

M.SC. CHEMISTRY THIRD SEMESTER

Course Title: APPLIED INORGANIC CHEMISTRY	Course Code: HCT31
Teaching Hours/Week (L-T-P): 4 - 0 - 0	No. of Credits: 04
Internal Assessment: 20 Marks	Semester End Examination: 80 Marks

Course objectives:

1.	To acquaint with the applications of organometallic chemistry
2.	Understand the importance and applications of nuclear chemistry
3.	To gain knowledge on bioinorganic chemistry related to biological processes
4.	To provide advanced aspects of halogen chemistry

Unit	Description	Hours
01	Reactions and Catalytic Applications of Organometallic Compounds Fundamental reactions: Substitution in carbonyl complexes, Mechanisms, Insertion reactions, CO, SO ₂ , olefin insertions, oxidative additions, one electron, addition of oxygen, reductive elimination, CH activation, Use of Organometallic Compounds as catalysts – Catalytic behaviour – Homo catalysis –. Anchoring of Catalysts Hydrogenation. Hydrogenation of olefins (oxo reaction-cobalt and rhodium oxo catalysts), carbonylation of alcohols – Monsanto acetic acid process, Wacker process. Polymerization of olefins and acetylenes: Ziegler – Natta catalysis systems. Fischer – Tropsch reaction, Water Gas Shift reactions.	15hrs
02	Bioinorganic Chemistry-I Metal ions in biological systems, essential and trace metals, disease due to metal deficiency and treatment: Iron, zinc, copper, manganese, sodium, potassium, magnesium and calcium. Metal complexes as therapeutic agents: Metal complexes in cancer therapy, metal complexes for the treatment of rheumatoid arthritis, vanadium in diabetes, metal complexes as radio diagnostic agents. Treatment of toxicity due to inorganics: Chelation therapy and requirements of a chelate/antidote. Mechanism of antidotes with poison rendering it inert: Arsenic, lead, mercury, iron, copper, plutonium, cyanide and carbon monoxide poisoning. Ion transport across membranes and active transport of ions across biological membranes, ionophores. Metal complexes in transmission of energy: Chlorophyll, photo systems-I and II in cleavage of water and model systems.	15hrs
03	Nuclear Chemistry Nuclear Stability – Mass Defect and Binding Energy.. Radioactivity: Radioactive elements, general characteristics of radioactive	15hrs

	decay, interaction of α , β and γ – rays with matter. Nuclear reactions Types of nuclear reactions, Nuclear fission. Applications of Radioactivity: Synthesis of various useful isotopes, use of isotopes in the elucidation of reaction mechanism, structure determination, kinetics of exchange reactions, measurement of physical constants including the diffusion constants, isotope dilution techniques, NAA, PGNAA, neutron absorptiometry and age determination, radio isotopes in field of medicine	
04	Chemistry of Lanthanides and Actinides. Lanthanide series: Review on electronic structure, oxidation states, spectral and magnetic properties, lanthanide contraction, abundance and extraction. Lanthanides as shift reagents. Separation of lanthanides: Solvent extraction and ion–exchange. Chemical properties of compounds of lanthanides in II, III, and IV oxidation states. Actinides: Review on Electronic structure and position in the periodic table, oxidation states, occurrence and synthesis of the elements. Spectral and magnetic properties of compounds of actinides in comparison with those of lanthanides and d-block elements. Trans actinides Chemistry of Trans – uranium elements.	15hrs
References: 1. Inorganic Chemistry-Principles of Structure and Reactivity, 4thEdn-J. E. Huheey, E.A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education (2009). 2. Shriver & Atkins' Inorganic Chemistry, 5th Edn-P. Atkins, Tina Overton, J. Rourke, Mark Weller and F.Armstrong.Oxford University Press (2010) 3. Concepts and models of Inorganic Chemistry-B.Douglas, D. McDaniel & J.Alexander, 3rd Edn. Wiley Student Edn.(2013). 4. Fundamentals of photochemistry-K. K. Rohatgi-Mukherjee, Revised Edn. New Age International. 5. Ferraudi G. L, Elements of Inorganic photochemistry, Wiley Eastern, 1988 6. Photochemistry and Photophysics of Ru(II) polypyridine complexes in the Bologna group. From early studies to recent developments, Coordination chemistry reviews, Vincenzo Balzani, Alberto Juris, 211, 97-115 ((2001). 7. F.A.Cotton and G.Wilkinson : Advanced Inorganic Chemistry, Wiley, 1991. 8. Environmental Chemistry-A. K. De (Wiley Eastern). 9. Environmental Chemistry-S. K. Banerji, (Prentice Hall India), 1993.		

Course outcomes:

1.	Acquaint and able to apply organometallic reactions.
2.	Learn to apply nuclear chemistry to related applications
3.	Able to prepare and comment on properties of various halogen compounds
4	Gain knowledge on the importance of inorganic chemistry in biological processes

Course Title: INORGANIC CHEMISTRY PRACTICALS-III	Course Code: HCP31
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 10 Marks	Semester End Examination: 40 Marks

Course objectives:

1.	To acquaint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge o the analsis of natural samples.

List of Experiments:

60 hrs

1.	Estimation of CaO in cement using EDTA.
2.	Estimation of copper in brass.
3.	Analysis of pyrolusite ore.
4.	Analysis of steel
5.	Estimation of Iron content in Heamatite
6.	Estimation of Calcium and Magnesium by complexometric titrations
7.	Colorimetric determination of Fe and Ni.

References:

1.	Vogel's Text book of Quantitative Inorganic Analysis – J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longamans Green and Company Ltd.
2.	Practical Inorganic Chemistry-G.Pass and H.Sutchliff
3.	General Chemistry Experiment- A.J.Elias
4.	Practical Inorganic Chemistry, G. Marr and B. W. Rockett, VonNostrand Reinhold Co., London 1972.

Course outcomes:

1.	Evaluate the industrial products for quantitative analysis
2.	Capable to perform spectrophotometric analysis

Course Title: THEORETICAL AND SOLID STATE CHEMISTRY	Course Code: HCT32
Teaching Hours/Week (L-T-P): 4 - 0 - 0	No. of Credits: 04
Internal Assessment: 20 Marks	Semester End Examination: 80 Marks

Course objectives:

1.	Understand the concepts of thermodynamics and statistics
2.	Gain knowledge in the area of quantum chemistry
3.	Study the solid state properties of materials
4.	Acquaint with the knowledge of colloids

Unit	Description	Hours
01	Statistical Thermodynamics and Quantum Statistics: Microstates' and Microstates, Assemblies of localized and Non-localized systems, Phase space, γ-Space, μ-Space, Ensembles and its types. Classical Statistics: Maxwell-Boltzman distribution law for ideal gases and mixture of gases equipartition of energies, Maxwell-Boltzman distribution of velocities and energies(no derivation). Quantum Statistics: Relationships between probabilities and entropy, Sterling approximation. Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Statistics and comparison between them. Heat capacity of Ortho-Para hydrogen systems. Einstein's heat capacity for solids. Partition Function: Definition and separation of partition functions. Translational, Vibrational, Rotational and Electronic partition functions for Monoatomic, Diatomic, and Polyatomic gaseous molecules. Sackur-Tetrode equation. Calculation of thermodynamic quantities in terms of partition functions, Residual entropy.	15hrs
02	Quantum Chemistry: Review of concepts of operators. Applications of Schrödinger wave equation to Hydrogen like atoms, rigid Rotor, Harmonic oscillators and Hartree Self consistent field theory. Ab initio and Density functional analysis. Approximation Methods-Variation theory and Perturbation theory (zero, first,). MO Theory: MO Theory of Hydrogen molecule and ion, Bonding and Anti-bonding orbitals. Examples of MO of simple HOMO and HETERO nuclear molecules. Notations of few molecular orbitals, correlation diagrams and Non-crossing rules, Simple Huckel theory of linear conjugated systems (HMO) and applications to systems like, ethylene and butadiene molecules. VB Theory: Secular equation and determinants, Columbic, exchange and overlap integrals. VB theory of H₂ molecule. Comparison of VB and MO	15hrs

	theories.	
03	Solid State Chemistry: Solid state reactions: General principles and classification of reactions Methods of Single Crystal Growth: Solution growth; Melt Growth-Bridgeman, Instrumentation Thermal analysis: TGA, DTA, DSC (Instrumentation, applications in characterizing solid materials) Electrical properties: Band theory of solids; semiconductors - extrinsic and intrinsic, Hall effect; thermoelectric effects (Seebeck); Fermi energy levels and their determination for semiconductors. ferroelectric, pyroelectric and piezoelectric properties; ionic and superionic conductors. Superconductivity: Basics, discovery and high T_c materials Magnetic properties: dilute and concentrated magnetic systems. Dia, para, ferro, ferri, and antiferro magnetic types; soft and hard magnetic materials; select magnetic materials such as spinels, garnets and perovskites and hexaferrites magnetoresistance and giant magnetoresistance. Understanding. Optical properties optical, reflectance, photoconductance structure and properties of amorphous materials (glasses) and zeolites	15hrs
04	Thermodynamics, Non-equilibrium Thermodynamics and Colloids: Solutions: Introduction, partial molar quantities, Gibb's function of mixing and other thermodynamic mixing functions (Gibbs-Duhmen and Duhmen-Margules equations), chemical potential of liquids and liquid mixtures, Excess function for non-ideal solutions. Non-equilibrium Thermodynamics: Microscopic reversibility, entropy production in irreversible process. Different types of forces and fluxes, stationary states. phenomenological equations. Onsagar's reciprocity relations (quantitative), Principle of minimum entropy production, phenomenological in non-linear region. Colloids: Electro kinetic phenomena of colloids, Classification of Surface active agents, Critical Micellar concentration (CMC), determination of Surface tension by different Method'.	15hrs
References : 1. Theoretical Chemistry- Glasstone. 2. Statistical Mechanics- Davidson. 3. Elements of Statistical Thermodynamics- E. K. Nash 4. Statistical Thermodynamics- M.C.Gupta 5. Introduction to Quantum Chemistry- A.K.Chandra 6. Quantum Chemistry- R.K.Prasad 7. Textbook of Quantum Mechanics-P M Mthews & P Venkateshan 8. Problems in Quantum Mechanics- G.L.Squiras. 9. Introduction to Solids- I. V. Azarrof. 10. Solid State Chemistry- A.R.west 11. Modern aspects of Solid State Chemistry- Ed. By C.N.Rao		

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| 12. New direction in Solid State Chemistry- C.N.Rao & Gopal Krishnan |
| 13. Thermodynamics by L.M. Koltz & R.M. Rosenberg |
| 14. Thermodynamics by Glasstone |
| 15. Physical Chemistry by P.W. Atkins. |
| 16. Molecular Quantum Chemistry by A. J. Atkins. |
| 17. P. Ball, Designing the Molecular World: Chemistry at the Frontier, |

Course outcomes:

1.	Able to apply thermodynamic aspects in chemical reactions
2.	Apply quantum chemistry aspects for various compounds
3.	Interpret the the properties of solid state materials and colloids

Course Title: PHYSICAL CHEMISTRY PRACTICALS-III	Course Code: HCP32
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 10 Marks	Semester End Examination: 40 Marks

Course objectives:

1.	To acquaint with the conductometric and potentiometric titrations
2.	Study of kinetics, phase diagram, etc
3.	Gain knowledge on the surface tension.

List of Experiments:

1.	Kinetic study of iodination of an acetone
2.	Study of kinetics of inversion of cane sugar by Polarimetry
3.	Phase diagram of three component system.
4.	Titration of p-Toludine against HCl by conductometry.
5.	Determination of end point of some typical titrations. (Precipitation & replacement) conductometrically.
6.	Potentiometric titration of o-phosphoric acid against alkalies NaOH.
7.	Potentiometric titration of halide mixture against AgNO ₃ .
8.	Titration of mixture of HCl, AcOH, CuSO ₄ against conductometrically
9.	Determination of equivalent conductance at infinite dilution of a strong electrolyte and verification of Onsager's law.
10.	Potentiometric titration of Pb(NO ₃) ₂ vs EDTA
11.	Potentiometric titration of mixture of weak acids, CH ₃ COOH, ClCH ₂ COOH Vs NaOH Estimation of metal ions solution by polarographic method.
12.	Determination of surface tension.

References:

1.	Fridley's Practical Physical Chemistry- B.P.levitt.
2.	Advanced Practical Physical Chemistry- G.B.Yadav
3.	Experiments Practical Physical Chemistry- Shomaker
4.	Systematic experimental Physical Chemistry- S.W.Rajbhoj & T.K.Chondeker
5.	Senior Physical Chemistry Practical- Kholsa et.al

Course outcomes:

1.	Evaluate the conductometric and potentiometric titrations
2.	Capable to perform kinetics of reactions

Course Title: SPECTROSCOPY	Course Code: HCT33
Teaching Hours/Week (L-T-P): 4 - 0 - 0	No. of Credits: 04
Internal Assessment: 20 Marks	Semester End Examination: 80 Marks

Course objectives:

1.	To understand the basic concepts of spectroscopy
2.	To gain knowledge on principle and instrumentation
3.	To familiarize with the working and applications

Unit	Description	Hours
01	IR Spectroscopy IR Spectroscopy: Basic principles of vibrational spectroscopy, Theory of Infrared Absorption, Vibrational modes and molecular vibrations, calculation of vibrational frequencies. Relationship between molecular structure and IR spectra.Instrumentation:Types of IR spectrometers, Single beam and double beam, Key components: source, interferometer, detector, Quantitative Analysis with IR Spectroscopy: Basics of Quantitative Analysis, Beer-Lambert Law and its application in IR spectroscopy, Calibration methods for quantitative measurements, Sample Preparation and Handling of solid, liquid, and gaseous samples, interpretation of IR spectra, factors affecting group frequencies and band shapes. IR spectra of coordination modes of ligands like nitrate, thiocyanate, sulphate, carbonate (bridging, bidentate etc.,) and water.Applications in Analytical Chemistry. Advanced IR Techniques: ATR (Attenuated Total Reflection) Spectroscopy: Principles and applications, Advantages over traditional transmission measurements.	15hrs
02	HNMR Spectroscopy Introduction – Nuclear spin and magnetic moment, origin of NMR spectra, Theory of NMR spectroscopy, resonance flipping, instrumentation and sampling, interpretation of NMR spectrum, equivalent and non-equivalent protons, chemical shifts(down field and up field), factors influencing chemical shifts, anisotropic effects, NMR scale, units, internal references, simple and complex splitting / coupling, coupling constant, correlation chart of chemical shifts, spin-spin relaxations, equivalence of protons–chemical and magnetic equivalence, spin– systems. solvent effects and Nuclear Overhauser Effect. Karplus relationships (Karplus curve–variation of coupling constant with dihedral angle), double resonance techniques, first order and second order patterns, lanthanide shift reagents, exchange phenomena. . High resolution ¹H NMR. FT NMR and its advantages.	15hrs

	Applications of NMR spectroscopy in structure elucidation of simple organic and inorganic molecules. Pulse techniques in NMR, two dimensional and solid state NMR. Use of NMR in Medical diagnostics. Deuterium exchange techniques limitations of H NMR spectroscopy .	
03	Introduction and applications of ^{13}C NMR spectroscopy, Broad band and off resonance coupling methods of detection. ^{13}C Chemical shifts of different classes of organic compounds—alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds. 2 DNMR spectroscopy, use of PMR spectrum in structural elucidation of organic compound. ^{31}P and ^{19}F NMR. COSY, NOESY (Nuclear Overhauser Effect) and EXSY (Exchange Spectroscopy), MRI. Conformational analysis, keto-enol tautomerism, Hbonding. Spectra of simple organic molecules, phosphates, polyphosphates, PH_3, phosphor halides, fluoro acetic acid, SF_4, P_4S_4, HPF_2. Raman Spectroscopy: Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Classical theory of Raman Effect – rotational Raman spectra – Linear – Vibrational Raman Spectra, rule of mutual exclusion principle. Instrumentation. Resonance Raman Spectroscopy: Resonance Raman Effect and its applications. Non-linear Raman effects: Hyper, stimulated and inverse Raman effects. Coherent Anti-Stokes Raman Scattering and its applications..	15hrs
04	Mass Spectroscopy: Introduction, Basic theory, ionisation, types of ions, molecular ion, fragment ion, meta stable ion, base peak, instrumentation, factors affecting fragmentation, intensity of M^+ peaks of alkanes, alkenes, alkynes, alcohols, amines, aldehydes and other compounds, McLafferty rearrangement nitrogen rule, some simple examples of fragmentations, applications of mass spectrometry. Advanced Mass Spectrometry Techniques: Introduction to advanced MS techniques such as tandem MS (MS/MS) and high-resolution MS (HRMS). Gas Chromatography (GC): Principle, instrumentation, columns, detectors (thermal conductivity, flame ionization, electron capture, mass spectrometry), factors affecting separation, applications, GC-MS and its applications. High-Pressure Liquid Chromatography (HPLC): Apparatus, pumps, column packing, characteristics of detectors (UV, IR, refractometer, fluorescence), advantages, applications, HPTLC, and its applications. Hyphenated Techniques: Introduction to hyphenated techniques like LC-MS/MS and GC-MS/MS. Advantages and applications of combining chromatography with mass spectrometry.	15hrs
References:		

1. Mass Spectrometry: Principles and Applications" by Edmond de Hoffmann and Vincent Stroobant (John Wiley & Sons).
2. Interpretation of Mass Spectra by Fred W. McLafferty and František Tureček (University Science Books).
3. Mass Spectrometry in Chemistry and Biochemistry by Victor R. Preedy (CRC Press).
4. "Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation" by J. Throck Watson and O. David Sparkman (John Wiley & Sons).
5. "Liquid Chromatography-Mass Spectrometry: An Introduction" by Robert E. Ardrey (John Wiley & Sons).
6. Fundamental of Analytical Chemistry. D.A.Skoog, D.M.West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
7. Analytical Chemistry. G.D. Christian, 5th edn, 2001 John Wiley & Sons, Inc, India.
8. Gas Chromatography Mass Spectrometry: Principles, Applications, and Reference Standards" by Jean-Francois Focant and Pat Sandra (Academic Press).
9. Tandem Mass Spectrometry: Molecular Characterization" by G. L. Glush and J. V. F. Martin (Wiley-Interscience).
10. "Practical LC-MS Method Development" by John W. Dolan and Thomas J. Moon (CRC Press).
11. An introduction to Magnetic Resonance spectroscopy, D.N. Sathyanarayana, I.K. International, 2013.
12. Spectroscopy of Organic compounds – P.S. Kalsi, New Age International Publications, New Delhi (6th Edn.), 2007.
13. Organic Spectroscopy – William Kemp 3rd Edn. ELBS, 1991
14. Instrumental methods of analysis. L. L. Meritt, J. A. Dean, F.A., settle 6th Edn. (Van Nostrand).
15. Principles of Instrumental Analysis. D. S. Kooj (Sander Colley).
16. Fundamentals of Analytical Chemistry. Skoog, West, Holler, 7th Edn. Harcourt Agra. Publication Harcourt College Publishers.
17. Principles of instrumental analysis. Skoog, Haller, Nieman, 5th Edn. Harcourt.
18. Treatise an analytical chemistry. F. J. Kohthiff & F. T. Elhiy, (M. Interscience).
19. Nuclear and Radiochemistry. G. Dridelandey, J. M. Millar, M. M. Keondy & E. S. Macias (John Willey).
20. Essentials of Nuclear Chemistry. H. J. Arnikaar (Wiley Eastern).
21. Text Book of quantitative chemical analysis. A.I. Vogel (ELBS).
22. Introduction to NMR Spectroscopy – R.J. Abraham, J. Fisher, P. Loftus, - Wiley Publications, 1988.

Course outcomes:

1.	Acquaint and able to apply spectroscopic techniques for qualitative and quantitative analysis
2.	Skilled with their handling and interpretation of data

Course Title: ORGANIC CHEMISTRY PRACTICALS-III	Course Code: HCP33
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 10 Marks	Semester End Examination: 40 Marks

Course objectives:

1.	To acquaint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge on synthetic principles of simple organic compounds

List of Experiments:

List of Experiments: Synthesis and Spectral Analysis (IR, HNMR, C13NMR, Mass) of Synthesised compounds.

I. Synthesis	
1.	Synthesis of Pthallic anhydride from Pthallic acid
2.	Synthesis of Pthalimide from Pthallic anhydride
3.	Synthesis of 7-Hydroxy-4-methyl-coumarine from Resorcinol
4.	Synthesis of Benzimidazole
5.	Synthesis of N-benzylideneaniline
6.	
7.	
8.	
II. Spectral Analysis	
Spectral Analysis of Alkenes, Cycloalkanes, Alkyl halides, Alcohols, Ethers, Acids, Ketones, Esters, Nitriles, Amines.	

References:

1.	Advanced Practical Organic Chemistry N K Vishnoi Second edition, Vikas Publishing House Pvt. Ltd, 1996
2.	Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis Renu Aggarwal
3.	Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra
5.	Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6.	Vogel's Textbook of Practical Organic Chemistry Brian S. Furniss, 5th Edition, Pearson India, 2005.
7.	Laboratory techniques in Organic chemistry, V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt. Ltd.
8.	Laboratory Manual of Organic Chemistry Raj K. Bansal. 5 th edition, New Age international, 2008

9.	Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India, 2009.
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Course outcomes:

1.	Evaluate the industrial products for quantitative analysis
2.	Capable to perform spectrophotometric analysis

Course Title: HETEROCYCLIC AND SYNTHETIC ORGANIC CHEMISTRY	Course Code: SCT31
Teaching Hours/Week (L-T-P): 4 - 0 - 0	No. of Credits: 04
Internal Assessment: 20 Marks	Semester End Examination: 80 Marks

Course objectives:

1.	To understand the basic concepts of heterocyclic compounds
2.	To gain knowledge on principle and mechanism involved in photochemical, pericyclic and retro synthesis.
3.	To acquire theoretical skills in bond extension reactions

Unit	Description	Hours
01	Heterocyclic compounds: Nomenclature of heterocyclic compounds. Synthesis (Each two methods) and reactivity (towards electrophilic and nucleophilic reactions) – Pyrroles, Furans, Thiophenes, Pyridines, Azepines, Fused heterocycles: Synthesis (Each two methods) and chemical properties towards electrophilic and nucleophilic reactions of benzopyrroles, benzofurans, benzothiophenes, quinolines and isoquinolines. Mesoinonic compounds: Nomenclature, synthesis, reactions and applications of Sydnone	15hrs
02	Photochemistry and Pericyclic reactions: Photochemistry and concerted reactions: Introduction, light absorption and electronic transitions, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones, enones, photooxidations, photoreductions Norrish type I and II reactions, Paterno-Buchi reaction, Barton reaction, Di-pi-methane rearrangements. Pericyclic reactions: Electrocyclic reactions: Stereochemistry, Symmetry and Woodward-Hofmann rules for electro cyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for cyclobutadiene and cyclohexadiene systems. Cycloaddition reactions: [2+2] [3+2] and [4+2] cycloadditions, analysis by FMO and correlation diagram method. Sigmatropic reactions: Classification, stereochemistry and mechanisms.	15hrs
03	Retro synthesis via disconnection approach: Organic Synthesis: Introduction to synthons, synthetic equivalents, functional group interconversions, Protection and de-protection in organic synthesis – Protection of hydroxyl, carboxyl, carbonyl, amino, thiol groups and their de-protection. Illustration of protection and deprotection in organic synthesis with examples. Disconnection approach: One group C-X disconnection- Carbonyl compounds, ethers and sulphides (Benzyl benzoate, propanil, p-methylanisole, isopentyl benzyl ether, chlorobenzene). Two group disconnection- 1, 1- difunctionalized compounds (Acetals,	15hrs

	cyanohydrins, amino acids etc.), 1,2-difunctionalized compounds (1,2-dicarbonyl compounds, α-hydroxyl carbonyl compounds). Retrosynthesis: Retrosynthesis of benzocaine, 4-methoxy acetophenone, saccharin, bisvoline, canthredine, lycorane and multstrin.	
04	Named reactions: C–C Bond forming reactions: Aldol condensation, Claisen condensation reaction, Michael reaction, Robinson annulations, Stobbe condensation, Wittig reaction, Acylation synthesis. Alder – Ene reaction, Bischler – Napieralski, Dieckmann condensation, Knoevenagel condensation, Mannich reaction. Coupling reactions: Hiyama cross-coupling reaction, Negishi cross-coupling reaction, Stille coupling, Suzuki – Miyaura coupling, C–N Bond forming reactions: Buchirer reaction, Buchwald – Hartwig amination, Stork enamine reaction, Hofmann – Löffler – Freytag reaction, Barton reaction. C–O Bond forming reactions: Dakin reaction, Mislow – Evans rearrangement, Mukaiyama reagent, Bayer – Villager reaction.	15hrs
References: 1. Modern Synthetic Reactions, H.O. House, W.A Benjamin 2. Some Modern Methods of Organic Synthesis, W Carruthers, Cambridge Univ. Press 3. Principles of Organic Synthesis, R.O.C Norman and J.M. Coxon, Blackie Academic & Professional 4. Advanced organic chemistry.F.A.carey and R.J.sunderberg 5. Rood's Chemistry of Carbon Compounds, S. Coffey. 6. Organic Synthesis-Concept, Methods and Starting Materials, J. Fuhmop and G. Penzillin. 7. Guide Book to Organic Synthesis, R.K. Mackie & D.M. Smith, ELBS. 8. Organic Synthesis, V.K. Ahuwalia and Renu Agarwal, Narosa 9. Synthesis, Approaches in Organic Chemistry, R.K. Bansal, Narosa 10. Advanced Organic Chemistry -Reactions, Mechanism and Structure, Jerry March, John Wiley. 11. Designing Organic Synthesis, S.Warren, Wiley. 12. Organic Synthesis, Stuart warren, 2012 John Wiley and sons camebridge University.		

Course outcomes:

1.	Able to carry out complex organic reactions
2.	Predict the reaction mechanism and conditions for reaction and synthetic applications.

Course Title: ORGANIC CHEMISTRY PRACTICALS-III	Course Code: SCP31
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 10 Marks	Semester End Examination: 40 Marks

Course objectives:

1.	To acquaint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge on synthetic principles of simple organic compounds

List of Experiments:

Synthesis of Drugs and Heterocycles	
1.	Synthesis of Schiff bases
2.	Preparation of paracetamol (acetaminophene)
3.	Synthesis of Sulfanilamide
4.	Synthesis of Antipyrine
5.	Synthesis of Aspirin
6.	Synthesis of Salicylaldehyde Schiff base derivatives
7.	Synthesis of Coumarin derivatives
8.	Synthesis of Dibenzalacetone
9.	
Spectral Analysis	
Spectral Analysis of Alkenes, Cycloalkanes, Alkyl halides, Alcohols, Ethers, Acids, Ketones, Esters, Nitriles, Amines.	

References:

1.	Advanced Practical Organic Chemistry N K Vishnoi Second edition, Vikas Publishing House Pvt. Ltd, 1996
2.	Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis Renu Aggarwal
3.	Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra
5.	Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6.	Vogel's Textbook of Practical Organic Chemistry Brian S. Furniss, 5th Edition, Pearson India, 2005.
7.	Laboratory techniques in Organic chemistry, V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt. Ltd.

8.	Laboratory Manual of Organic Chemistry Raj K. Bansal. 5 th edition, New Age international, 2008
9.	Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India, 2009.

Course outcomes:

1.	Evaluate the industrial products for quantitative analysis
2.	Capable to perform spectrophotometric analysis

Course Title: MEDICINAL CHEMISTRY	Course Code: SCT32
Teaching Hours/Week (L-T-P): 4 - 0 - 0	No. of Credits: 04
Internal Assessment: 20 Marks	Semester End Examination: 80 Marks

Course objectives:

1.	To understand the basic concepts of medicinal chemistry
2.	To gain knowledge on drug action, designing and pharmacokinetics.
3	To acquaint with the process of drug discovery

Unit	Description	Hours
01	Introduction to Medicinal Chemistry: History and development of medicinal chemistry, Physicochemical properties in relation to biological action, Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism. Drugs: Essential Drugs, Nomenclature of Drugs, Routes of Drug Administration, Adverse effects of Drugs, IUPAC Naming of Drugs.	15hrs
02	Drug discovery process: Brief introduction to bioinformatics and chemo informatics, Molecular modeling: Energy minimization, geometry optimization, conformational analysis. Drug discovery process: Computer Aided Drug Design (CADD), Development of New Drugs, Factors Affecting development of New Drugs. Concept of prodrugs and soft drugs, Drug Receptors. Molecular docking: Rigid docking, flexible docking, manual docking. Autodock and Dock softwares with examples.	15hrs
03	Pharmacokinetics: Introductions, Drug Absorption, Distribution, Metabolism (Phase I and Phase II), Excretion and Toxicity (ADMET). Pharmacodynamics: Introduction, Drug receptor interaction, Types of Interactions, Enzyme Stimulation, Enzyme Inhibition, Membrane Active Drugs, QSAR- 2D QSAR and 3D-QSAR.	15hrs
04	Drug Action: Theories of Drug Action, Molecular Recognition in Drug-Receptor Binding, Enzyme Inhibitors (Modes of inhibition). Antibacterial, Antifungal, Antiviral and Anticancer drugs (Major drug classes, mechanism of drug action, Drug resistance). Analgesic Drugs, anesthetics (general, local), Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants, Steroids.	15hrs

References:

1. The Organic Chemistry of Drug Design and Drug Action, by Richard B. Silverman, 2nd Edition. Elsevier Academic Press, 2004, ISBN 0-12-643732-7.
2. Foye's Principles of Medicinal Chemistry, 5th Edition, by David A. Williams and Thomas L. Lemke, Lippincott Williams & Wilkins, 2002.
3. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd Edition, by Thomas Nogrady and Donald F. Weaver, 2005.
4. Medicinal Chemistry, An Introduction, by Gareth Thomas, John Wiley & Sons, 2000.
5. The Practice of Medicinal Chemistry, ed. Camille Wemuth, Academic Press, 1996.

Selected Medicinal Chemistry Journals

1. Journal of Medicinal Chemistry
2. Journal of Medicinal Chemistry Letters (starting with 2010, Volume 1)
3. Bioorganic & Medicinal Chemistry
4. Bioorganic & Medicinal Chemistry Letters
- European Journal of Medicinal Chemistry
6. ChemMedChem

Course outcomes:

1.	Able to comments on the drug action
2.	Design the drug molecules based on their pharmacokinetics

Course Title: MEDICINAL CHEMISTRY PRACTICALS	Course Code: SCP32
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 10 Marks	Semester End Examination: 40 Marks

Course objectives:

1.	To acquaint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge on synthetic principles of simple organic compounds

I. Preparation of dyes and drug	
1.	Preparation of Methyl Orange
2.	Preparation of Fluorescein
3.	Synthesis of Crystal violet
4.	Synthesis of Phenolphthalein
5.	Preparation of paracetamol (acetaminophen)
6.	Preparation of phenacetin
7.	Synthesis of Sulfanilamide
8.	Synthesis of Antipyrine
9.	Synthesis of Aspirin

References:

1.	Advanced Practical Organic Chemistry N K Vishnoi Second edition, Vikas Publishing House Pvt. Ltd, 1996
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra
5.	Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6.	Vogel's Textbook of Practical Organic Chemistry Brian S. Furniss, 5th Edition, Pearson India, 2005.
7.	Laboratory techniques in Organic chemistry, V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt. Ltd.
8.	Laboratory Manual of Organic Chemistry Raj K. Bansal. 5 th edition, New Age international, 2008
9.	Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India, 2009.

Course outcomes:

1.	Evaluate the industrial products for quantitative analysis
2.	Capable to perform spectrophotometric analysis

Course Title: AGRO, HEALTH AND MEDICINAL CARE CHEMICALS	Course Code: SCT33
Teaching Hours/Week (L-T-P): 4 - 0 - 0	No. of Credits: 04
Internal Assessment: 20 Marks	Semester End Examination: 80 Marks

Course objectives:

1.	To understand the chemistry of general chemicals of routine use
2.	To gain knowledge on the composition of agro chemicals and health care chemicals.
3.	To acquire concepts and methodology of clinical chemistry

Unit	Description	Hours
01	Fertilizers: Introduction, Essential plant Nutrients, Classification of Essential Nutrients, Primary Nutrients, Secondary Nutrients, Micronutrients, Macronutrients, Classification of Fertilizers Straight Fertilizers, Compound/Complex Fertilizers, Fertilizer Mixtures, Feed Stock/ Raw materials- Nitrogenous Fertilizers, Phosphatic Fertilizers, Potassic Fertilizers, Manufacture and general properties of Fertilizer products- Intermediates- Ammonia, Nitric Acid, Sulphuric Acid, Phosphoric Acid, Nitrogenous Fertilizers- Ammonium Sulphate, Ammonium Nitrate, Calcium Ammonium Nitrate, Calcium Nitrate, Ammonium Chloride, Urea, Phosphatic Fertilizers, Ground Rock Phosphate, Single Superphosphate, Triple Superphosphate, Potassic Fertilizers- Potassium Chloride (Muriate of Potash), Potassium Sulphate (Sulphate of Potash), Potassium Nitrate, Complex Fertilizers- Ammonium Phosphate Sulphate, Ammonium Phosphates, Mono Ammonium Phosphate (MAP), Di-Ammonium Phosphate (DAP), Nitrophosphates, Urea Ammonium Phosphates, NPK Complex Fertilizers, Fertilizer mixtures-Physical Mixtures, Granulated Mixtures.	15hrs
02	Insecticides: Introduction, classification, Organochlorine insecticides-BHC, DDT, endosulfan, sevin, Insect pheromones, general introduction and applications in integrated pest management. Repellents: Survey & synthesis of the repellents-N,N-diethyltoluamide, 2-ethyl-1,3- hexanediol. Fungicides: Introduction, Inorganic & organic fungicides, Systemic fungicides-types & examples. Herbicides: Introduction, study of sulfonyl ureas, Mechanism of action and toxicities of insecticides, fungicides and herbicides.	15hrs
03	Perfumery: Introduction, Compounds used in perfumery and their classification, methods of preparation and importance of phenyl ethanol,	15hrs

	Yara yara, Ionone musk ketone, musk ambrette, musk xylene, phenyl acetic acid and its esters, benzyl acetate, synthetic musks and jasmine. Essential oils: Source, constituents, isolation & uses. Dyes: Classification of dyes according to the mode of applications and according to the chemical constitution; Methods of preparation of commercial dyes of different classes with suitable examples; Typical manufacturing processes of dyes; Fluorescent brightening agents	
04	Oils, soaps and Detergents: Refining of edible oils, manufacturing of soaps, detergents classification-anionic, cationic, non-ionic and amphoteric detergents, detergent builders and additives, liquid soaps. Manufacturing of fatty acids and glycerol, greases from fatty acids, Turkey red oil. Clinical Chemistry: Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulin, barbiturates, acidic and alkaline phosphates, Immunoassay , principals of radio immunoassay and applications. The blood- gas analysis –trace elements in the body.	15hrs

References:

1. Statistical Quality Control, 2nd Edn., Manohar Mahajan Dampat Rai and Sons, 1995.
2. Quality management: a process improvement approach, Fryman Mark A, Cengage learning, 2002.
3. Quality Control, Paranthaman D, Tata, McGraw Hill, 1987.
4. Gupta R. N. Chemical warfare and casualty management 2011
5. Vyas M. N. Safety and hazards management in chemical industries 2013. Atlantic publication.
6. Dikshith T.S.S Safety evaluation of environmental chemicals. New Age International, 1996.
7. Chemical Safety Matters-IUPAC-IPCS, Cambridge univ. Press, 1992.
8. Environmental Chemistry, A.K. Dey, Wiley Eastern.
9. Environmental Chemistry, S.K. Banerji, Prentice Hall India, 1993.
- Chemistry, I. Williams, John Wiley, 2001
14. Engineering Chemistry by Jain and Jain.
10. Industrial electrochemistry by Peltcher
16. Modern Electrochemistry, Vol I, IIA & IIB (1998) J.O.M. Bockries and A.K.N. Reddy
11. Chemical Engineers Hand Book, 8th Edn., Robert H. Perry, Mc Graw Hill, 1995.
18. Principles of Industrial Chemistry, C. A. Clausen and G. Matts

Course outcomes:

1.	Able to understand the synthesis and composition of routinely used dyes, fertilizers and health care products
2.	Comment on their use and applications

Course Title: AGRO, HEALTH AND MEDICINAL CARE PRACTICALS	Course Code: SCP33
Teaching Hours/Week (L-T-P): 0 - 0 - 4	No. of Credits: 02
Internal Assessment: 10 Marks	Semester End Examination: 40 Marks

Course objectives:

1.	To acquaint with the analysis of industrial samples
2.	Hands-on training for the colorimetric analysis of the samples.
3.	Acquire knowledge on synthetic principles of simple organic compounds

Experiments

1.	Estimation of Blood Glucose by colorimetrically (Glucose oxidase-Peroxidase Method).
2.	Estimation of Urea fertilizer by Kjeldahl Method
3.	Estimation of Amino acids by Colorimetry.
4.	Estimation of Albumin by Colorimetry
5.	Estimation of Carbohydrates by Colorimetry.
6.	Iodine value of fat or oils
7.	Estimation of Aspirin by titration
8.	Preparation Dichloro Diphenyl Trichloro ethane (DDT)

References:

1.	Advanced Practical Organic Chemistry N K Vishnoi Second edition, Vikas Publishing House Pvt. Ltd, 1996
2.	Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis Renu Aggarwal
3.	Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra
5.	Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
6.	Vogel's Textbook of Practical Organic Chemistry Brian S. Furniss, 5th Edition, Pearson India, 2005.

Course Title:	INSTRUMENTAL ANALYTICAL TECHNIQUES	Course code:	OET 31
Total Contact Hours:	30	Course Credits:	02
Formative Assessment Marks:	10	Duration of ESA/Exam:	2h
Summative Assessment Marks:	40		

Course Objectives:

1.	Study the basics and fundamentals of analytical techniques
2.	Acquire knowledge on spectroscopic techniques for the analysis of simple compounds
3.	To understand the principle and applications of spectroscopic techniques for qualitative and quantitative analysis

Unit	Description	Hours
1	Introduction: Qualitative and quantitative analysis; Concentration terms; Sampling and its Importance Conductometry: theory, types of conductometric curves , Instrumentation and applications Potentiometry: principle, instrumentation and applications Polarography, reference electrodes, dropping mercury electrode, instrumentation and applications Spectroscopic techniques: Interaction of electromagnetic radiation with matter, Beer-Lambert's law- Limitations; UV-Vis-Spectroscopy: Principle, Instrumentation and applications for determination of composition of metal to ligand; metal ions like Fe, Ti and biological samples FTIR spectroscopy: Principle, sample preparation, Instrumentation and applications for determination of functional groups of hydrocarbons, alcohols, carbonyl compounds, amines, etc Fluorescence Spectroscopy: Principle and applications	15

2	NMR Spectroscopy: Principle, sample preparation, chemical shift, factors affecting chemical shift, Interpretation of spectra and applications for simple molecules Mass spectroscopy: Principle, fragmentation process, factors affecting fragmentation, base peak and molecular ion peak, nitrogen rule, Interpretation of spectra and applications for simple molecules. Raman Spectroscopy: Principle, Instrumentation and applications X-ray diffraction: measurement of X-rays, GM counter, Ionization counter, Semicinductor detectors, Scintillation counters, X-ray absorption and emission spectroscopy, Bragg's law, Debye Scherrer X-ray diffraction method, applications Electron microscopic techniques: Principle, Instrumentation and applications of SEM, TEM and AFM	15
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References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001).
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th Edn, prentice Hall, Inc. New Delhi, 1993.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. Pearson Education Pvt. Ltd., New Delhi, (2003).
5. Spectroscopy of Organic compounds – P.S. Kalsi, New Age International Publications, New Delhi (6th Edn.), 2007.

Course Outcomes:

1.	Capable to predict the structure of simple compounds
2.	Helps in scientific career

Course Title: BIOANALYTICAL TECHNIQUES	Course code: OET 32
Total Contact Hours: 30	Course Credits: 02
Formative Assessment Marks: 10	Duration of ESA/Exam: 2h
Summative Assessment Marks: 40	

Course Objectives:

1.	Study the basics principles of separation techniques
2.	Understand the importance of separation techniques for qualitative and quantitative analysis
3.	Learn the principle and applications of basic spectroscopic techniques

Unit	Description	Hours
1	Distillation: Importance, Principle, methodology, distillation of high boiling solvents, applications Filtration: Principle, methodology and application Crystallization: Principle, methodology and application Ultracentrifugation: Principle, sedimentation constant, sedimentation equilibrium, sedimentation velocity, methodology and applications. Solvent extraction: Principle, Distribution law, types, methodology, application for the extraction of Fe, Cu Thin layer Chromatography: Principle, methodology, RF value, application in identification and monitoring of the reaction Electrophoresis: types, the basic of electrophoretic separations, migration rates and plate heights, electro osmotic flow, instrumentation, capillary zone electrophoresis, capillary gel electrophoresis, capillary isoelectrophoresis	15

2	Column chromatography: Principle, methodology, application in identification and monitoring of the reaction Gas chromatography: Mobile phase, stationary phase, Principle, Components and instrumentation, applications in the analysis of volatile compounds, Assay High Performance liquid chromatography: Principle, Components and instrumentation, applications in the analysis of volatile compounds, Assay and purity UV-Vis-Spectroscopy: Principle, Instrumentation and applications for determination of composition of metal to ligand; metal ions like Fe, Ti and biological samples FTIR spectroscopy: Principle, sample preparation, Instrumentation and applications for determination of functional groups of hydrocarbons, alcohols, carbonyl compounds, amines, etc	15
References: 1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005). 2. Analytical Chemistry, G.D. Christian, 5th ed, John Wiley & Sons, Inc, India (2001). 3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, prentice Hall, Inc. New Delhi, (1993). 4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint. Pearson Education Pvt. Ltd., New Delhi, (2003).		

Course Outcomes:

1.	Capable to separate the simple products in a mixture
2.	Able to adopt the skills of separation