship, Joule's law, Joule-Thomson coefficient and inversion temperature, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible and irreversible processes.	12
2	**Thermochemistry:** Standard state, enthalpy of reaction, standard enthalpy of formation, Hess's law of constant heat summation and its applications, enthalpy of combustion, enthalpy of neutralization, bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy, Kirchoff's equation.	11
3	**Second law of thermodynamics:** Second law of thermodynamics, need of the law, different statements of the law, Carnot theorem, Carnot cycle and its efficiency.	11
4	**Entropy and free energy:** Concept of entropy, entropy as a function of V&T, P&T, entropy change in ideal gases and mixing of ideal gases, free energy and spontaneity, variation of Gibbs free energy (G) and Helmholtz free energy(A) with P, V and T.	11
	TOTAL	45

Suggested Readings:

1. Peter, A. & Paula, J. de., Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).

4. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. &Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6. Levine, I.N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
7. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).

Semester-V

MIC-5 (P): Chemical Thermodynamics and its Applications (P)

Course Outcomes

After completion of this practical course, students will be skilled in determining:

CO1: different types of enthalpy changes.

CO2: the heat capacity of calorimeter.

MIC-5: Chemical Thermodynamics and its Applications (Practical: 3 credits)
Practical: **Chemical Thermodynamics and its Applications** 1. Determination of water equivalent of calorimeter. 2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Determination of enthalpy of ionization of ethanoic acid. 4. Determination of heat of displacement of Cu by Zn from Cu^{2+} salt solution. 5. Determination of enthalpy of hydration of copper sulphate.

Suggested Readings:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry, New Age International, New Delhi (2001).

SEMESTER – V

MIC-6 (T): Inorganic Chemistry: *s*-, *p*- and d-block elements (T)

Course Outcomes

After completion of the course, the students will be able to understand: -

CO1: different oxidation states of elements with their relative stability and complex forming properties.

CO2: the ring, cage and polymers of B, Si & P.

CO3: to carry out the preparation of inorganic compounds.

CO4: the important properties of transition metals such as their oxidation states, colour, magnetic and spectral, use of Latimer diagrams in identifying oxidizing, reducing and disproportionating species.

CO5: the concepts related with noble gases, their compounds, shapes, properties and applications.

***s*-, *p*- and *d*-block elements (Theory: 3 credits)**		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Periodic Table and Periodicity of Elements:** The long form of periodic table, detailed discussion of the following periodic properties of the elements a) Atomic radii (covalent, metallic and van der Waals) b) Ionization enthalpy, successive ionization enthalpies, factors affecting ionization enthalpy and applications of ionization enthalpy. c) Electron gain enthalpy. d) Electronegativity: Pauling's and Mullikan, variations of electronegativity with bond order and partial charge. General electronic configuration of *s*- and *p*- block elements, inert pair effect, relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group, allotropy and catenation properties.	14
2	**Compounds of *p* block elements:** Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses:- Boric acid, borates, borazines, silicates, silicones, NH_3-manufacture (Haber's process), oxides, oxy- and peroxy acids of nitrogen, phosphorus and sulphur.	11
3	**Chemistry of noble gases:** Occurrence and isolation, rationalization of inertness of noble gases, shape and structure of noble gas compounds using VSEPR theory, preparation and properties of XeF_2, XeF_4 and XeF_6.	8
4	**Chemistry of d-block elements:** General electronic configuration of d-block metals and their group trends, variable oxidation states and their relative stabilities, magnetic and catalytic properties of metals, colour, complex forming ability of metals, Chemistry of Cr, Mn and Fe in various oxidation states with special reference to their following compounds: peroxo compounds of Cr, potassium dichromate, potassium permanganate..	12
	TOTAL	45

Readings:

1. Lee, J. D., Concise Inorganic Chemistry, 5th Ed., Wiley India (2008).
2. Housecroft, C. E.; Constable, E. C. Chemistry-An Introduction to Organic, Inorganic and Physical Chemistry, 4th Ed., Pearson Education (2010).
3. Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., Shriver Atkins's Inorganic Chemistry, 6th Ed., Oxford University Press India (2015).
4. Miessler, G.; Tarr, D. A., Inorganic Chemistry, 3rd Ed., Pearson Education India (2008).
5. Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., Inorganic Chemistry: Principles of Structures and Reactivity, 4th Ed., Pearson Education India (2006).
6. Cotton, F. A.; Wilkinson, G.; Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley India (2007).
7. Puri, B. R.; Sharma, L. R.; Kalia, K. C., Principles of Inorganic Chemistry, 33rd Ed., Vishal Publishing (2017).

Semester-VI

MIC-7 (P): Qualitative Analysis of Inorganic Salt Mixture Containing Four Radicals (P)

Course Outcomes

After the end of this practical course students will be skilled in: -

CO1: identification of basic radicals from known and unknown salts.

CO2: identification of acid radicals from known and unknown salts.

Qualitative Analysis of inorganic salt mixture containing Four Radicals. **(Practical 3 credits)**
1. Identification of known cations (basic radicals) and anions (acid radicals) from the supplied salt. 2. Identification of cation (basic radicals) and anions (acid radicals) from unknown salt. 3. Identification of cation (basic radicals) and anions (acid radicals) from binary mixture of inorganic salts.

SuggestedReadings:

1. Raj, G., Advanced Practical Inorganic Chemistry, Krishna Prakashan, Meerut (2013).
2. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., Vogel's Quantitative Chemical Analysis, 6th Ed., Pearson Education India (2009).

Semester-VI

MIC-8 (T): Organic Chemistry: Compounds with Oxygen Containing Functional Groups (T)

CourseOutcomes

After the completion of the course, students will be able to understand:

CO1: preparation, properties and reactions of compounds with oxygen containing functional groups.

CO2: to draw plausible mechanisms for reactions involving these functional groups.

CO3: the knowledge of various named organic reactions associated with these functional groups.

CO4: chemistry of epoxides.

CO5: the detection of *O*-containing functional groups like alcohols, phenols, carbonyl and carboxylic acid groups.

CO6: the preparation of various organic compounds by functional group transformations and other common organic reactions.

CO7: the green practices in Organic syntheses.

Compounds with Oxygen Containing Functional Groups (Theory: 3 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Alcohols, Phenols, Ethers and Epoxides** **Alcohols:** Classification and nomenclature. Preparation of 1^{o}, $2^{o}$and 3^{o}alcohols using substitution reaction, addition reactions, Grignard reagent. **Reactions:** With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation. **Phenols:** Classification, nomenclature and properties **Preparation:** Cumene hydroperoxide method, from diazonium salts. **Reactions:** Electrophilic substitution: Nitration, halogenation and sulphonation. Kolbe's–Schmidt Reaction, Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Schotten–Baumann Reaction. **Ethers and epoxides (aliphatic and aromatic):** Classification, nomenclature, preparation and properties. **Reactions:** Cleavage of ethers with HI. Syntheses of epoxides, Acid and base–catalyzed ring opening of epoxides.	17
2	**Aldehydes and ketones (aliphatic and aromatic):** Structure, reactivity and preparation; nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives and their mechanisms; mechanisms of Aldol and Benzoin condensation, Knoevenagel condensations, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reactions, haloform reaction and Baeyer Villiger oxidation, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV and PDC).	10

	Addition reactions of unsaturated carbonyl compounds: Michael addition.	
3	**Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of monocarboxylic acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.	09
4	**Carbohydrates** Classification and general properties of carbohydrates, Glucose and Fructose (open chain and cyclic structure), Mutarotation, ascending and descending in monosaccharides.	09
	TOTAL	45

Suggested Readings:

1. Greeves, N.; Clayden, J.; Warren, S., Organic Chemistry, 2nd Ed., Oxford University, Press India (2014).
2. Sykes, P., A Guide book to Mechanism in Organic Chemistry, 6th Ed., Pearson Education India (2003)
3. Ghosh, S. K., Advanced General Organic Chemistry, Part-I & Part-II, 3rd Ed., New Central Book Agency (2010).
4. Bhal, B. S.; Bhal, A., A Textbook of Organic Chemistry, 22nd Ed., S. Chand and Company (2016).
5. Sengupta, S., Basic Stereochemistry of Organic Molecules, 2ndEd., Oxford University Press India (2018).
6. Finar, I. L. Organic Chemistry (Volume1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Semester-VII

MIC-9 (P): Organic Chemistry: Identification of Oxygen Containing Functional Groups (P)

Course Outcomes:

When the students will finish this practical course, they will be skilled in: -

CO1: acetylation and benzoylation of various functional groups present in organic compounds.

CO2: oxime formation, hydrazone formation, semi-carbazone formation, iodoform test and in the bromination of phenols.

CO3: oxidation of alcohols and reduction of nitro compounds.

CO4: Aldol Condensation by conventional and green methods.

Compounds with Oxygen Containing Functional Groups (Practical: 2 credits)
(a) Acetylation of salicylic acid. (b) Benzolyation of aniline. (c) Preparation of Oximes and 2,4-dinitrophenylhydrazones of aldehydes and ketones (d) Bromination of Phenol.

Suggested Readings:

1. Agarwal, O. P., Advanced Practical Organic Chemistry, Krishna Prakashan, Meerut (2014).
2. Ahluwalia, V. K.; Aggarwal, R., Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Universities Press (2000).
3. Furniss, B. S.; Hannafold, A. J.; Smith, P. W. G.; Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Pearson Education India (2003).
4. Clarke, H. T., A Handbook of Organic Analysis: Qualitative and Quantitative, 4th Ed., CBS Publishers India (2007).
5. Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J. & Smith, P. W. G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
6. Mann, F.G. & Saunders, B. C. Practical Organic Chemistry Orient-Longman, 1960.
7. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi(2011).

22-9-23 22-09-23 22/9/2023 22-9-23 22/09/2023 22/09/23

Semester-VII

MIC-9 (T): Colligative Properties of Dilute Solutions, Chemical Kinetics and Photochemistry (T)

Course Outcomes

After completion of the course, students will be able to understand:-

CO1: Colligative properties of dilute solutions and determination of these properties.

CO2: Abnormal colligative properties and molar mass.

CO3: Azeotropes, maximum and minimum boiling azeotropic mixture.

CO4: Kinetics of simple and complex reactions.

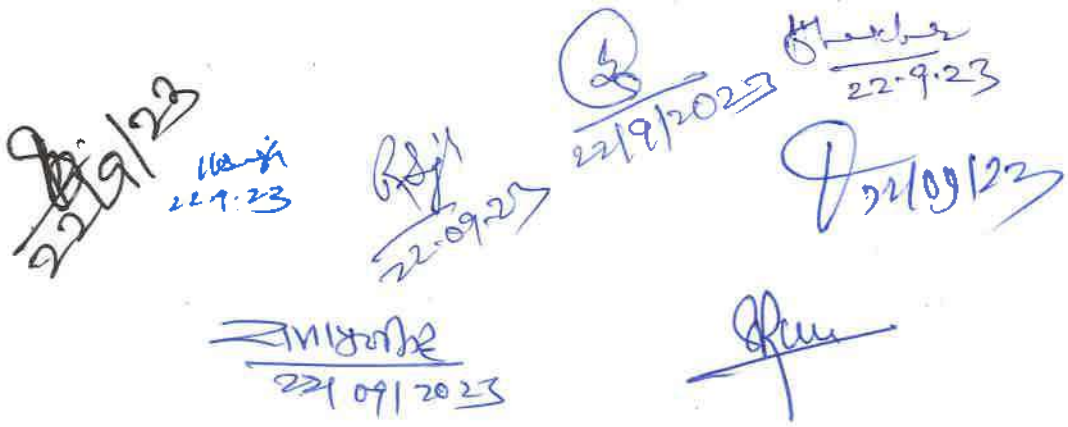
CO5: Jablonski diagram and laws of photochemistry.

Colligative Properties of Dilute Solutions, Chemical Kinetics and Photochemistry (Theory: 2 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1.	**Colligative Properties of Dilute Solutions:** Colligative properties of solutions, Henry's law, Raoult's law (thermodynamic derivation), ideal and non-ideal solutions, azeotropes, thermodynamic derivation and experimental determination of relative lowering in vapour pressure, elevation in boiling point, depression in freezing point and osmotic pressure, abnormal colligative properties due to association and dissociation of solutes in solutions, van't Hoff's factor, abnormal molar mass, applications of colligative properties in determining molar mass of solutes, degree of dissociation and association.	8
2.	**Kinetics of Elementary Reactions:** Rate laws of first, second, third and zero order reactions, methods of determination of order of reactions, temperature dependance of reaction rate, Arrhenius equation, Activation energy, **Catalysis:** Theory and applications.	8
3.	**Kinetics of Complex Reactions:** Steady state approximation, integrated rate expression (first order only) for the 1. Opposing reactions 2. Parallel reactions and 3. Consecutive reactions.	7
4.	**Photochemistry:** Introduction, consequences of light absorption, Lambert-Beer's law, laws of photochemistry, Grotthus-Draper law, Stark-Einstein law of photochemical equivalence, quantum yield, photochemical reactions ($H_2 + Cl_2$, $H_2 + Br_2$, decomposition of HI), photochemical rate laws.	7
	TOTAL	30

Suggested Readings:

1. Physical Chemistry: P.W. Atkins (ELBS)
2. Comprehensive Physical Chemistry: Hemant Snehi
3. Theoretical Physical Chemistry: Gladstone
4. Physical Chemistry: G.M. Barrow.
5. Modern Electrochemistry: JOM Bakris and A.K.N. Reddy

6. Text Books of Polymer Science: F.W. Billmayer Jr.
7. Advanced Physical Chemistry: Gurdeep Raj



Semester-VIII

MIC-10: Physical Chemistry: Phase Equilibria, Conductance and Electrochemical Cells (T)

Course Outcomes

After completion of the course, students will be able to understand: -

CO1: the degree of ionization, pH and salt hydrolysis.
CO2: the different types of Buffer solutions.
CO3: the concepts of solubility product.
CO4: the conductivity, specific conductivity, equivalent conductivity and molar conductivity, application of conductance measurement in determining various physical parameters.
CO5: the standard electrode potential of half cells and calculate the EMF of a cell using Nernst equation.
CO6: EMF measurements in determining various parameters like free energy, enthalpy, entropy, equilibrium constants, etc.
CO7: the concentration cells with and without transference.
CO8: the principle of potentiometric titrations.

MIC-10: Physical Chemistry: Ionic Equilibria, Conductance and Electrochemical Cells (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Phase Equilibria:** Phases, components and degrees of freedom of systems, criteria of phase equilibria, Gibbs Phase Rule and its thermodynamic derivation, phase diagram of one component system (water/sulphur).	15
2	**Conductance:** Conductance, specific conductance (conductivity), equivalent and molar conductance, their variation with dilution for weak and strong electrolytes, Kohlrausch law of independent migration of ions, transference number.	15
3	**Electrochemical cells:** Electrode and electrode potential, reference electrodes (Standard hydrogen electrode and Calomel electrode), standard electrode potential, type of electrodes, galvanic cells, electrochemical series and its significance, Nernst equation and its importance, types of electrochemical cells – chemical cells and concentration cells, concept of EMF of a galvanic cell, measurement of EMF of a cell, construction and working of a Galvanic cell.	15
4	**Applications of EMF measurements** Determination of equilibrium constant, ΔG, ΔS and ΔH of cell reactions, calculation of solubility product of a sparingly soluble salt, the valency of ions.	15
	TOTAL	60

Suggested Readings:

1. Atkins, P. W.; de Paula, J.; Keeler, J., Physical Chemistry, 11th Ed., Oxford University Press India (2018).
2. Bahl, A.; Bahl, B. S.; Tuli, G. D., Essentials of Physical Chemistry, S.

Chand and Company (2014).
3. Negi, A. S.; Anand, S. C., Physical Chemistry, New Age International Publishers (2007).
4. Puri, B. R.; Sharma, L. R.; Pathania, M. S., Principles of Physical Chemistry, 47th Ed., Vishal Publishing (2017).
5. Silbey, R. J.; Alberty, R. A.; Bawendi, M. G., Physical Chemistry, 4th Ed., Wiley India (2006).
6. Rakshit, P. C., Physical Chemistry, Revised Ed. Sarat Book House (2014).
7. Kapoor, K. L., A Textbook of Physical Chemistry: States of Matter and Ions in Solution, Vol. I, 6th Ed., McGraw Hill Education India (2019).

Course Structure

Chemistry

(B) Multidisciplinary Courses to be offered by the department for students of different disciplines.

Sem	Type of Course	Name of Course	Credits	Marks
I	MDC-1 (T)	Inorganic Chemistry: Atomic Structure, Chemical Bonding and fundamentals of Organic Chemistry.	2	100
	MDC-1 (P)	Inorganic and Organic Chemistry Lab	1	100
II	MDC-2-(T)	Inorganic Chemistry: Atomic Structure, Chemical Bonding and fundamentals of Organic Chemistry.	2	100
	MDC-2 (P)	Inorganic and Organic Chemistry Lab (P)	1	100
III	MDC-3 (T)	Chemistry in Everyday Life	2	100
III	MDC-3 (P)	Inorganic and Organic Chemistry Lab (P)	1	100

Sub Total: 09

SEMESTER-III

MDC-3 (T): Chemistry in everyday life

Course outcomes:

After completion of this course, student will be able to understand:

CO1: Chemistry of hydrocarbons.

CO2: applications of Chemistry in everyday life.

MDC-3 (T): Chemistry in everyday life (Theory: 3 credits)		
Unit	**Name of Course**	**No. of Lectures**
1	**Polymers:** Monomers and polymers, classification of polymers, addition and condensation of polymers, homopolymers and copolymers, preparation, properties and applications of polymers, styrene, PVC, Teflon, acrolein, nylon-6, nylon-66, natural rubber, Buna-S, Buna-N, bakelite, neoprene, biodegradable polymers.	8
2	**Sources of energy:** Nuclear energy, solar energy, bioenergy, hydral energy, bio additives to fuels, blue and green hydrogen as fuel.	8
3	**Colloids:** True solution, suspension, colloidal solution, types of solution, preparation of colloids, Tindal effect, Brownian motion, electrophoresis, cataphoresis, dialysis.	8
4	**Chemistry in everyday life:** Air Pollution, Water Pollution, Toxic Chemicals (Inorganic and Organic), Chemicals in soil, Important Fertilizers, Green Chemistry and foods preservatives.	6
	TOTAL	30

Suggested Readings:

1. Organic Chemistry- Morrison & Boyd.
2. Environmental Chemistry, B. K. Sharma

Semester-III

MDC-3 (P): Qualitative Analysis of Inorganic Salt Mixture Containing Four Radicals (P)

Course Outcomes

After the end of this practical course students will be skilled in: -

CO1: identification of basic radicals from known and unknown salts.

CO2: identification of acid radicals from known and unknown salts.

Qualitative Analysis of inorganic salt mixture containing Four Radicals. **(Practical 1 credits)**
1. Identification of known cations (basic radicals) and anions (acid radicals) from the supplied salt. 2. Identification of cation (basic radicals) and anions (acid radicals) from unknown salt. 3. Identification of cation (basic radicals) and anions (acid radicals) from binary mixture of inorganic salts.

SuggestedReadings:

1. Raj, G., Advanced Practical Inorganic Chemistry, Krishna Prakashan, Meerut (2013).
2. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., Vogel's Quantitative Chemical Analysis, 6th Ed., Pearson Education India (2009).