Syllabus for Semesters V and VI

Five Year Integrated B.Sc.(Hons.)-M.Sc. Program in Chemistry

(under CBCS, *w.e.f.* Academic Session 2022-2023)

Offered By

Department of Chemistry and Chemical Sciences

CENTRAL UNIVERSITY OF JAMMU
Rahya-Suchani (Bagla), District-Samba
Jammu-181143, (J&K) India

Semester – V

Course Code	Course	Type	Credits	Contact hours per week (L-T-P)
	Organic Chemistry-IV	CC	4	3-1-0
	Physical Chemistry-IV	CC	4	3-1-0
	Organic Chemistry Lab-IV	CC	2	0-0-4
	Physical Chemistry Lab-IV	CC	2	0-0-4
	Natural Products Chemistry	DSE	4	3-1-0
	Properties of Inorganic Metal Complexes	DSE	4	3-1-0
	Applied Chemistry	DSE	4	3-1-0
	Applied Chemistry Lab	DSE	2	0-0-4
	Total		26	

Semester – VI

Course Code	Course	Type	Credits	Contact hours per week (L-T-P)
	Organic Chemistry-V	CC	4	3-1-0
	Physical Chemistry-V	CC	4	3-1-0
	Organic Chemistry Lab-V	CC	2	0-0-4
	Physical Chemistry Lab-V	CC	2	0-0-4
	Selected Topics in Inorganic Chemistry	DSE	4	3-1-0
	Project/Dissertation	DSE	6	0-0-12
	Total		22	

Examination Pattern

Course	Credit	CIA	MSE	ESE	Max. Marks
Theory	4	25	25	50	100
Theory	2	12.5	12.5	25	50
Practical	2	25	-	25	50

Semester: V
Course Name: Organic Chemistry-IV
Course Code: 4 Credits (3-1-0)

UNIT – I **14 hours**

Carboxylic acids: Nomenclature, Structure and bonding, Preparation of monocarboxylic acids, Physical properties, Acidity of carboxylic acids, Effect of substituents on acid strength, Reactions of carboxylic acids, HVZ reaction, Reduction of carboxylic acids, Mechanism of decarboxylation, Methods of formation and chemical reactions hydroxy acids: Malic, Tartaric and Citric acids, Dicarboxylic acids: Methods of formation and effect of heat and dehydrating agents, Unsaturated acids: Cinnamic, Maleic and Fumaric acids.

Carboxylic acid derivatives: Preparation and reactions of acid chlorides, anhydrides, esters, amides and acid anhydrides, Comparative study of nucleophilic substitution at acyl group, Mechanism of acidic and alkaline hydrolysis of esters, Claisen and Dieckmann condensations, Reformatsky reaction, Hofmann bromamide degradation, Curtius rearrangement.

UNIT – II **12 hours**

Nitro compounds: Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes, Mechanism of nucleophilic substitution in nitroarenes, Picric acid.

Amines: Preparation of alkyl and aryl amines *via* reduction of nitro compounds and nitriles, Reductive amination, Hofmann degradation, Gabriel-phthalimide reaction, Hoffmann rearrangement, Separation of a mixture of primary, secondary and tertiary amines (Hinsberg's method), Reactions of amines, Electrophilic aromatic substitution, Basicity of amines and effect of substituents on basicity, Amine salts as phase transfer catalysts

Diazonium salts: Preparation and reactions.

UNIT – III **12 hours**

Organosulfur compounds: Nomenclature, Methods of formation of thiols, thioethers, sulphonic acids, sulphonamides, suphur ylides, thiocyanates, isothiocyanates and sulphaguanidine.

Organophosphorus and organosilicon compounds: Preparation and chemical reactions of organophosphorous and organosilicon compounds, Phosphines, Phosphorous ylides, Wittig reaction, Phophine oxides, Esters of phosphorous acids, Alkyl silanes, Silanols, Siloxanes, Silylamines, Hiyama coupling.

UNIT – IV **10 hours**

Amino acids, peptides and proteins: Classification, Structure and stereochemistry of amino acids, Zwitterions, Isoelectric point, Electrophoresis, Synthesis, ionic properties and reactions of α-amino acids, Classification of proteins, Peptide structure determination: End group analysis and Selective hydrolysis of peptides, Solid-phase peptide synthesis, Primary and secondary structures of proteins.

UNIT – V **12 hours**

Nucleic acids: Components of nucleic acids, Nucleosides and nucleotides, Synthesis of Adenine, Guanine, Cytosine, Uracil and Thymine, Structure of polynucleotides, Ribonucleosides and Ribonucleotides, The double helical structure of DNA.

Lipids: Introduction to oils and fats, Common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, Acid value, Iodine number.

Enzymes: Classification and characteristics of enzymes, Salient features of active site of enzymes, Mechanism of enzyme action (chymotrypsin), Factors affecting enzyme action, Enzyme inhibitors and their importance.

REFERENCES

1. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., 2011.
2. A. Bahl and B. S. Bahl, *A Text Book of Organic Chemistry*, 22nd Ed., 2016.
3. I. L. Finar, *Organic Chemistry*, Vol. I and II, 6th Ed., 2002.
4. L.G. Wade Jr., *Organic Chemistry*, Prentice Hall, 8th Ed., 2016.
5. P. Y. Bruice, *Organic Chemistry*, 8th Ed., 2016.
6. F. A. Carey and R. M. Giuliano, *Organic Chemistry*, *McGraw Hill*, 10th Ed., 2016.
7. F. A. Carey and R. J. Sundberg, *Advanced Organic Chemistry: Part A: Structure and Mechanisms*, 5th Ed., 2008.
8. M. B. Smith, *March's Advanced Organic Chemistry, Reactions, Mechanisms and Structure*, 7th Ed., 2016.
9. D. L. Nelson and M. M. Cox, *Lehninger's Principles of Biochemistry*, 7th Ed., W. H. Freeman and Company, 2017.
10. J. M. Berg, J. L. Tymoczko, G. J. Gatto Jr. and L. Stryer, *Biochemistry*, 8th Ed., 2015

Semester: V
Course Name: Physical Chemistry-IV
Course Code: **4 Credits (3-1-0)**

UNIT – I **12 hours**

Quantum mechanics-I: Basic principles of quantum mechanics, Inadequacy of classical mechanics, The concept of quantization, Black–body radiation, Planck's radiation law, Photoelectric effect, Heat capacity of solids, Bohr's model of hydrogen atom and its defects, Compton effect, The wave-particle duality, The Heisenberg's uncertainty principle, Operator formalism: Linear operator, Hermitian operator and angular momentum operator, Commutator, Eigen functions and eigen values, Expectation values.

UNIT – II **12 hours**

Quantum mechanics-II: Hamiltonian operator, Schrödinger wave equation and its importance, Physical interpretation of the wave function, Orthogonal and orthonormal functions, Correspondence principle, Postulates of quantum mechanics and their analysis, Particle in a one, two and three-dimensional box, Degeneracy and its applications to conjugated systems.

UNIT – III **12 hours**

Quantum mechanics-III: Simple harmonic oscillator: Setting up of the Schrodinger stationary equation, Energy expression (without derivation), Expression of wave function for $n = 0$ and $n = 1$ (without derivation) and their characteristic features; Schrödinger wave equation for *H*-atom, Transformation of coordinates: Cartesian to polar (without derivation), Separation into three total differential equations in terms of the variables r, θ, φ; and their significance, Solution of φ equation and emergence of magnetic quantum number '*m*', Concept of orbital.

UNIT – IV **12 hours**

Surface chemistry: Structure of solid surfaces: Adsorption and desorption of molecules, physisorption and chemisorption, Surface reaction kinetics, Langmuir, BET and Freundlich adsorption isotherms, The rates of surface processes, Temperature dependence of adsorption, Structure of heterogeneous surfaces: Langmuir-Hinshelwood and Eley-Rideal mechanism.

UNIT – V **12 hours**

Colloidal state: The colloidal systems, general properties, Tyndall effect, Properties of hydrophobic colloidal systems: Electrical properties (electrical double layer) and electrokinetic properties (electro-osmosis).
Surface active agent, Classification of surface-active agent, Critical micelle concentration (CMC), Factor affecting the CMC of surfactants, Hydrophobic interaction, Thermodynamics approach to CMC and micellization.

REFERENCES

1. D. A. McQuarrie and J. D. Simon, *Physical Chemistry: A Molecular Approach*, Viva Student Ed., 2011.
2. D. A. McQuarrie, *Quantum Chemistry,* Viva Student Ed., 2014.
3. R. K. Prasad, *Quantum Chemistry*, New Age International Publishers Ltd., New Delhi, 4th revised Ed., 2014.
4. A. K. Chandra, *Introductory Quantum Chemistry*, Tata McGraw Hill, 4th Ed., 1998.
5. I. N. Levine, *Quantum Chemistry*, Pearson, 7th Ed., 2013.

6. P. W. Atkins and J. de Paula, *The Elements of Physical Chemistry*, Oxford, 10th Ed., 2014.
7. P. W. Atkins and R. Friedman, *Molecular Quantum Mechanics*, Oxford University Press, 5th Ed., 2012.
8. B. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 47th Ed., 2017.

Semester: **V**
Course Name: **Organic Chemistry Lab-IV**
Course Code: **2 Credits (0-0-4)**

Separation of organic mixture (at least 4-6 mixtures)

The given mixture of organic compounds will be separated *via* biphasic extraction method. A binary mixture containing strongly acidic, weakly acidic, basic and neutral compounds will be provided from the following list.

1. Strongly acidic compounds: Carboxylic acids, Sulphonic acids
2. Weakly acidic compounds: Phenols, Naphthols
3. Basic compounds: Amines
4. Neutral compounds: Hydrocarbons, Carbohydrates, Amides, Anilides, Diamides, Esters, Nitro compounds, Halogen compounds, etc.

Any other related experiment as desired by the course teacher.

REFERENCES:

1. F. G. Mannand, B. C. Saunders, *Practical Organic Chemistry*, Pearson Education, 2009.
2. B. S. Furniss, A. J. Hannaford, P. W. G, Smith and A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson, 2012.
3. In-house laboratory manual with experimental procedures and relevant information (Department of Chemistry and Chemical Sciences, Central University of Jammu).

Semester: **V**
Course Name: **Physical Chemistry Lab-IV**
Course Code: **2 Credits (0-0-4)**

Electrochemistry

1. Determination of degree of hydrolysis of aniline hydrochloride in 0.001 M solution at room temperature and hence calculate the hydrolysis constant of the salt and dissociation constant of the base.
2. Potentiometric titrations of
   (i) Strong acid with strong base
   (ii) weak acid with strong base
   (iii) dibasic acid with strong base
3. Potentiometric titration of Mohr's salt with potassium dichromate.
4. Determination of the *p*H of a number of buffer solution using quinhydrone electrode
5. Acid hydrolysis of methyl acetate with hydrochloric acid conductometrically.
6. Determine the relative strength of chloroacetic acid and acetic acid by conductance measurement.
7. Determination of the *p*H of different solutions using *p*H-meter
8. Preparation of buffer solutions
   (i) Sodium acetate-acetic acid,
   (ii) Ammonium chloride-ammonium hydroxide

Any other related experiment as desired by the course teacher.

REFERENCES

1. A. Ghoshal, B. Mahapatra and A. K. Nad, *An Advanced Course in Practical Chemistry,* New Central Book Agency Pvt. Ltd., 3rd Ed., 2012
2. B. P. Levitt, *Findley's Practical Physical Chemistry*, Longman Group Limited, 9th Ed., 1954.
3. J. B. Yadav, *Advanced Practical Physical chemistry*, Goel Publishing, 1st Ed., 2015.
4. B. Viswanathan and P. S. Raghavan, *Practical Physical chemistry*, Viva Books Pvt. Ltd., 1st Ed., 2014.

Semester: V
Course Name: Natural Products Chemistry
Course Code: 4 Credits (3-1-0)

UNIT – I **12 hours**

Carbohydrates: Classification, Chemistry of monosaccharides (glucose and fructose), Mechanism of osazone formation, Interconversion of glucose and fructose, Chain lengthening and chain shortening of aldoses, Configuration of monosaccharides, Erythro and threo diastereomers, Mechanism of mutarotation, Introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination, Industrial applications of starch and cellulose.

UNIT – II **12 hours**

Terpenoids: Classification, Isoprene rule, General methods of structural elucidation, Synthesis and stereochemistry of Citral, Geraniol and Menthol.
Carotenoids: Introduction, Structural elucidation and total synthesis of β-carotene.

UNIT – III **12 hours**

Alkaloids: Natural occurrence, General structural features, Physiological action, Occurrence and isolation, General methods of structural determination, Hoffmann's exhaustive methylation, Emde's modification, Synthesis of Coniine, Nicotine and Piperine.

UNIT – IV **12 hours**

Steroids: Occurrence, Nomenclature, Basic skeleton, Diel's hydrocarbon, Stereochemistry, Isolation, Structural determination and synthesis of Cholesterol and Estrone.

UNIT – V **12 hours**

Plant pigments: Occurrence, General methods of structural determination of Flavones and Isoflavones, Synthesis of Quercetin, Cyanidin and Cyanin, Biosynthesis of flavonoids:Acetate pathway.

REFERENCES

1. J. Mann, R. S. Davidson, J. B. Hobbs, D.V. Banthrope and J. B. Harborne, *Natural Products: Their Chemistry and Biological Significance*, Harlow, Essex, England Longman Scientific & Technical, New York, Wiley, 1stEd., 1994.
2. M. Nogradi, *Stereoselective Synthesis A Practical Approach*, 2ndEd., 2008, VCH.
3. K. Hostettmann, M. P. Gupta and A. Marston, Chemistry, *Biological and Pharmacological Properties of Medicinal Plants From the Americas*, 1997, Harwood Academic Publishers.
4. B. A. Bohm, *Introduction to Flavonoids*, 1998, Harwood Academic Publishers.
5. Atta-ur-Rahman M. I. Choudhary, *New Trends in Natural Product Chemistry*, 1998, Harwood Academic Publishers.
6. S. Dev, Insecticides of Natural Origin, 1997, Routledge; 1st Ed., 2017.
7. I. L. Finar, *Organic Chemistry*, Vol. II, ELBS Publishers, 1985.

Semester: V
Course Name: Properties of Inorganic Metal Complexes
Course Code: 4 Credits (3-1-0)

UNIT – I 12 hours

Electronic spectra of transition metal complexes-I: Quantum numbers, Types of electronic transitions, Selection rules for *d-d* transitions, Spectroscopic ground states, Term symbols, Microstates, Spectrochemical series of ligands, Orbital and spin magnetic moments, Orbital contribution, Quenching of magnetic moment, Russel-Saunders Coupling: *l-l* coupling, *J-J* coupling, *L-S* coupling, Derivation of Russell-Saunders terms: p^2, d^2 configuration, Orgel diagram (d^1 to d^9 states), Electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion, Nepheleuxatic effect.

UNIT – II 12 hours

Magnetic properties of transition metal complexes-I: Definition of magnetic properties, Types of magnetic bodies (Diamagnetism, Paramagnetism Ferromagnetism, Ferrimagnetism, and Antiferromagnetism), Mechanism of anti-ferromagnetic interaction, Spin-only formula, Spin orbit coupling, Lande interval rule, Energies of *J*-levels, Curie law, Curie-weiss law, Temperature independent paramagnetism (TIP), Derivation and application of Van-Vleck susceptibility equation, Magnetic exchange coupling and spin crossover (Low spin and high spin cross over), Anomalous magnetic moments, Magnetic properties of binuclear and polynuclear complexes.

UNIT – III 12 hours

Magnetic properties of transition metal complexes-II: Magnetic susceptibility-orbital and spin effects, Importance of magnetic susceptibility, Diamagnetism and Pascals's constant, Gouy's method, Faraday method, Vibrating sample magnetometer, SQUID, NMR method for measuring magnetic susceptibility, Correlation of μs and μeff values, Orbital contribution to magnetic moments, Magnetic properties based on crystal field models: Octahedral, Tetrahedral, Trigonal bipyramidal, Square pyramidal and tetragonally distorted octahedral complexes.

UNIT – IV 12 hours

Metal π-complexes–I: Metal carbonyls, Classification of metal carbonyls, Effective atomic number, Preparation and important reactions (substitution, nucleophilic, electrophilic, reduction reactions) of metal carbonyls, Structure and chemical bonding in metal carbonyls, Preparation of anionic metal carbonyl complexes and substituted metal carbonyl complexes, Vibrational spectra of metal carbonyls for bonding and structural elucidation, Application of metal carbonyls complexes.

UNIT – V 12 hours

Structure, Bonding, and important reactions with transition metals, Metal nitrosyls complexes-Preparation, Structure, Bonding and important reactions with transition metals, Ligating behaviour of tertiary phosphines, Isopoly and heteropoly acids-salts of molybdenum and tungsten.

REFERENCES

1. B. R. Puri, L. R. Sharma and K. K. Kalia, *Principles of Inorganic Chemistry*, 33rd Ed., New Delhi, S. L. N. Chand & Co., 2017.
2. J. E. Huhey, Harpes and Row, *Inorganic Chemistry-Principles of structure and reactivity*, 4th Ed., Pubs: Harper Collins 2006.

3. J. D. Lee, *Concise Inorganic Chemistry*, 5th Ed., Oxford University Press, John Wiley & Sons, 2010.
4. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, *Shriver and Atkins' Inorganic Chemistry*, 5th Ed., Oxford University Press, 2009.
5. A. B. P. Lever, *Inorganic Electronic Spectroscopy*, Elsevier Applied Science, 1984.
6. R. D. Madan, G. D. Tuli and W. U. Malik, *Selected Topics in Inorganic Chemistry*, S. Chand & company, New Delhi, 2010.
7. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, *Shriver and Atkins' Inorganic Chemistry*, 5th Ed., Oxford University Press, 2009.
8. A. Earnshaw, *Introduction to Magnetochemistry*, 1st Ed., Academic Press, 2013.
9. R. L. Carlin, *Magnetochemistry*, Springer Verlag, Berlin, 1986.
10. A. Syamal and R. L. Dutta, *Elements of Magnetochemistry*, 2nd Ed., East-West Press Pvt. Ltd, 2004.
11. F. E. Mabbs, D. J. Machin, *Magnetism and Transition Metal Complexes*, Dover Publications, 2008.

Semester: V
Course Name: Applied Chemistry
Course Code: 4 Credits (3-1-0)

UNIT – I **14 hours**

Polymers: Monomers and their functionality, Classification, Degree of polymerization, Type of polymerization, Addition and condensation polymerization, Mechanism of free radical, cationic, anionic and Ziegler-Natta polymerizations, Stereochemistry of polymer, Thermo and thermosetting plastics, Preparation, properties and uses of Polythene, Polystyrene, PVC, Phenol-formaldehydes, Nylons, Kevlar, Terylene, Rubber: natural and synthetic rubbers, Silicone rubber, Functional polymers-Fire retarding polymers and electrically conducting polymers, Biomedical polymers-contact lens, dental polymers artificial heart, kidney, skin and blood cells.

UNIT – II **12 hours**

Dyes and paints: Classification of dyes, Synthetic dyes: Methyl orange, Congo red, Malachite green, Crystal violet, Primary constituents of a paint, Binders and solvents for paints, Oil based paints, Latex paints, Constituents of varnishes.

Soaps and detergents: Soap action, Raw materials for soaps, Classification and manufacture of soaps, Batch process, Continuous process, Difference between soap and detergent, Active ingredients in detergents, Anionic surfactant, Cationic surfactant, Amphoteric surfactant and Nonionic surfactant.

UNIT – III **12 hours**

Food additives: Food additives, Definition, Classification, Functions, Artificial sweeteners, Food flavors, Food colour, Acidulants, Antioxidants, Alkalies, Edible emulsifiers and edible foaming agents, Baking powder, Yeast, Sequesterants, Taste enhancers, Uses and abuses of these substances in food beverages.

Food preservation and processing: Food deterioration, Methods of preservation and processing, Food preservatives, Methods of preservation, Packaging of foods

UNIT – IV **10 hours**

Cement: Type of cements, Raw material for manufacture, Manufacture of Portland cement, Manufacturing processes, Dry process, Wet process, Setting of cement, Hydrolysis, Hydration, Properties of cement, Role of gypsum in cement, Special type cements, High alumina cement, White cement, Mortar, Concrete and RCC, Curing and decay of concrete.

Glass: Physical and chemical properties of glass, Raw materials, Manufacture of glass by potand tank furnaces, Types of glass, Tempered glass, Laminated glass, Water glass, Optical glass, Borosilicate glass, Lead glass, Safety glass, Fibre glass, Insulating glass.

UNIT – V **12 hours**

Fertilizers: Plant nutrients and its role, Classification of fertilizers, Properties of fertilizers, Nitrogenous fertilizers and its manufacture: Ammonium nitrate, Ammonium sulphate, Urea, Calcium cyanamide, Manufacture of phosphate fertilizer: Normal super phosphate, Triple super phosphate, Mono-ammonium phosphate, Diammonium phosphate, Potassium fertilizer, NPK fertilizer, Bio-fertilizers, Formulation and utilization.

Pesticides and insecticides: Classification of pesticides with examples and their modes of action, Organic and inorganic pesticides, Biopesticides, Impact of pesticides on soil, plants and environment.

REFERENCES

1. F. W. Billmeyer, *Textbook of Polymer Science*, John Wiley & Sons, Inc, 3rd Ed., 2007.
2. V. R. Gowariker, N. V. Viswanathan and J. Sreedhar, *Polymer Science*, New Age International (P) Ltd. Pub, 2ndEd., 2015.
3. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., 2010.
4. G. N. Pandey, *Text Book of Chemical Technology*, Vol. 1 Chand Publishers House, 2018.
5. E. Stocchi, *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK, 1990.
6. R. M. Felder and R. W. Rousseau, *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi, 3rd Ed., 2014.
7. P. C. Jain and M. Jain, *Engineering Chemistry*, 16th Ed., Dhanpat Rai and Sons, Delhi, 2013.
8. T. P. Coultate, *Food-The Chemistry of its components*. Royal Society of Chemistry London, 2009.
9. M. Swaminathan, *Text Book on Food and Nutrition*, Printing and Publishing CO., Ltd., Bangalore. 2018.
10. M. F. Ali, B. M. El Ali and J. G. Speight, *Handbook of Industrial Chemistry: Organic Chemicals*, McGraw-Hill Education, 2005.
11. B. K. Sharma and H. Gaur, *Industrial Chemistry*, 19th Edition, Goel Publishing House, Meerut, 2016.
12. H. R. Alcock and F.R. Lambe, *Contemporary Polymer Chemistry*, Prentice Hall, 3rd Ed., 2003.

Semester: **V**
Course Name: **Applied Chemistry Lab**
Course Code: **2 Credits (0-0-4)**

Technical Analysis (At least eight experiments)

1. Estimation of iodine in antiseptic drug through drug analysis.
2. Estimation of available chlorine in the given bleaching powder sample.
3. Estimation of manganese dioxide in pyrolusite.
4. Determination of CaO in the given sample of commercial lime.
5. Estimation of nitrogen in a given fertilizer (inorganic).
6. Determination of iodine value of an oil sample.
7. Determination of saponification value of an oil sample.
8. Determination of percentage composition of a mixture of sodium hydroxide and sodium chloride.
9. Determination of amount of dissolved oxygen in water.
10. Determination of total, permanent and temporary hardness of water.

Any other related experiments as desired by the course teacher.

REFERENCES

1. V. V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Ed., 1974, National Publishing Company, Chennai.
2. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denny, *Vogel's Text Book of Inorganic Qualitative Analysis*, 4th Ed., 1974, ELBS, London.
3. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, *Basic Principles of Practical Chemistry*, 2nd Ed., 2017, Sultan Chand and Sons, New Delhi.

Semester: **VI**
Course Name: **Organic Chemistry-V**
Course Code: **4 Credits (3-1-0)**

UNIT – I **12 hours**

UV-Vis spectroscopy: Introduction, Absorption laws, Instrumentation, Formation of absorption bands, Types of electronic transitions, Chromophores, Auxochromes, Absorption and intensity shifts, Solvent effects, Woodward-Fieser rules for calculating absorption maximum in dienes and α,β-unsaturated carbonyl compounds.

IR spectroscopy: Introduction, Theory of molecular vibrations, Vibrational frequency, Factors influencing vibrational frequencies, Finger print region, Applications of IR spectroscopy in functional group analysis, Effect of hydrogen bonding, conjugation, resonance and ring size on IR absorptions.

UNIT – II **12 hours**

NMR Spectroscopy: Basic principles of proton magnetic resonance, Instrumentation, Number of signals, Position of signals (Chemical shift), Shielding and deshielding effects, Factors influencing chemical shifts: Inductive effect, Anisotropic effect in alkenes, alkynes, aldehydes and aryl compounds, Hydrogen bonding, Splitting of signals, Spin-spin coupling, Coupling constant, Introduction to ^{13}C NMR.

UNIT – III **12 hours**

Introduction to mass spectrometry: Instrumentation, Ionization, Fragmentation, Molecular ion peak, Base peak, Isotopic peaks, Nitrogen rule, McLafferty rearrangement, Retro Diels-Alder reaction.

Applications of spectral techniques: Structural determination of simple organic compounds using UV, IR and NMR spectral data.

UNIT – IV **12 hours**

Heterocyclic compounds-I: Classification and nomenclature, Methods of formation of five membered heterocycles: Furan, Thiophene and Pyrrole, Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis, Aromatic characteristics of pyrrole, furan and thiophene, Chemical reactions, Mechanism of electrophilic substitution.

Six membered heterocycles, Methods of formation of pyridine and pyrimidine, Mechanism of nucleophilic substitution reactions in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole.

UNIT – V **12 hours**

Heterocyclic compounds-II: Introduction to condensed five- and six-membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline, Fischer indole synthesis, Madelung synthesis, Skraup synthesis, Friedländer synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski synthesis, Pictet-Spengler reaction, Pomeranz-Fritsch reaction.

REFERENCES

1. R. M. Silverstein, F. X. Webster, D. V. Kiemle and D. L. Bryce, *Spectrometric Identification of Organic Compounds*, 8th Ed., Wiley, 2014.
2. P. S. Kalsi, *Spectroscopy of Organic* Compounds, 8th Ed., New Age International, 2020.
3. W. Kemp, *Organic Spectroscopy*, 2nd Ed., Macillan, 2019.

4. D. H. Williams and I. Fleming, *Spectroscopic Methods in Organic Chemistry*, 6th Ed., McGraw Hill Education, 2011.
5. T. L. Gilchrist, *Heterocyclic Chemistry*, 3rd Ed., Addison Wesley Longman Limited, 1997.
6. R. R. Gupta, M. Kumar and V. Gupta, *Heterocyclic Chemistry, Vol. I, II and III*, Springer Nature, 2011.
7. J. A. Joule, K. Mills and G. F. Smith, *The Chemistry of Heterocycles*, 3rd Ed., Chapman and Hall, 1995.
8. *Comprehensive Heterocyclic Chemistry*, A.R. Katritzky and C.W. Rees (Eds.), Vol I-VIII, Ist Ed., Pergamon Press.
9. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, *Organic Chemistry*, 7th Ed., 2010.
10. I. L. Finar, *Organic Chemistry*, Vol. I and II, 6th Ed., 2002.

Semester: **VI**
Course Name: **Physical Chemistry-V**
Course Code: **4 Credits (3-1-0)**

UNIT – I **12 hours**

Spectroscopy: Introduction: Electromagnetic radiation, Regions of the spectrum, Basic elements of practical spectroscopy, Lambert-Beer Law, Width and intensity of spectral lines, Statement of Born-Oppenheimer approximation.

Rotational spectroscopy: Diatomic molecules, Energy levels of a rigid rotor (semi-classical principles), Selection rules, Spectral intensity, Distribution using population distribution (Maxell- Boltzmann distribution), Rigid diatomic molecule, Non-rigid rotator, Spectrum of non-rigid rotator, Polyatomic molecules, Determination of bond length, Isotope effect.

UNIT – II **12 hours**

Vibrational spectroscopy: Infrared spectrum: Energy levels of simple harmonic oscillator, Selection rules, Pure vibrational spectrum, Intensity, Determination of force constant and qualitative relation of force constant and bond energies, Effect of anharmonic motion and isotope on the spectrum, Idea of vibrational frequencies of different functional groups, Vibration–rotation spectroscopy, P-branch and R-branch.

Raman spectroscopy: Concept of polarizability, Stokes and Anti-Stokes lines, Pure rotational and pure vibrational Raman spectra of diatomic molecules, Selection rules, Mutual Exclusion.

UNIT – III **12 hours**

Electronic spectroscopy: The characteristics of electronic transitions, Electronic spectroscopy of atoms, Term symbol, Photoelectron spectroscopy, Electronic spectroscopy of molecules, Selection rules, Vibrational structure and Franck-Condon principle, Franck-Condon factor, Concept of HOMO-LUMO transitions, Simple Dissociation energy, Pre-dissociation, Quantum yield and radiative processes, Fluorescence and phosphorescence, Jablonski diagram, Internal conversion and intersystem crossing.

UNIT – IV **12 hours**

Photochemistry: Generation of excited states, Singlet and triplet states, Spin-orbit coupling, Kinetics of photophysical and photochemical processes, Timescales, The primary quantum yield, Mechanism of decay of excited singlet states, Quenching, Stern-Volmer equation and its applications, Flash photolysis, Laser flash photolysis, Lasers and their applications.

UNIT – V **12 hours**

Computers in chemistry: General introduction to computers, Different components of a computer, Hardware and software, Conceptual background of theory, Computations and molecular modeling, Z-matrix, Potential energy surfaces and chemical properties, Cost and efficiency, algorithms, Elementary ideas of molecular mechanics and force fields, Parameterization, Potential energy functional forms, Conceptual ideas of Molecular orbital methods, Concept of equilibrium structures, Transition state structures and harmonic frequency calculations, Born-Oppenheimer approximation, Awareness of computational chemistry software, Introduction to computer languages, Programming and operating systems.

REFERENCES

1. P. W. Atkins and J. de Paula, *The Elements of Physical Chemistry*, Oxford, 10th Ed., 2014.

2. B. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 47th Ed., 2017
3. C. Banwell and E. McCash, *An Introduction to Molecular Spectroscopy*, McGraw Hills, 4th Ed., 1994.
4. C. Banwell, C. McCash and H. Chaudhury, *Fundamentals of Molecular Spectroscopy,* McGraw Hill Education, 4th Ed., 2013.
5. J. Michael Hollas, *Modern Spectroscopy*, Wiley, 4th Ed., 2004.
6. K. K. Rohatgi-Mukerjee, *Fundamentals of Photochemistry*, Wiley Eastern Ltd., 1986.
7. C. J. Cramer, *Essentials of Computational Chemistry*, Wiley-Blackwell, 2nd Ed., 2004.
8. F. Jensen, *Introduction to Computational Chemistry*, Wiley, 2nd Ed., 2007.
9. On-line manual of *Gaussian 16* and *GAMESS.* www.gaussian.com and www.msg.ameslab.gov/gamess
10. T. Engel and P. Reid, *Physical Chemistry*, Pearson, 2nd Ed., 2010.

Semester: **VI**
Course Name: **Organic Chemistry Lab-V**
Course Code: **2 Credits (0-0-4)**

Part A: Quantitative estimation of organic compounds:

1. Estimation of aniline (Bromate-bromide method)
2. Estimation of glucose (Fehling's method)
3. Estimation of phenol (Bromate-bromide method)
4. Estimation of ascorbic acid in Vitamin C tablets
5. Estimation of amino acid

Part B: Organic Spectroscopy:

1. Record of the UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water and comment on the effect of structure on the UV spectra of organic compounds.
2. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

Any other related experiment as desired by the course teacher.

REFERENCES:

1. F. G. Mann and B. C. Saunders, *Practical Organic Chemistry*, Pearson Education, 2009.
2. B. S. Furniss, A. J. Hannaford, P. W. G, Smith and A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson, 2012.
3. In-house laboratory manual with experimental procedures and relevant information (Department of Chemistry and Chemical Sciences, Central University of Jammu).

Semester: **VI**
Course Name: **Physical Chemistry Lab-V**
Course Code: **2 Credits (0-0-4)**

Part A: Spectroscopy

1. Determination of the specific rotation of a given optically active compound.
2. Determination of the λ_{max} for different colour solutions by colorimetric measurements.
3. Verify Beer- Lambert Law for a coloured solution ($KMnO_4$/$K_2Cr_2O_7$, etc.).
4. Determination of indicators constant (pK_{In}) of methyl red colorimetrically.
5. Study of the formation of a complex between ferric and thiocyanate (or salicylate) ions.

Part B: Electrochemistry

1. Study of titration of a mixture of hydrochloric acid and oxalic acid conductometrically.
2. Determine the concentration of each component in the following solutions:
   a) HCl and NH_4Cl in a solution
   b) NH_4OH and NH_4Cl in a solution

Part C: Computer in Chemistry

1. Study of simple control commands of *vi* editor embedded in a Linux box.
2. Plotting a linear graph using MS excel and Xmgrace from a given set of data set.
3. Plotting a non-linear graph using a given data set.
4. Study of quantum chemistry using computational chemistry software:
   a) Determination of the Z-matrices (Cartesian coordinate) of simple molecules: H_2, H_2O, H_2O_2, H_2CO, etc.
   b) Draw 3D structures of complex molecules using GaussView and determination of Z-matrices.

Any other related experiment as desired by the course teacher.

REFERENCES

1. A. Ghoshal, B. Mahapatra and A. K. Nad, *An Advanced Course in Practical Chemistry,* New Central Book Agency Pvt. Ltd., 3rd Ed., 2012
2. B. P. Levitt, *Findley's Practical Physical Chemistry*, Longman Group Limited, 9th Ed., 1954.
3. J. B. Yadav, *Advanced Practical Physical chemistry*, Goel Publishing, 1st Ed., 2015.
4. B. Viswanathan and P. S. Raghavan, *Practical Physical chemistry*, Viva Books Pvt. Ltd., 1st Ed., 2014.
5. On-line manual of *Gaussian 16 and GauessView,* www.gaussian.com

Semester: **VI**
Course Name: **Selected Topics in Inorganic Chemistry**
Course Code: **4 Credits (3-1-0)**

UNIT – I **12 hours**

Oxidation and reduction: Oxidation number, Redox potential, Half-cell reaction, Nernst equation (without derivation), Electrochemical series, Use of redox potential data–Analysis of redox cycle, Redox stability in water, Latimer diagram for oxygen, copper (acidic medium) and for chlorine (acidic/alkaline medium), Calculation of E values for skip-step couples using EMF diagrams, Frost diagrams for oxygen and nitrogen, Pourbiax diagram for iron couple, Applications of redox reactions to the extraction of elements from their ores: Ellingham diagrams.

UNIT – II **10 hours**

Chemistry of lanthanides elements: Position of lanthanides in the periodic table, Occurrence and isolation, Electronic configuration, Oxidation states, Ionic radii, Magnetic and spectral properties, Complex formation, Lanthanide contraction, Application of lanthanides.

UNIT – III **12 hours**

Chemistry of actinides elements: Position of actinides in the periodic table, Occurrence and isolation, Electronic configuration, Oxidation states, Ionic radii, Magnetic and spectral properties, Complex formation, Separation of lanthanides: Ion-exchange method, Principles of separation of Np, Pu and Am from U, Application of actinides, Trans-uranium elements.

UNIT – IV **12 hours**

Nuclear chemistry and radioactivity-II: Introduction to radioactivity: Radioactive decay and equilibrium, Q value, Cross sections, Radioactive techniques, Tracer technique, Neutron activation analysis, Counting techniques such as G.M. ionization and proportional counter, Radioactive disintegration, Half life, Average life, Artificial transmutation, Decay kinetics, Types of decay, α-, β-, γ-emissions, Different radioactive series (natural and artificial), Group displacement law, Chemical reaction pathways and dating techniques, Mass defect and binding energy, Application of radioactivity and radio isotopes as tracers in analysis, in medicines, in biological field, in agriculture and in carbon dating.

UNIT – V **14 hours**

General principles of bioinorganic chemistry: Introduction to bio-inorganic chemistry, Classification of elements (essential and trace) in biological system with special reference to Na^+, K^+ and Mg^{2+} ions, Sodium-potassium pump (Na^+/K^+ pump), Nitrogen fixation-Biological and Chemical, Role of Mg^{2+} ion in energy production and chlorophyll, Hemoglobin and Myoglobin-Electronic and spatial structures, Protein-Classification, Structures, Functions, Role of proteins with reference to bones.

REFERENCES

1. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, *Shriver and Atkins' Inorganic Chemistry*, 5th Ed., Oxford University Press, 2009.
2. B. Douglas, D. McDaniel and J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3rd Ed., John Wiley & Sons, 2010.
3. B. R. Puri, L. R. Sharma and K. K. Kalia, *Principles of Inorganic Chemistry*, 33rd Ed., New Delhi, S. L. N. Chand & Co., 2017.

4. J. E. Huhey, Harpes and Row, *Inorganic Chemistry-Principles of structure and reactivity*, 4th Ed., Pubs: Harper Collins 2006.
5. J. D. Lee, *Concise Inorganic Chemistry*, 5th Ed., Oxford University Press, John Wiley & Sons, 2010.
6. G. L. Miessler P. J. Fischer, D. A. Tarr, *Inorganic Chemistry*, 5th Ed., Pearson, 2014.
7. R. Gopalan and V. Ramalingam, Concise *Coordination Chemistry*, 1st Ed., S. Chand, 2008.
8. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, 6th Ed., , John Wiley & Sons, 2008.
9. R. D. Madan, G. D. Tuli and W. U. Malik, *Selected Topics in Inorganic Chemistry*, S. Chand & company, New Delhi, 2010.
10. H. J. Arnikar, *Essentials of Nuclear Chemistry*, New Age International Private Limited, 4th Ed., 2011.
11. M. Sharon and M. Sharon, *Nuclear Chemistry*, Ane Books, 2nd Ed., 2018.
12. S. J, Lippard and J. M. Berg, *Principles of Bioinorganic Chemistry*, University Science Books, 1994.
13. R. Crichton, Biological Inorganic Chemistry-A New Introduction to Molecular Structure and Function, 3rd Ed., 2018.

Semester: **VI**
Course Name: **Project/Dissertation**
Course Code: **6 Credits (0-0-12)**

The students will identify a research problem and execute it under the supervision of a faculty member. They will learn literature survey, basic experimental and analytical techniques and carry out the research work. The research finding will be documented and a dissertation will be submitted. The students will deliver a power point presentation at the end of semester examination.