III SEMESTER

ADVANCED ORGANIC CHEMISTRY			
Course Code	22MSC31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	4	Exam Hours	3

Course Learning Objectives:

- To understand the reactions of organic compounds involving various reagents.
- To learn the synthesis and retro-synthesis of different organic compounds.

Module-1

Oxidation: (a)Metal based and non-metal based oxidations of alcohols (chromium, manganese, silver, ruthenium, DMSO, and hypervalent iodine). (b) Peracids oxidation of alkenes and carbonyls. (c) Alkenes to diols (manganese, osmium based), alkenes to carbonyls with bond cleavage (manganese, ruthenium, and lead based, ozonolysis), and alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, and selenium based allylic oxidation).
(d) Asymmetric epoxidations (Sharpless, Jacobsen, and Shi epoxidations) and Sharpless asymmetric dihydroxylation.

Module-2

Reduction: (a) Catalytic homogeneous and heterogeneous hydrogenation, Wilkinson catalyst. (b) Metal based reductions using Li/Na in liquid ammonia, sodium, magnesium, zinc, titanium, and samarium. (c) Hydride transfer reagents: $NaBH_4$, L- selectride, K-selectride, Luche reduction, $LiAlH_4$, DIBAL-H, Red-Al, Trialkylsilanes, and Trialkylstannane. (d) Enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata) and Noyori asymmetric hydrogenation.

Module-3

Modern Synthetic Methods: (a) Baylis-Hillman reaction, Henry reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Brook rearrangement, Tebbe olefination.
(b) Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi and Sonogashira, Nozaki-Hiyama, Buchwald-Hartwig, Ullmann coupling reactions, directed ortho metalation. (c) Stereoselective synthesis of tri- and tetra-substituted olefins, Synthetic applications of Claisen rearrangement, ene reaction (metallo-ene, Conia ene).

Module-4

Construction of Ring Systems: (a) Different approaches towards the synthesis of three, four, five, and six-membered rings. (b) Pauson-Khand reaction, Bergman cyclization; Nazarov cyclization, cation-olefin cyclization and radical-olefin cyclization, inter-conversion of ring systems (contraction and expansion). (c) Construction of macrocyclic rings and ring closing metathesis.

Module-5

Retrosynthetic Analysis: Basic principles and terminology of retrosynthesis, synthesis of aromatic compounds, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions Protecting groups: Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups and carbon-carbon multiple bonds; chemo- and regioselective protection and deprotection; illustration of protection and deprotection in synthesis.

References

1. W. Carruthers, Modern Methods of Organic Synthesis, Cambridge University Press, 1996.

2. L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier

Academic Press, 2005.

3. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press, 2001.

4. F. A. Cary and R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edition, Springer, 2009.

5. M. B. Smith, Organic Synthesis, 2nd Edition, 2005

6. S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.

7. J. Tsuji, Palladium Reagents and Catalysts, New Perspectives for the 21st Century, John Wiley & Sons, 2003.

8. I. Ojima, Catalytic Asymmetric Synthesis, 2nd edition, Wiley−VCH, New York, 2000.

9. R. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.

Course Outcomes: After completion of the course, students will have

CO1	Students are familiar about chemistry of oxidants and various types of oxidants used for oxidation reactions
CO2	Better understanding of reducing agents and reduction reaction mechanisms
CO3	Familiar about various moderns synthetic methods and reactions
CO4	Able to construct various ring systems
CO5	Analyse the reactions by Retro-synthetic approach

Mapping of Cos and Pos

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**X**		**X**			**X**	**X**
CO2	**X**						
CO3	**X**	**X**					
CO4	**X**	**X**	**X**			**X**	**X**
CO5	**X**	**X**	**X**			**X**	**X**

ADVANCED ANALYTICAL TECHNIQUES			
Course Code	22MSC32	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	4	Exam Hours	3

Course Learning Objectives:

- To learn sampling techniques and conventional volumetric methods and chromatographic techniques.
- To understand the concepts and applications of microscopic techniques

Module-1

Titrimetric Analysis: Acid-Base, Complexometric, redox, precipitartion and gravimnetric analysis
Thermal Analysis: TGA, DTG, DTA, DSC - combustion calorimetry- Thermal diffusivity by the laser flash technique- simultaneous techniques including analysis for gaseous products.
Electro-analytical technique Principle and applications of : Coulometry, Polarography, Hydrodynamic voltametry , Pulse Polarography , Cyclic Voltammetry and Amperometry.

Module-2

Principles of chromatography- Chromatographic separations and classification of principal chromatographic separations. Chromatographic mechanisms-sorption isotherms; adsorption systems-stationary and mobile phases, partition systems-stationary and mobile phases.
Characterization of solutes-distribution ratio, retention factor, retention time and retardation factor.
Thin layer chromatography (TLC) - Principles and procedures, stationary and mobile phases, solute-detection, alternative TLC procedures and applications of TLC.
Gas chromatography (GC) - Principles and types. Mobile phases, Sample injections, columns and stationary phases. Temperature control and solute detection; thermal conductivity detector (TCD), flame ionization detector (FID), nitrogen-phosphorus detector (NPD) and electron capture detector (ECD).
High performance liquid chromatography(HPLC): Principles, mobile phases, solvent delivery systems, sample injection system, column and stationary phases.

Module-3

Ion-exchange chromatography (IEC): Principles, apparatus and instrumentation, and applications. Size-exclusion chromatography (SEC): Principles, apparatus and instrumentation, and applications. Affinity chromatography (AFC): Principles, methodology and applications. Supercritical fluid chromatography (SFC): Properties of supercritical fluids, instrumentation and operating variables, comparison of SFC with other chromatographic techniques, applications. Supercritical fluid extraction (SFE): Advantages, instrumentation, choice of supercritical fluids, off-line and on-line extraction, applications. Electrophoresis (EP) and electrochromatography(EC): Principles- high performance capillary electrophoresis and capillary electrochromatography, running buffers, supporting medium, sample injection, solutes- detection, instrument control and data processing.

Module-4

Solvent and solid phase extraction: Extraction techniques, extraction efficiency and selectivity. Solvent extraction (SE) - Extraction of organic acids and bases, extraction of metals. Methods of extraction and applications. Solvent phase sorbents, solid phase extraction (SPE) formats. Automated solid phase extraction. Solid phase micro extraction (SPME). Applications of SPE and SPME.

Module-5

Microscopic Techniques: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM). Scanning Probe Microscopy: Atomic Force Microscopy, Scanning Tunnelling Microscopy (STM), Near field scanning optical microscopy (NSOM). Principles of Fluorescence microscopy. Confocal Laser

Scanning Microscopy.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8 th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
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, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prenticeHall, Inc. New Delhi.
6. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
9. Principles of instrumental analysis, Douglas A Skoog, Donald M West, Saunders College, Philadelphia. **Publisher:** Cengage; 6 edition (1 November 2014) **ISBN- 13:** 978-81-315-25579.
10. X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, 2nd Edition - Harold P. Klug, Leroy E. Alexander,**Publisher:** Wiley-Blackwell; 2nd Revised edition edition (1 January 1974) **ISBN-13:** 978-0471493693
11. Transmission Electron Microscopy: A Textbook for Materials Science (4-Vol Set)**-** David B. Williams and C. Barry Carter, **Publisher:** Springer; 1st ed. 1996. Corr.6thprinting edition (15 April 2005) **ISBN-13:** 978-0306453243
12. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM **-** Ray F. Egerton ,**Publisher:** Springer; Softcover reprint of hardcover 1st ed. 2005 edition (12 October 2010) **ISBN-13:** 978-1441938374

Course Outcomes: After completion of the course, students will have

CO1	Skills on sampling, purification, characterizations and data analysis using instrumental techniques.
CO2	Knowledge of chromatographic techniques
CO3	Principle of Instrumentation and analytical applications of chromatographic techniques
CO4	The idea of Solvent and solid phase extraction methods
CO5	Better understanding about Microscopic techniques

Mapping of COs and POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**X**						
CO2	**X**						
CO3	**X**	**X**					
CO4	**X**	**X**					
CO5	**X**	**X**	**X**				**X**

ADVANCED INORGANIC CHEMISTRY			
Course Code	22MSC33	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	4	Exam Hours	3

Course Learning Objectives:

- To understand the fundamental concepts of organo-metallic chemistry and general principles of homogeneous and hetrogeneouse catalysis.
- To learn the concepts of metal clusters, silicates and silicones.

Module-1

Fundamental concepts: Introduction, Classification of organometallic compounds by bond type, nomenclature, the effective atomic number rule, complexes that disobey the EAN rule, common reactions used in complex formation.

Organometallics of transition metals: Preparation, bonding and structures of nickel, cobalt, iron and manganese carbonyls. Preparation and structures of metal nitrosyls.

Ferrocene: Preparation, structure and bonding**. Metal-carbene and metal-carbyne complexes**.

Complexes containing alkene, alkyne, arene and allyl ligands: Preparation, structure and bonding

Module-2

General principles of Catalysis: Language of catalysis. Homogeneous and heterogeneous catalysts.

Homogeneous catalysis - Industrial Applications: Alkene hydrogenation and hydroformylation, The Wacker's process, Monsanto acetic acid process and L-DOPA synthesis, alkene oligomerizations, water-gas shift reactions. The Reppe reaction.

Heterogeneous catalysis –The nature of heterogeneous catalysts. Alkene polymerization: Ziegler-Natta catalysis, Fischer-Tropsch carbon chain growth. New directions in heterogeneous catalysis.

Module-3

Zeolites as catalysts for organic transformation: Uses of ZSM – 5.

Alkene metathesis, hydroboration, arylation or vinylation of olefins (Heck reaction).

Biological and Medicinal Applications: Organomercury, organoboron, organosilicon and organoarsenic compounds.

Module-4

Chemistry of main group elements: Diborane and its reactions, polyhedral boranes(preparation, properties, structure and bonding). Wade's rules, carboranes andmetallocarboranes. Borazines. Phosphazenes, S-N compounds.

Metal clusters: Evidences and factors favoring of M-M bonding, Wade's-Mingo's-Lauher rules, bi, tri, tetra, penta and hexa nuclear metal carbonyl clusters. Low and high nuclearity carbonyl clusters. Electron counting schemes in carbonyl clusters. The isolobal analogy.

Module-5

Silicates: Structure, classification - silicates with discrete anions, silicates containing chainanion, silicates with layer structure, silicones with three dimensional net-work and applications.

Silicones: General methods of preparation, properties. Silicone polymers – silicone fluids, silicone greases, silicone resins, silicone rubbers and their applications.

References

1. Organometallic Chemistry, 2nd edition, R.C. Mehrothra and A. Singh, New Age International Publications (2006).

2. Fundamental Transition Metal Organometallic Chemistry - Charles M. Lukehart, Brooks, Cole

Publishing Company (1985).
3. The Organometallic Chemistry of the Transition Metals, 4th edition, Robert H. Crabtree, Wiley Interscience, (2005).
4. Organometallics - A Concise Introdution, 2nd edition, ChistophElschenbroich and Albert Salzer VCH, (1992).
5. Inorganic Chemistry, 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).
6. Inorganic Chemistry- 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education,(2004).
7. Basic Organometallic Chemistry - B.D. Gupta and A.J. Elias, Universities Press (2010).
8. Inorganic Chemistry Principles of Structure and Reactivity: James E. Huheey, Ellen A.
9. Keiter, Richard L. Keiter, Okhil K. Medhi, Delhi University, New Delhi (2006)
10. Chemistry of the Elements – N.N. Greenwood and A. Earnshaw, Pergamon Press (1985).
11. Inorganic Chemistry, 6th edition. D.F. Shriver, M. Weller. T. Overton, J. Rourke and F. Armastrong, Oxford University Press (2014).
12. Organometallic Chemistry and Catalysis, Didier Astruc, Springer (2007).
13. Transition Metal Organometallic Chemistry, Francois Mathey, Springer (2013).

Course Outcomes:

CO1	Fundamental concepts of organometallic chemistry and synthesis, structure and bonding in different organometallics and their applications.
CO2	Homogeneous and heterogeneous catalyst and their in applications in the synthesis of organic compounds in industries.
CO3	Knowledge about zeolites, Biological and Medicinal Applications
CO4	Chemistry of main group elements, metal clusters
CO5	Better understanding of silicates and silicones and their applications in day to day life.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**						
CO3	**X**						
CO4	**X**						
CO5	**X**	**X**				**X**	**X**

POLYMERS AND COMPOSITES			
Course Code	22MSC34	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the basics of polymers and kinetics of polymerization
- To understand the basics of composites
- To familiarize about different types of composites

Module-1

Polymers: Fundamentals of polymers - monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers, Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization and ring opening polymerization. Molecular weight and size, polydispersion. Average molecular weight concepts – number, weight and viscosity average molecular weight. Determination of molecular weights - viscosity method, osmotic pressure method, sedimentation and light scattering methods.

Module-2

Kinetics of Polymerization - Condensation, addition, free radical, ionic, co-ordination polymerization. Phase transitions in polymers and thermal characterization: Glass transition, crystallinity and melting-correlation with the polymer structure. Polymers in solution:
Criteria of polymer solubility, thermodynamics of polymer solutions.

Module-3

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC).Functional roles of reinforcement and matrix and importance of interface. Polymer matrix composites (PMCs): Fiber reinforced and particulate filled polymer composites. Reinforcements (glass, carbon/graphite, Kevlar), Matrices – Thermoset matrices – polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters – Thermoplastic matrices. Choice of reinforcements and matrices for different application needs.

Module-4

Polymer nanocomposites

Introduction to polymer composites, Processing of nanoparticles, binding mechanisms in nanoparticles, dispersion of nanoparticles, and stabilization of nanoparticles. Processing and fabrication of polymer nanocomposites, Melt blending, solvent casting, In-situ polymerization, solution polymerization, template synthesis, high shear mixing. Homogeneous/heterogeneous nucleation, plasma promoted nucleation.

Module-5

Ceramic metal nanocomposites

Ceramic based nanoporous composites, metal matrix nanocomposites, natural nano-bioccomposites, bio-mimetic nanocompostes and biologically inspired nanocomposites, nanocompsites for hard coatings, DLC coatings, thin film naocomposites, modelling of nanocomposites, synthesis of various nanocomposites materials, sputtering, mechanical alloying.

References

1. Text Book of Polymer Science, F.W. Billmeyer, Jr., John Wiley, London (1994).
2. Polymer Science. V. R. Gowrikar, N.V. Vishwanathan and J. Sreedhar, Wiley Eastern, New Delhi (1990).
3. Fundamentals of Polymer Science and Engineering. A. Kumar and S.K. Gupta, Tata – McGraw Hill

New Delhi (1978).
4. Polymer Characterization, D. Campbell and J.R. White, Chapman and Hall, New York.
5. Fundamental Principles of Polymer Materials, R.L. Rosen, John Wiley and Sons, New York.
6. Nanocomposite science and technology by P.M.Ajayan, L.S. Schadler and P.V. Braun, Wiley-VCH GmbH Co. 2003.
7. Encyclopedia of Nanotechnology by H.S.Nalwa, American Scientific Publishers, 2003.
8. Metalopolymer nanocomposites, Ed A.D. Pomogailo and V.N.Kestelman, Springer-Verlag, 2005.
9. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

Course Outcomes:

CO1	Fundamentals of polymers and their applications in controlling the quality and waste management of polymer product.
CO2	Fundamentals of composites, their types, preparations and applications

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**	**X**			**X**	**X**
CO2	**X**	**X**	**X**			**X**	**X**

NMR AND MASS SPECTROSCOPY			
Course Code	22MSC35	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	2	Exam Hours	3

Course Learning Objectives:

- To understand the basic concepts NMR spectroscopy.
- To familiarize with the mass spectroscopy

Module-1

NMR Spectroscopy: Magnetic properties of nuclei (magnetic moment, g factor, nuclear spin), effect of external magnetic field on spinning nuclei, Larmor precession frequency, resonance conditions, population of nuclear magnetic energy levels, relaxation processes, relaxation time, line width and other factors affecting line width. Chemical Shift: Standards employed in NMR, factors influencing chemical shift: electronegativity, shielding and deshielding, van der Walls deshielding magnetic anisotropy, H-bonding, diamagnetic and paramagnetic anisotropies, spin-spin coupling, chemical shift values and correlation for protons bonded to carbon and other nuclei, Instrumentation. Chemical shift equivalence and magnetic equivalence, effects of chiral centre, Karplus curve-variation of coupling constants with dihedral angle.

Module-2

Complex NMR Spectra: Simplification of complex spectra-isotopic substitution, increased magnetic field strength, double resonance and lanthanide shift reagents, Nuclear Overhauser Effect (NOE), FT-NMR, Spectroscopy and advantages. 13CNMR Spectroscopy, multiplicity-Proton decoupling-Noise decoupling-Off resonance decoupling-Selective proton decoupling - Chemical shift, application of 13C, 19F, 31P, 11B and 15N. Applications of NMR: Structural diagnosis, conformational analysis, keto-enol tautomerism, H bonding. Solid state NMR and its applications. Multiple resonance spectroscopy: Introduction to 2D-techniques: DEPT, COSY and NOESY

Module-3

Mass Spectrometry: Basic principles, Instrumentation -Mass spectrometer, interpretation of mass spectra, resolution, exact masses of nuclides, molecular ions, meta-stable ions and isotope ions. Different methods of ionization (chemical ionization, electron impact, field ionization, MALDI etc.). Fragmentation processes-representation of fragmentation, basic fragmentation types and rules. Factors influencing fragmentations and reaction pathways. McLafferty rearrangement.

Module-4

Fragmentations (fragmentation of organic compounds with respect to their structure determination) associated with functional groups- alkanes, alkenes, cycloalkanes, aromatic hydrocarbons, halides, alcohols, phenols, ethers, acetals, ketals, aldehydes, ketones, quinines, carboxylic acids, esters, amides, acid chlorides, nitro compounds, amines & nitrogen heterocycles. Fragmentation patterns of glucose, myrcene, nicotine, retro Diels-Alder fragmentation. Application in structure elucidiation and evaluation of heats of sublimation & ionization potential. Nitrogen rule. LC-MS and GC-MS, High resolution mass spectroscopy.

Module-5

Composite problems involving the applications of UV, IR, 1H and 13C-NMR and mass spectroscopic techniques. Structural elucidation of organic and inorganic compounds. Industrial Case studies.

References

1. Organic Spectroscopy-3rd Ed.-W. Kemp (Pagrave Publishers, New York), 1991.
2. Spectrometric Identification of Organic Compounds - Silverstein, Bassler & Monnill (Wiley) 1981.

3. Spectroscopy of Organic Compounds-3rd Ed.-P.S. Kalsi (New Age, New Delhi) 2000.
4. E.A.V. Ebsworth, D.W.H. Ranklin and S. Cradock: Structural Methods in Inorganic Chemistry, Blackwell Scientific, 1991.
5. J. A. Iggo: NMR Spectroscopy in Inorganic Chemistry, Oxford University Press, 1999
6. C. N. R. Rao and J. R. Ferraro: Spectroscopy in Inorganic Chemistry, Vol I & II (Academic) 1970.
7. Spectroscopy, B. P. Straughan and S. Salker, John Wiley and Sons Inc., New Yourk, Vol.2, 1976.
8. Application of Absorption Spectroscopy of Organic Compounds, John R. Dyer, Prentice/Hall of India Private Limited, New Delhi, 1974.
9. Organic Spectroscopy, V. R. Dani, Tata McGraw-Hall Publishing Company Limited, New Delhi. 1995.
10. Interpretation of Carbon-13 NMR Spectra, F.W. Wehrli and T. Wirthin, Heyden, London, 1976.
11. NMR spectroscopy-Powai

Course Outcomes:

CO1	Describe the NMR spectroscopic techniques including the basic principles for recording of NMR spectra.
CO2	Predict the structure of organic compounds on Mass spectral data
CO3	The course related to understand the spectroscopic techniques for the charterization in organic chemistry

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**	**X**	**X**			**X**	**X**
CO3	**X**	**X**	**X**			**X**	**X**

ORGANIC CHEMISTRY PRACTICALS			
Course Code	22MSC36	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	50
Total Hours of Pedagogy	72	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand synthetic methods by carrying out different experiments.
- To develop the skill for the separation and qualitative analysis of binary mixtures of organic compounds.

PART-A

Multistep synthesis

1. Preparation p-bromoaniline from acetanilide.
2. Preparation of n-butyl bromide from n-butyl alcohol.
3. Oxidation of cyclohexanol to adipic acid.
4. Esterification: Preparation of benzoccaine from p-nitrotoluene.
5. Diazotization (Sandmeyer's reaction): Preparation of p-chlorobenzoic acid from ptoluidine.
6. Preparation benzilic acid from benzoin.
7. Preparation of o-hydroxy benzophenone from phenyl benzoate via Fries rearrangement.
8. Preparation of benzanilide from benzophenone oxime via Beckmann rearrangement.
9. Preparation of benzoic acid from benzaldehyde (Cannizzaro Reaction).
10. Preparation of 2,4-dinitrophenylhydrazine from 2,4-dinitrochlorobenzene.
11. Preparation of m-nitrobenzoic acid from methylbenzoate.
12. Preparation of chalcone.

PART-B

Qualitative analysis:

Separation of binary mixtures, identification of functional groups and preparation of suitable solid derivatives.

Interpretation of Spectra: Structural elucidation of some simple organic compounds by UV, IR, NMR and mass. Spectra have to be provided by the Examiners.

References

1. Vogel' text book of practical organic chemistry, V edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatehell.
2. Elementary practical organic chemistry, Part-I: Small scale preparations, Part-II: Qualitative organic analysis, By Arthur I, Vogel.
3. Hand book of organic analysis, H. T. Clarke and Norman Collie.
4. Experiments in Organic Chemistry, Louis F. Fieser.
5. Laboratory manual of Organic Chemistry by B. B. Dey and M. V. Sitaraman.
6. Practical Organic Chemistry by Mann F. G. and Saunders.

Course Outcomes:

CO1	Students are involved in the multi-step synthesis of different organic compounds
CO2	Understand the qualitative analysis of binary mixture of organic compounds through separation, identification of functional groups and preparation of some solid derivatives.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**	**X**	**X**	**X**	**X**	**X**	**X**

ANALYTICAL CHEMISTRY PRACTICALS			
Course Code	22MSC37	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	50
Total Hours of Pedagogy	72	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand basic concepts by carrying out analytical experiments.
- The experimental results are subjected to validation of analytical parameters.

PART-A

1. Determination of total acidity of vinegar and wines by acid-base titration.
2. Determination of purity of a commercial boric acid sample, and Na_2CO_3 content of washing soda.
3. Analysis of chromate-dichromate mixture by acid-base titration.
4. Determination of replaceable hydrogen and relative molecular mass of a weak organic acid by titration with NaOH.
5. Determination of ephedrine and aspirin in their tablet preparations by residual acid-base titrimetry.
6. Determination of purity of aniline and assay of chlorpromazine tablets by nonaqueous acid-base titration.
7. Periodate determination of ethylene glycol and glycerol (Malprade reaction).
8. Determination of carbonate and bicarbonate in a mixture by *p*H-metric titration and comparison with visual acid-base titration.
9. Determination of purity of a commercial sample of mercuric oxide by acid-base titration.
10. Determination of benzoic acid in food products by titration with methanolic KOH in chloroform medium using thymol blue as indicator.
11. Determination of the *p*H of hair shampoos and *p*H determination of an unknown soda ash.
12. Analysis of water/waste water for acidity/alkalinity by visual, *p*H metric and conductometric titrations.
13. Determination of carbonate and hydroxide-analysis of a commercial washing soda by visual and *p*H-titrimetry.
14. Determination of ammonia in house-hold cleaners by visual and conductometric titration.
15. Potentiometric determination of the equivalent weight and Ka for a pure unknown weak acid.
17. Spectrophotometric determination of creatinine and phosphorus in urine.
18. Flame emission spectrometric determination of sodium and potassium in river/lake water.
19. Spectrophotometric determination of *p*Ka of an acid-base indicator.

PART-B

1. Determination of percentage of chloride in a sample by precipitation titration- Mohr, Volhard and Fajan's methods.
2. Determination of silver in an alloy and Na_2CO_3 in soda ash by Volhard method.
3. Mercurimetric determination of blood or urinary chloride.
4. Determination of total hardness, calcium and magnesium hardness and carbonate and bicarbonate hardness of water by complexation titration using EDTA.
5. Determination of calcium in calcium gluconate/calcium carbonate tablets/injections and of

calcium in milk powder by EDTA titration.
6. Analysis of commercial hypochlorite and peroxide solution by iodometric titration.
7. Determination of copper in an ore/an alloy by iodometry and tin in stibnite by iodimetry.
8. Determination of ascorbic acid in vitamin C tablets by titrations with $KBrO_3$ and of vitamin C in citrus fruit juice by iodimetric titration.
9. Determination of iron in razor blade by visual and potentiometric titration using sodium metavanadate.
10. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium(IV) sulphate.
11. Determination of nickel in steel by synergic extraction and boron in river water/sewage using ferroin.
12. Determination of total cation concentration of tap water by ion-exchange chromatography.
13. Determination of magnesium in milk of magnesium tablets by ion-exchange chromatography.
14. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration.
15. Gas chromatographic determination of ethanol in beverages.
16. Determination of aspirin, phenacetin and caffeine in a mixture by HPLC.
17. Solvent extraction of zinc and its spectrophotometric determination.
18. Anion exchange chromatographic separation of zinc and magnesium followed by EDTA titration of the metals.
19. Separation and determination of chloride and bromide on an anion exchanger.
20. Thin layer chromatographic separation of amino acids.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
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, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
7. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
8. Practical Clinical Biochemistry by Harold Varley and Arnold.Heinmann, 4th edition.

Course Outcomes:

CO1	Develop the skill to carry out acid-base titrimetric analysis, potentiometric and conductometric methods.
CO2	Understand the chemistry of different chemical reactions involved in the determination of pharmaceutical, industrial and vegetable samples.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	X	X					
CO2	X	X	X	X	X	X	X

IV SEMESTER

FORENSICS CHEMISTRY

ELEMENTS OF FORENSIC CHEMISTRY AND TOXICOLOGY			
Course Code	22MSCF1	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the basic concepts of chemistry and toxicology as they relate to forensic science.
- To gain proficiency in analytical techniques used in forensic chemistry, such as chromatography and spectroscopy.
- Learn to identify and quantify various toxic substances.

Module-1

General Forensic Chemistry: Definition, Important cases associated with Forensic chemistry, Types of cases which require chemical analysis, Presumptive and confirmatory testing of chemical evidences.

Module-2

Scientific Instrumentation and Equipments involving analysis of chemical evidences: Early Analytical Techniques: Wet Chemistry, Chemistry of Color, Thin-Layer Chromatography Development of Instrumental Techniques Microscopy, Hyphenated Instruments: Separation and Detection, Spectrophotometry.

Module-3

Drugs of Abuse: Introduction and classification of Drugs of Abuse (Narcotics, Stimulants, Depressant and hallucinogens), Status of Drug abused in India, Introduction to Club drugs and Drug abuse in Sports, Drugs as Evidence.
Introduction and brief analysis of Phenolphthalein in Trap case, Petroleum adulteration. Illicit liquors and Arson and Explosives.

Module-4

Forensic Toxicology: Definition, Areas of Forensic Toxicology, Elements of Forensic Toxicology Nature of cases, Role of the Forensic Toxicologists, Laws related to Forensic Toxicology.
Poisons: Definition of Poison, Toxin and Toxicant, Ideal Poison, Classification of poisons based on their origin and Chemical nature, mode of action.

Module-5

Types and Trends of Poisoning: Animals and Human poisoning in India with special reference to Suicidal, Homicidal and accidental poisons, Major vesicants used as chemical-warfare agents. Factors affecting the poisoning, methods of administration.
Extraction methods of some important poisons and their forensic identification

References

1. Modi's (1988) Medical Jurisprudence & Toxicology, M. M. Trirathi Press Ltd. Allahabd,.
2. Saferstein, R (1982) Forensic Science Hand Book, Vol I, II and III, Pretince Hall, NI.
3. Saferstein, R (2000) Criminalistics.
4. Curry (1986) Analytical Methods in Human Toxicology, Part II.
5. Curry, A.S. (1976) Poison Detection in Human Organs.
6. Mathew E. Johll (2009) Investigating Chemistry: A Forensic Science Perspective
7. Suzanne Bell (2009) Drugs, Poisons, and Chemistry
8. DFS Manuals of Forensic Chemistry and Narcotics.

Course Outcomes:

CO1	Demonstrate proficiency in using analytical techniques such as chromatography and mass

	spectrometry for substance identification and quantification.
CO2	Apply fundamental concepts of chemistry and toxicology to analyze and interpret forensic evidence.
CO3	Assess the effects of various toxic substances on human health and recognize symptoms of exposure.
CO4	Exhibit best practices in the collection, preservation, and documentation of chemical evidence, ensuring integrity and reliability.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**	**X**	**X**				
CO3	**X**	**X**					
CO4	**X**	**X**	**X**	**X**	**X**	**X**	**X**

CHEMISTRY OF NATURAL PRODUCTS			
Course Code	22MSCF2	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- Define natural products and categorize them, with a specific focus on lipids, flavonoids, and isoflavonoids.
- Explore the biosynthetic pathways involved in the production of lipids, flavonoids, and isoflavonoids, including key enzymes and regulatory mechanisms.
- Examine the chemical structures of lipids, flavonoids, and isoflavonoids, emphasizing their functional groups and structural variations.

Module-1

Lipids: Nomenclature, classification, purification, structure and synthesis of fatty acids, phospholipids, sphingolipids. Biological importance of lipids (Lecithin, sphingolipids, oils and fats). Prostaglandins: Introduction, classification and biological importance of PG‘s. Constitution of PGE1. Synthesis of PGE & F series.

Module-2

Terpenoids: Introduction, classification and general methods of structural elucidation. Chemistry of pinene, camphor, caryophyllene, santonin. Biosynthesis of terpenoids.
Porphyrins: Introduction, structure and biological functions of haemin. Vitamin B12: structure and as coenzyme in molecular rearrangement reactions; Chlorophyll: structure and biological importance

Module-3

Flavonoids and Isoflavonoids: Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin, Kaempferol, Quercetin, wedelolactone, Butein, Daidzein. Biosynthesis of flavonoids and isoflavonoids: Acetate Pathway and Shikimic acid Pathway. Biological importance of flavonoids and isoflavonoids

Module-4

Alkaloids: Introduction, classification, isolation and general methods of structural elucidation of alkaloids. Classification of alkaloids. Biological importance of alkaloids. Structural elucidation of nicotin, papavarine, quinine, reserpine and morphine. Biosynthesis of alkaloids (nicotin, conine and cocaine).

Module-5

Steroids: Introduction, Structural elucidation of cholesterol, bile acids, Ergosterol and its irradiation products. Sex hormones and corticosteroids: Synthesis of estrone, progesterone, androsterone, testosterone. Barton reaction for the synthesis of aldosterone. Brief discussion of homosteroids, norsteroids and oral contraceptives. Biological significance of anabolic steroids.

References

1. Organic Chemistry, VI edition, Robert T. Morrison, Robert N. Boyd.
2. Organic Chemistry, Vol-II by I. L. Finar.
3. Schaum's outline of theory and problems of Organic Chemistry, Harbert Meislich, Howard Nechamkin and Jocob Sharefkin.
4. Natural products: Their chemistry and biological significance, J. Mann, R. S. Davidson, J. B. Banthorpe and J. B. Harborne.
5. Synthetic drugs, Gurdeep R. Chatwal.
6. Heterocyclic chemistry by Achison.
7. Heterocyclic chemistry by Smith and Joule. 8. Heterocyclic chemistry by Pacquete.

Course Outcomes:

CO1	Demonstrate a thorough understanding of the structure, classification, and properties of lipids, flavonoids, and isoflavonoids.
CO2	Design and conduct research projects focused on natural products, demonstrating the ability to formulate hypotheses, collect data, and analyze results.
CO3	Demonstrate an understanding of the ethical implications of using natural products in research and industry, including sustainability and biodiversity considerations.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**					
CO2	**X**	**X**	**X**				
CO3	**X**	**X**	**X**			**X**	**X**

FORENSIC DRUG ANALYSIS			
Course Code	22MSCF3	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the basic principles of forensic science and the role of drug analysis within the forensic field.
- To classify various types of controlled substances, including their chemical structures, categories, and legal implications.
- To learn forensic analytical techniques specifically applicable to the detection and analysis of drugs of abuse in biological samples.

Module-1

Drug: Definition of Drug, Drug Use & Misuse, Drug Chemistry, Drug Dependence and chemistry of Addiction, Drug Receptors and Brain Chemistry.
Drugs of Abuse: Definition, Classification based on Form and Origin, Use, Effects and Schedules, Structure of NDPS Act and the definitions of each drug classification, Drugs as Evidence, Profiling Examples of Illegal Drugs, United Nations International Drug Control Programme

Module-2

Chemistry and Analysis of Drugs of Abuse: Origin, Pharmacology, Methods of preparation, Storage, Diluents and Adulterants, Sample Handling, Optimization of Experimental Conditions, Presumptive/Screening and Confirmatory Methods: Color/spot test, Microscopic examination, Microcrystalline tests, Thin-Layer Chromatography, Sample Preparation before TLC Specimen, Extraction Evaluation of TLC for Drug Screening, Immunoassay Methods, UV Spectrophotometry, IR/FTIR Spectrophotometry, NMR, GC-MS & HPLC/LC-MS, Legal Implications and Data Interpretation of Opium and Opioids analgesics, Stimulants (Cocaine, Amphetamine & other amphetamine derivatives), Depressants (Barbiturates and Benzodiazepines), Hallucinogens (Cannabis, LSD, Psilocybine and Mescaline), OTC, Inhalant and Volatile Substances, Drugs in sexual assault

Module-3

Clandestine laboratory: Meaning and Definition of Clandestine, Clandestine Laboratory, Related Problems, Factors Contributing to Clandestine Drug Labs, Harms Caused by Clandestine Drug Labs,
Equipment Needs: Reflux, Distillation, Hydrogenation, Bucket Chemistry, Extractions, Chemical Needs, Cooking Methods Commonly Used in Clandestine Drug Labs, Extraction Process, Conversion Process, Synthesis Process, Tableting.
Designer drugs: Definition, Analogs of Fentanyl and Meperidine (both synthetic opioids), Phencyclidine (PCP), Amphetamines and methamphetamines (which have hallucinogenic and stimulant properties).

Module-4

Laboratory Analysis: The Chemist, Extractions: Physical Extraction, Dry Wash/Extraction, Liquid/Liquid Extractions, Analysis: Chemical Color Tests, Microscopic Techniques, Infrared Spectroscopy, Thin-Layer Chromatography, Ultraviolet Spectroscopy, Gas Chromatography. Format of NDPS Report Writing & Court Room Testimony.

Module-5

Drug Abuse in Sports: Introduction, International Olympic Committee (IOC), World Anti-Doping Agency (WADA), classification of commonly prohibited substances and Performance enhancing Drugs, Steroids, Stack and Pyramid methods, Dope test and Blood Doping, Sampling techniques, analytical approaches.

References

1. Clarke's Analysis of Drugs and Poisons, (Formerly Isolation & Identification of Drugs) 3rd Ed. 2 Vol. Set.
2. Clark, E.G.C. : Isolation and identification of Drugs, VI and Vol. II, 1966, 1975-1986.
3. Modi, Text Book of Medical Jurisprudence Forensic Medicines and Toxicology (1999) CBS Pub. New Delhi
4. Saferstien (1982) Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA.
5. DFS -Working Procedure Manual- Narcotics
6. E. Stahl (1969) Thin Layer Chromatography: ALaboratory Handbook.
7. Saferstein (1976) Criminalistics.

Course Outcomes:

CO1	Demonstrate a comprehensive understanding of the definitions, classifications, and effects of commonly abused drugs.
CO2	Apply forensic analytical techniques to accurately identify and quantify drugs in various samples.
CO3	Conduct independent research on emerging trends in drug abuse and forensic analysis, demonstrating critical thinking and analytical skills.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**					
CO2	**X**	**X**	**X**	**X**		**X**	**X**
CO3	**X**	**X**	**X**	**X**	**X**	**X**	**X**

ADVANCED FORENSIC CHEMISTRY			
Course Code	22MSCF5	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To develop skills to identify and analyze complex chemical evidence from crime scenes, including illicit drugs, explosives, and trace evidence.
- To conduct quantitative analyses of chemical substances, applying statistical methods to interpret data and ensure the reliability of results.
- To conduct laboratory experiments utilizing advanced analytical techniques, demonstrating proficiency in instrumentation and data analysis.

Module-1

Introduction to Forensic Chemistry, branches of and cases involved in Forensic chemistry, preliminary and confirmatory methods used in Forensic chemistry.

Analytical Chemistry: Nature and scope of analytical chemistry in Forensic chemical analysis, Concepts of **S**tructure and function of drug molecules, Concept of Mole, Molecular Mass and Molecular Weight, Atomic Number and Atomic Mass, Classification of acids, bases and salts, pH value and pH scale, Buffer solutions, Oxidizing and reducing agents in organic chemistry, Functional group analysis, Schemes of identification of unknown solids, Volumetric/Titrimetric methods of analysis, Theory of indicators, Gravimetric methods of analysis, Process of precipitation, Saturated and supersaturated solution, Methods of sample preparation in organic and inorganic analytical chemistry.

Chemical separation Techniques: Solvent extraction (Liquid-liquid extraction), Solid phase extraction, Solid phase microextraction (SPME).

Module-2

Phenolphthalein in trap case: Chemistry and Forensic examination of Phenolphthalein used in Bribe trap cases, and related legal issues.

Forensic significance of Cosmetics: Introduction to cosmetics of forensic interest and their role in crime investigation, General Chemistry of Colorants, Dyes, Pigments & Polymers**.**

Industrial Products: Physical and chemical examination of adulterated and non-adulterated oils and fats, Analysis of chemical fertilizers, consumer items such as gold, silver, tobacco, tea, sugar, salts.

Corrosive chemicals: Hydrochloric acid, sulphuric acid, and nitric acid and alkalis' in crime exhibits of acid/alkali throwing cases.

Module-3

Fire & Arson: Light and Flame, Chemistry of Fire, Combustion reaction, Fire Triangle, Fire Tetrahedron; Backdraft, Thermo-chemistry of Fire, Heat Capacity and Phase changes, Accelerants & types of accelerants, Combustible and Flammable liquids, Flash point, Fire point, Ignition point, Auto Ignition point, vapour density, vapour pressure, Fire extinguisher.

Arson: Legal Definition, Arson motives, Degrees of Arson, Forensic and legal Concepts, Determining origin and cause; Fire patterns, Collection/Preservation of Arson Evidences, Flashover, Backdraught, Live or dead at time of arson; Documenting the fire or crime scene;

Scheme of analysis: Extraction of samples from debris (Direct and solvent extraction methods, Head Space method, SPME, Distillation), Clean-up (Filtration & Acid stripping), Analysis (GC, GC-MS, FTIR & SEM etc.), Interpretation of GC-MS spectra.

Petroleum Products: Introduction to Petroleum Products, Properties and Testing of Petroleum and Petroleum Products, Adulteration of petroleum products as per Prevention of Malpractices in Supply and

Distribution, Analysis of common petroleum products including, Petrol, Kerosene, Diesel, Lubricating Oil, Furnace Oil and Grease as per BIS specifications. Analysis of Dyes used in petroleum products, Chemical fingerprinting of petroleum products

Module-4

Explosives: Definition of Explosives, Definition as per Indian Explosive Acts. History of Explosives, Chemistry of explosives, Deflagration and Detonation phenomenon (Redox Chemistry, Kinetics-Molecular Theory of gases & Gas Laws), Characteristics of high and low explosives, Dust explosion, Gas/vapour explosion, BLEVE, Effect of blast wave on structures & human and Pyrotechnics.
Improvised Explosive Device: Definition of IED, Components of IED, Explosives Initiation (Explosive Trains); Types (Molotov cocktail, Letter bomb, Pipe bomb, VBIED and CBRN), Detection of Hidden Explosives.
Bomb Scene: Specific approach to scene of explosion, Reconstruction of sequence of events, Evaluation and assessment of scene of explosion,
Analysis of Explosive: Pre-blast and Post blast residue collection, Systematic examination of explosives and explosion residues in the laboratory using chemical and instrumental techniques and interpretation of results.

Module-5

Liquors (Alcoholic beverages): Definition**,** classification of liquors based on origin (Indian Made Foreign Liquors, Country Made Liquors and Illicit Liquors), Fermented and Distilled methods (Pot Still and Continuous Still), Characteristics of Beer, wines and Whisky, Congeners in alcoholic beverages, Laws and penalties as per Excise/ Act.
Laboratory methods of determination alcoholic strength, Forensic analysis of distilled and fermented liquors including illicit liquors.
Report Writing & Court Room Testimony: Evidence and testimony in court, Information required by the Forensic expert, Components of Forensic Reports, Preparation of Report, Presenting findings in a Report format.

References

1. Modi's (1988) Medical Jurisprudence & Toxicology, M. M. Trirathi Press Ltd. Allahabd,.
2. Saferstein, R (1982) Forensic Science Hand Book, Vol I, II and III, Pretince Hall, NI.
3. Saferstein, R (2000) Criminalistics.
4. Curry (1986) Analytical Methods in Human Toxicology, Part II.
5. Curry, A.S. (1976) Poison Detection in Human Organs.
6. Mathew E. Johll (2009) Investigating Chemistry: A Forensic Science Perspective
7. Suzanne Bell (2009) Drugs, Poisons, and Chemistry
8. DFS Manuals of Forensic Chemistry and Narcotics.
9. ANaquest (1984) legal chemistry. a guide to the detection of poisons, examination of tea, stains, etc.
10. DFS -Working Procedure Manual- Chemistry, Explosives
11. E. Stahl (1969) Thin Layer Chromatography: ALaboratory Handbook.
12. Jehuda Yinon; Forensic and Environmental Detection of Explosives
13. Saferstein (1976) Criminalistics.
14. Saferstien: Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA
15. Yinon Jitrin (1993)Modern Methods & Application in Analysis of Explosives, John Wiley & Sons ,England
16. J ASiegel, P.J Saukko (2000) Encyclopedia of Forensic Sciences Vol. I, II and III, Acad. Press.

Course Outcomes:

CO1	Collaborate effectively with professionals from other forensic disciplines, integrating

	chemical analysis with biological, digital, and investigative aspects of forensic science.
CO2	Conduct independent research, critically evaluating forensic literature and proposing innovative solutions to contemporary forensic challenges.
CO3	Effectively interpret and report quantitative data, applying statistical methods to ensure the reliability and validity of forensic analyses.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**					
CO2	**X**	**X**					
CO3	**X**	**X**	**X**			**X**	**X**

ANALYTICAL FORENSIC TOXICOLOGY			
Course Code	22MSCF4	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the fundamental principles of toxicology, including concepts of toxicity, dose-response relationships, and the classification of toxic substances.
- To learn proper procedures for the collection, preservation, and transportation of biological and environmental samples to ensure the integrity of evidence related to poisoning cases.
- To conduct laboratory experiments to apply analytical techniques specifically for the detection of poisons.

Module-1

Samples required in Toxicological analysis: Selection of Post-mortem samples and reference to particular class of poison, Classes of samples (Biological and Non-biological), Methods of sample collection (Living and Dead person), Classification of matrices, choice of preservatives, containers and storage conditions.
Alternative specimens: Hair analysis, Drugs in oral fluid, Detection of drugs in sweat etc.
Analysis of Exhumed and decomposed bodies.

Module-2

Alcohol Intoxication & analysis: Related cases, Properties and types of Alcohols, Pharmacology, Toxic properties and effects of alcohol.
Chemical tests for alcohol in blood and urine including Breath Alcohol Screening devices, Method of analysis of some alcoholic beverages in biological materials by chemical methods (Kozelka- Hine) and instrumental methods (GC), Legal context to drinking and driving.

Module-3

Format of Report Writing & Court Room Testimony: Information required by the Forensic toxicologist, Presenting findings in a Report format.

Module-4

Animal Poisons: Insects and animal toxins and their examination, Composition of Snake venoms, Sites and mode of action, Effect on the body as a whole, and tests for identifications.
Plant poisons: Classification and characteristics, method of extraction and stripping of plant poisons in matrices and analysis by chemical and instrumental techniques.

Module-5

Gaseous Poisoning: Carbon Monoxide, Hydrogen Cyanide and Phosphine gase, significance, signs and symptoms, methods of diagnosis, tests for identification.
Food Poisoning: What is food poisoning, Food poisoning due to chemical and bacterial, Sign and symptoms of food poisoning, collection and preservation of evidence material, extraction and isolation, from food material, Biological material, detection and identification by colour test and Instrumental techniques.

References

1. DFS Manual of Forensic Toxicology
2. A C Moffat Clarke's Analysis of Drugs and Poisons, (Formerly Isolation & Identification of Drugs) 3rd Ed. 2 Vol. Set.
3. Casarett & Doll Toxicology (2003) The Basic Science of poisons.
4. Clark, E.G.C. : Isolation and identification of Drugs, VI and Vol. II, 1966, 1975-1986.

5. Curry A.S (1986) Analytical Methods in Human Toxicology, Part II, CRC Press Ohio
6. Curry, A.S. (1976) Poison Detection in Human Organs.
7. Michael J. Deverlanko et al (1995) Hand Book of Toxicology CRC Press.
8. Morgan B.J.T (1996) Statistics in Toxicology, Clarendon Press, Oxford.
9. Modi, Text Book of Medical Jurisprudence Forensic Medicines and Toxicology (1999) CBS Pub. New Delhi
10. Saferstien (1982) Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA.

Course Outcomes:

CO1	Accurately conduct the analysis of biological and environmental samples for the presence of toxins, ensuring adherence to established protocols for evidence handling.
CO2	Apply knowledge of the legal framework surrounding forensic toxicology and poisoning, understanding the implications of toxicological evidence in judicial proceedings.
CO3	Effectively utilize advanced analytical techniques, such as GC to identify and quantify poisons and other toxic substances in biological samples.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**	**X**				
CO2	**X**	**X**	**X**				**X**
CO3	**X**	**X**	**X**			**X**	**X**

NANO CHEMISTRY

SYNTHESIS AND PROPERTIES OF NANOMATERIALS			
Course Code	22MSCN1	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To learn various synthesis methods for nanomaterials, with a focus on physical and chemical methods.
- To investigate the applications of nanomaterials in various fields, such as medicine, electronics, energy storage, and environmental remediation.
- To examine the applications of nanomaterials in fields such as medicine, electronics, energy, and environmental science.

Module-1

Physical Methods:

Bottom-Up versus Top-Down; Top-down approach with examples. Ball milling synthesis, Arc discharge, RF-plasma, Plasma arch technique, Inert gas condensation, electric explosion of wires, Ion sputtering method, Laser pyrolysis, Molecular beam epitaxy and electrodeposition. Electro spinning, Physical Vapor Deposition (PVD) – Chemcial Vapour Deposition (CVD) - Atomic layer Deposition (ALD) – Self Assembly- LB (Langmuir-Blodgett) technique.

Module-2

Chemical methods:

Chemical precipitation methods- Coprecipitation, Arrested precipitation, Sol-gel method, Chemical reduction, Photochemical synthesis, Electrochemical synthesis, Microemulsions or Reverse Micelles, Sonochemical synthesis, Hydrothermal, Solvothermal, Supercritical fluid process.

Module-3

Combustion and Solution Methods:

Solution combustion process, spray pyrolysis method, flame spray pyrolysis, gas phase synthesis, gas condensation process, chemical vapour condensation. Fundamental aspects of VLS (Vapour-Liquid-Solid) and SLS (Solution-Liquid-Solid) processes – VLS growth of Nanowires – Control of the size of the nanowires – Precursors and catalysts – SLS growth – Stress induced recrystallization.

Module-4

Biological methods:

Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Natural and artificial synthesis of nanoparticles in microorganisms; Use of microorganisms for nanostructure formation, Role of plants in nanoparticle synthesis, synthesis of nanoparticles using proteins and DNA templates.

Module-5

Electronic Properties

Classification of materials based on band structures - Brillouin zone – Effect of temperature on conductors – Intrinsic and extrinsic semiconductors - Electrical and electronic conductivity- Hall effect and its determination.

Dielectric Properties, Optical Properties: Photoconductivity, Optical absorption and transmission - Photoluminescence, fluorescence and phosphorescence

Mechanical behavior

Stress-strain, tensile strength, toughness,. **Thermal properties:** Heat capacity, thermal conductivity and thermal expansion of nanomaterials. **Magnetic properties:** Magnetic hysteresis – Superparamagnetism .

References

1.Guozhong Cao, "Nanostructures and Nanomaterials, synthesis, properties and applications", Imperial College Press, 2004

2.M.S. Ramachandra Rao, Shubra Singh, Nanoscience and Nanotechnology: fundamentals to Frontiers, Wiley 2013. Introduction to Nanotechnology - Charles P. Poole Jr. and Franks. J. Qwens

3. Hari Singh Nalwa - Encyclopedia of Nanotechnology.

4. Processing & properties of structural Naonmaterials by Leon L. Shaw (editor)

5. Chemistry of Nanomaterials : Synthesis, properties and applications by CNR Rao et.al.

6. Nanochemistry: A chemical approach to Nanomaterials Roayal Society of Chemistry, Ozin and Arsenault, Cambridge UK 2005,

7.Nanoparticles: From Theory to Applications, G.Schmidt, Wiley Weinheim 2004.

8. M.S.Vijaya,G.Rangarajan, Materials Science , Tata McGraw-Hill publishing company Ltd., New Dehli.

9. Fundamental Properties of Nanostructured Materials, Ed. D. Fiorani (World Scientific, Singapore, 1994.

10. Properties of Materials, Robert E.Newnham,Oxford University Press, 2005.

11. Nanostructured Materials, Edited by Carl C. Koch, Noyes Publications, New York, 2002.

Course Outcomes:

CO1	Understand principles and mechanisms of various synthesis and processing techniques.
CO2	Demonstrate the knowledge to synthesize different nanomaterial choosing suitable method
CO3	Design desired nanostructure with size and morphology controlled to get desired property.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**						
CO3	**X**	**X**	**X**			**X**	**X**

CHARACTERISATION OF NANOMATERIALS			
Course Code	22MSCN2	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To identify and describe various characterization techniques used for nanomaterials, including microscopy (e.g., TEM, SEM, FTIR).
- To analyze and interpret data obtained from characterization techniques, understanding the significance of the results in the context of nanomaterial applications.

Module-1

X-Ray based characterization

Principles and applications of X-ray diffraction, powder (polycrystalline) and single crystalline XRD techniques; Debye-Scherrer equation to treat line broadening and strain induced in nanoparticles and ultra-thin films. Basics of structure refinement (Reitveld). Rotating anode and synchrotron based X-ray diffraction for probing structure.X-ray photoelectron spectroscopy – basic principle, instrumentation, X-ray absorption techniques: XANES, EXAFS.

Module-2

Electron microscopy techniques

Introduction, Principles and applications of Electron beam, Electron beam interaction with matter. Scanning electron microscopy (SEM/FESEM), transmission electron microscopy (TEM/HRTEM), Electron-diffraction, SAED**.** Scanning Probe Microscopy: Principles and applications, Atomic Force Microscope, Scanning Tunnelling Microscope.

Module-3

Spectroscopic techniques

UV-VIS Spectrophotometers, IR/FTIR Spectrophotometers, Principles, operation and application for band gap measurements. Raman spectroscopy principles and applications. Optical microscope: Nanoparticle size measurement by Dynamic light scattering methods zeta potential.

Module-4

Magnetic characterization

Types of magnetic materials, Magnetic susceptibility, Curie-Weis plot for paramagnetic materials, Neel temperature, Curie temperature VSM and SQUID magnetometers – M vs H, M vs T, MH-loops.

Module-5

Electrical measurements

Cyclic Voltameter, Impedance Measurement, IV, AC and DC electric measurements, impedance spectral information.

References

Books

1. Characterization of Nanostructure materials by XZ.L.Wang
2. Instrumental Methods of Analysis, 7th edition- Willard, Merritt, Dean, Settle
3. *Scanning Probe Microscopy: Analytical Methods (NanoScience and Technology)-Roland Wiesendanger*

References:

1. X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, 2nd Edition Harold P. Klug, Leroy E. Alexander
2. Transmission Electron Microscopy: A Textbook for Materials Science (4-Vol Set)- David B. Williams and C. Barry Carter
3. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM - Ray F. Egerton.

Course Outcomes:

CO1	Demonstrate a comprehensive understanding of the fundamental properties and behaviors of nanomaterials.
CO2	Proficiently utilize a range of characterization techniques (e.g., TEM, SEM, FTIR, XRD) to analyze nanomaterials.
CO3	Conduct independent research projects involving the characterization of nanomaterials, demonstrating the ability to design experiments and draw meaningful conclusions.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**					
CO2	**X**	**X**				**X**	**X**
CO3	**X**	**X**	**X**			**X**	**X**

CARBON AND ADVANCED NANOSTRUCTURES			
Course Code	22MSCN3	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To describe the various allotropes of carbon (e.g., graphene, carbon nanotubes, fullerenes) and their unique structural, electrical, and mechanical properties.
- To identify and utilize appropriate characterization techniques (e.g., Raman spectroscopy) to analyze the structural and functional properties of carbon nanostructures.

Module-1

Carbon Nanotubes (CNT): History, types of CNTs, synthesis methods, CVD method, Laser ablation and electric arc processes, growth mechanisms, purification and characterization methods, mechanical reinforcements, solid disordered carbon nanostructures.

Module-2

Graphene: Background, structure, exfoliation or synthesis methods- physical methods-micromechanical (scotch tape method), CVD, electric arc process. Chemical approaches-Hammers method, oxidation and reduction of graphite, solvothermal, supercritical fluid, solvent sonication method, chemically modified graphene, electrochemical synthesis and other methods

Module-3

Fullerenes and derivatives: Fullerenes and types, diamond like carbon, nanodiamond, clusters, metal carbide derived carbon nanostructures, synthesis and applications.
Nanostructures: Graphite, Whiskers, Cones, and Polyhedral crystals, structure, properties and applications. **Properties of Carbon nanostructure:** Electronic, Vibrational, Mechanical Properties of CNTs, optical properties & Raman spectroscopy of CNTs.

Module-4

Functionalization of carbon nanostructures: (CNT, Graphene and fullerenes)- reactivity, covalent functionalization-oxidative purification, defect functionalization, transformation and modification of carboxylic functionalization like amidation, thiolation, halogenations, hydrogenation, addition of radicals, sidewall functionalization through electorphilic addition, nano covalent exohedralfunctionalization, endohedro functionalization.

Module-5

Advanced 2D nanostructures: Introduction to 2D nanostructures, Structure and properties of metal nitrides, carbides, selenides, sulphides, metal dichalcogenides, MXenes. Synthesis methods and surface chemistry, functionalization of MXenes. Applications of 2D nanostructures

References

TEXT BOOKS:

1. Carbon Nanotubes: properties and applications-Mchael J. O'Connell, Taylor & Francis, 2006
2. Nanotubes and Nanowires-CNR Rao and A Govindaraj RSC publishing
3. Handbook of Carbon, YuryGagotsi, Taylor & Francis, 2006
4. Mxenes and their Composites Synthesis, Properties and Potential Applications. Edited by Kishor

Kumar Sadasivuni. Elsevier, 2022. https://doi.org/10.1016/C2019-0-05458-1

Reference

1. Physical properties of carbon nanotube- R. Satio
2. Applied physics of Carbon nanotubes: fundamentals of theory, optics and transport devices- S.Subramoney and S.V.Rotkins
3. Carbon nanotechnology-Liming Dai

Course Outcomes:

CO1	Demonstrate a deep understanding of the properties, synthesis, and applications of various carbon nanostructures, including graphene, carbon nanotubes, and fullerenes.
CO2	Successfully perform synthesis techniques for carbon nanostructures and evaluate their effectiveness based on desired properties.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**					
CO2	**X**	**X**	**X**			**X**	**X**

NANOCOMPOSITES			
Course Code	22MSCN4	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To explain the fundamental concepts of nanocomposites, including definitions, types, and the significance of nanoscale materials in composite formation.
- To identify and describe various synthesis methods for nanocomposites, such as sol-gel processes, melt mixing, and in situ polymerization.
- To develop skills in designing and conducting experiments related to the synthesis and characterization of nanocomposites, including data analysis and interpretation.

Module-1

Introduction to nanocomposites

Definition of composite material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites. Advantage of composite materials, mechanical properties, Thermal, electrical and electronic and optical properties. Super hard nanocomposites-designing and mechanical properties - stress-strain relationship, toughness, strength, and plasticity.

Module-2

Ceramic metal nanocompsites

Ceramic based nanoporous composites, metal matrix nanocomposites, natural nano-bioccomposites, bio-mimetic nanocompostes and biologically inspired nanocomposites, nanocompsites for hard coatings, DLC coatings, thin film naocomposites, modelling of nanocomposites, synthesis of various nanocomposites materials, sputtering, mechanical alloying.

Module-3

Polymer nanocomposites

Introduction to polymer composites, Processing of nanoparticles, binding mechanisms in nanoparticles, dispersion of nanoparticles, and stabilization of nanoparticles. Processing and fabrication of polymer nanocomposites, Melt blending, solvent casting, In-situ polymerization, solution polymerization, template synthesis, high shear mixing. Homogeneous/heterogeneous nucleation, plasma promoted nucleation. Polymer nanocomposites with structural, gas barrier and flame retardant properties, carbon fibre reinforced polymer composites, elastomer and thermoplastic elastomer nanocomposites for propulsion systems, water borne fire-retardant nanocomposites, hybrid composites for cosmetics, protective and decorative coatings.

Module-4

Natural nanocomposite systems

Spider silk, bones, shells; organic–inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposite material; use of synthetic nanocomposites for bone teeth replacement. Bioactive nanocomposites in bone grafting and tissue engineering, inorganic/polymer nanocomposites for dental restoration and bone replacement applications.

Module-5

Bio ceramics for implant coating

Calcium phosphates-hydroxyapatites Ti_6Al_4V and other biomedical alloys, implant tissue interfacing-metal organic CVD-use of tricalcium phosphate-biomimetic and solution based processing- osteoporosis- osteo plastic, regeneration of bones by using bio compatible ceramics, bio interactive hydro gels- PEG coating and surface modifications, PEG hydrogels patterned on surfaces- PEG based hydrogels.

References

TEXT BOOKS:

1. Nanocomposite science and technology by P.M.Ajayan, L.S. Schadler and P.V. Braun, Wiley-VCH GmbH Co. 2003.
2. Encyclopedia of Nanotechnology by H.S.Nalwa, American Scientific Publishers, 2003.
3. Metalopolymer nanocomposites, Ed A.D. Pomogailo and V.N.Kestelman, Springer-Verlag, 2005.
4. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

References:

1. Biomedical nanostructures by Kenneth E.Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair. John-Wiley & Sons, 2008.
2. Nanobiotechnology II: Edited by Chad A. Mirkin and Christof M. Niemeyer, Wiley-VCH, 2006.
3. Handbook of Biomineralization: Biomimetic and Bioinspired, Chemistry edited by Peter Behrens, Edmund Bäuerlein John-Wiley Sons, 2006.3. Steven S Saliterman, Fundamentals of BioMEMS and Medical Microdevices, 2006

Course Outcomes:

CO1	Demonstrate a thorough understanding of the principles, types, and significance of nanocomposites in materials science.
CO2	Successfully synthesize various types of nanocomposites using established methods and evaluate their effectiveness based on desired properties.
CO3	Analyze the effects of nanoscale fillers on the overall properties of composites, demonstrating an ability to relate structure to function.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**	**X**				**X**	**X**
CO3	**X**	**X**	**X**			**X**	**X**

ORGANIC AND INORGANIC NANOMATERIALS			
Course Code	22MSCN5	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To explain the basic principles and characteristics of organic and inorganic nanomaterials, including their unique properties at the nanoscale.
- To investigate the diverse applications of organic and inorganic nanomaterials in agriculture.
- To explore current trends and future directions in the field of nanomaterials, particularly in agricultural applications and plant protection, identifying potential innovations and challenges.

Module-1

Agricultural Nanotechnology:

Conventional Farming: Issues and Limitations, Intensive Conventional Farming Affects Environment, Current Agricultural Production Systems, Nanotools -Nano processes, and Nanomaterials Production of Bionanomaterials from Agricultural Wastes**:** Cellulose and Nanocellulose from Citrus and Orange Wastes, Synthesis of Graphene Oxide from Agro wastes, Production of Amorphous Silica Nanoparticles from Agrowastes, Carbon Nanomaterials from Agrowastes,

Module-2

Nanoengineering Superabsorbent Materials in Agriculture:

Introduction, Formation and Structure of Cross-Linked Polyacrylates, Formation and Structure of Cross-Linked Polyacrylates; Statistical Models, Mechanisms of Swelling in Superabsorbent Polymers, Mechanisms of Swelling in Superabsorbent Polymers; Hydration, Hydrogen Bonds, Properties of Superabsorbent Polymers, Absorption of Aqueous Solution, Moisture Absorption Superabsorbent Polymers Application in Agriculture Superabsorbent/Clay Nanocomposites

Module-3

Nanotechnology in plant protection:

Nanotechnology and Their Applications in Insect's Pest Control; Formulations of Nanoinsecticides-Nanoemulsions, Components, Preparation, Types and Methods, Nanoparticle-Based Plant Disease Management; Interactions between NPs, Pathogens, and Plants, Plant Disease Diagnosis Using different NPs, Nanotechnology in Microbial Plant Pathogen and insect Management, Targeted Delivery of Agrochemicals Using Nanotechnology, Nanobased Pesticides in Agriculture, Nano-based Fertilizer Efficiency, Improving Plant Traits against Environmental Stresses Using Nanotechnology, Nanotechnology and Its Applications in Water Conservation

Module-4

Nanoparticles in food production and diagnostics:

Food and New Ways of Food Production - Efficient Fractionation of Crops Efficient Product Structuring - Optimizing Nutritional Values - Applications of Nanotechnology in Foods: Sensing, Packaging, Encapsulation, Engineering Food Ingredients to Improve Bioavailability - Nanocrystalline Food Ingredients - Nanoemulsions - Nano-Engineered Protein Fibrils as Ingredient Building Blocks Preparation of Food Matrices - Concerns about Using Nanotechnology in food production. Diagnostics Enzyme Biosensors and Diagnostics - DNA- Based Biosensors and Diagnostics Radiofrequency Identification- Integrated Nanosensor Networks: Detection and Response- Lateral Flow (Immuno) assay - Nucleic Acid Lateral Flow (Immuno)assay - Flow-Through (Immuno)assays - Antibody Microarrays

Surface Plasmon Resonance Spectroscopy.

Module-5

Nanotechnology in food packaging:

Crop improvement - Reasons to Package Food Products - Physical Properties of Packaging Materials - Strength - Barrier Properties Light Absorption – Structuring of Interior Surfaces - Antimicrobial Functionality - Visual Indicators – Quality Assessment - Food Safety Indication - Product Properties - Information and Communication Technology - Sensors -Radiofrequency Identification Technology- Risks - Consumer and Societal Acceptance

References

Books

1) Nanobiotechnology Applications in Plant Protection by Kamel A. Abd-Elsalam and Ram Prasad, Volume 2, Springer, 2018.
2) Nanotechnology an Agricultural Paradigm by Ram Prasad, Manoj Kumar, Vivek Kumar Springer, 2017.
3) Nanoscience in Food and Agriculture by Shivendu Ranjan, Volume 1, Springer, 2016.
4) Nanotechnology and Plant Sciences by Manzer H. Siddiqui, Springer, 2015.
5) Nanoparticle Assemblies and Superstructures by Nicholas A. Kotov, CRC, 2006.
6) Nanotechnology in agriculture and food production by Jennifer Kuzma and Peter VerHage, Woodrow Wilson International, 2006.
7) Bionanotechnology by David S Goodsell, John Wiley & Sons, 2004.
8) Nanobiomaterials Handbook by Balaji Sitharaman, Taylor & Francis Group, 2011.

Course Outcomes:

CO1	Demonstrate a comprehensive understanding of the properties, characteristics, and classifications of both organic and inorganic nanomaterials.
CO2	Successfully synthesize a variety of organic and inorganic nanomaterials using established methodologies and evaluate their effectiveness based on specific criteria.
CO3	Conduct independent research related to organic and inorganic nanomaterials, including designing experiments, data collection, analysis, and interpretation.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**	**X**					
CO3	**X**	**X**	**X**			**X**	**X**

PHARMACEUTICAL CHEMISTRY

BASIC MEDICINAL CHEMISTRY			
Course Code	22MSCP1	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the basic principles of medicinal chemistry, including drug design, development, and the chemical properties of biologically active compounds.
- To understand how changes in chemical structure affect drug activity and effectiveness.
- To explore basic methods for synthesizing organic compounds relevant to medicinal chemistry.

Module-1

Local Anti-infective agents: Introduction, classification, mechanism of action, Synthesis and SAR of nitrofurazone and furazolidos

Sulfonamides: Introduction, classification, mechanism of action, Synthesis and SAR of sulfisooxazoles and sulfamethoxazoles

Antibiotics: Introduction, classification, mechanism of action, Synthesis and SAR of Penicillin G, cephalosporins, and tetracyclins.

Module-2

Antitubercular and antileprotic agents: Introduction, classification, mechanism of action, Synthesis of isoniazid, ethambutal, clofazimine, dapsone.

Analgesic and anti-inflammatory agents: Introduction, classification, mechanism of action, Synthesis of Ibuprofen, phenylbutazone, acetaminophen, diclofenac sodium.

Anticancer/antiviral, hypoglycemic agents: Introduction, classification, mode of action, Synthesis of 5-flurouracil, azidothymadine, Tolbutamide and tolazamide

Module-3

Antihistamine: Introduction, classification, mode of action, Synthesis of Phenarimine maleate, pyrilamine, ranitidine, cimetidine

Cardiovascular Agents: Introduction, classification, mechanism of action, Synthesis of **Antiarrythmicagents verapamil**,

Antihypertensive agent clonidine and hydralazine derivatives

Module-4

Antimalarials Introduction, classification, mechanism of action, Synthesis of Chloroquine, mefloquine, primaquine. SAR of antimalarial agents.

Antiamoebic agents Introduction, classification, mechanism of action, Synthesis ofMetronidazole and iodoquinol

Psychopharmacological agents Introduction, classification, mechanism of action, Synthesis of Benzodiazepines: diazepam, Phenothiazines: chlorpromazine**,** Amitryptyline.

Module-5

Anticonvulsant Introduction, classification, mechanism of action, Synthesis ofPhenytoin sodium, carbamazepine.

Sedatives and hypnotics Introduction, classification, mechanism of action, Synthesis ofPhenobarbital, Chlordiazepoxide

General anesthetics Introduction, classification, mechanism of action, Synthesis of Halothane, Methahexital sodium

References

1. Principles of Medicinal chemistry-Foye,Vargheese and Co.
2. Drug discovery and development-M. S. Chorgade, Vol -2.

3. Wilson and Gisvold's: Text Book of Medicinal Chemistry
4. Comprehensive Medicinal Chemistry-C. Hansch, Series 1-VI , Academic press.
5. Burgers Medicinal Chemistry Volume-1 to Volume 6

Course Outcomes:

CO1	Understand key concepts in medicinal chemistry, including how drugs work.
CO2	Demonstrate basic methods for synthesizing medicinal compounds.
CO3	Clearly present key concepts and findings in medicinal chemistry.

Mapping of COs and POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**X**	**X**					
CO2	**X**	**X**					**X**
CO3	**X**	**X**	**X**			**X**	**X**

DRUG DESIGN AND DEVELOPMENT			
Course Code	22MSCP2	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the basic principles of drug design, including target identification and lead compound optimization.
- To explain the roles of pharmacokinetics and pharmacodynamics in drug design and development.
- To understand the principles of drug formulation, including dosage forms and delivery methods.

Module-1

Drug discovery from natural products and through enzyme inhibition: Introduction, drug discovery and design a historical outline, Sources of drugs and lead compounds, Classification of drugs, Route of administration, the pharmaceutical phase, Introduction to drug action: ADME process. Bioavailability of drug, the pharmacodynamic phase. Introduction to medicinal plants: preparation of initial extracts and preliminary biological screening, methods for compound structure elucidation and identification, compound development, a brief explanation on the development of natural product drugs.

Module-2

Drug design: General approach to discovery of new drugs - lead discovery – lead modification –physiochemical principles of drug action – drug stereo chemistry –drug action - 3Ddatabase search – computer aided drug design – docking - molecular modeling indrug design – structure based drug design – pharmacophores - QSAR.

Module-3

Drug Design and relationship of functional groups to Pharmacologic activity: ***Introduction to drug discovery*****:** Introduction, stereochemistry and drug design: structurally rigid groups, confirmation, configuration. Solubility and drug design: The importance of water solubility, solubility and drug structure, salt formation. The incorporation of water solubilizing groups in structure:The type of group. Reversibility and irreversibility attached groups, the position of water solubilizing group, methods of introduction of solubilizing groups.

Module-4

Introduction, relationship between molecular structure and biological activity, selectivity of drug action and drug receptors. Discovery and structural modification of lead compounds. Drug discovery through random screening of synthetic compounds. Refinement of lead structure. Functional group modification.

Module-5

Vitamins: Introduction, classification, Properties, biological significance of vitamins. Synthesis and Biological importance (Occurrence, Chemical properties, Deficiency and Excess defect), of following Vitamins: Retinal, Thiamine (B1), Ascorbic acid, Pantathionic acid, Vitamin K.

Lipids: nomenclature, classification, purification, structure and synthesis of lipids, phospholipids, sphingolipids. Biological importance of lipids: Lecithin, sphingolipids, oils and fats.

References

1. Principles of medicinal Chemistry-Foye,Vargheese and Co.
2. Text Book of Medicinal Chemistry-Wilson and Gisvold's.
3. Comprehensive Medicinal Chemistry-Series 1-VI , (Academic press)
4. Fundamentals of medicinal chemistry-Gareth Thomas John Wiley & Sons Ltd.
5. Organic Synthesis, The disconnection approach, Stuart Warren and Paul Wyatt,2nd edition,
6. Natural Products-Gurdeep and Chatwal, Himalya Publishers.
7. Terpenoids-V. K. Ahluwalia
8. Biochemistry-Jain

Course Outcomes:

CO1	Demonstrate a thorough understanding of the drug design process, including target identification and lead optimization.
CO2	Demonstrate basic methods for synthesizing new drugs.
CO3	Understand how pharmacokinetics and pharmacodynamics influence drug action.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**		**X**				
CO2	**X**	**X**					
CO3	**X**	**X**	**X**				**X**

CHEMISTRY OF DRUG ACTION			
Course Code	22MSCP3	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To understand the basic principles of drug action, including how drugs interact with biological systems at the molecular level.
- To describe the mechanisms by which drugs exert their effects on target receptors, enzymes, and other biomolecules.
- To investigate current trends and advancements in the chemistry of drug action, including targeted therapies and biotechnology.

Module-1

***Introduction to drug discovery*:** Introduction, stereochemistry and drug design: structurally rigid groups, confirmation, configuration. Solubility and drug design: The importance of water solubility, solubility and drug structure, salt formation. The incorporation of water solubilizing groups in structure:The type of group. Reversibility and irreversibility attached groups, the position of water solubilizing group, methods of introduction of solubilizing groups.

Module-2

Introduction, relationship between molecular structure and biological activity, selectivity of drug action and drug receptors. Discovery and structural modification of lead compounds. Drug discovery through random screening of synthetic compounds. Refinement of lead structure. Functional group modification.

Module-3

Selective examples of drug action at some common target areas: Introduction, Examples of drugs that disrupt cell membranes and walls-Antifungal agents, Azoles, Allylamines, Phenols, Antibacterial agents-Ionophoric antibiotic action, Cell wall synthesis inhibition, Drugs that target enzymes- Reversible inhibitors, Irreversible inhibition, Transition state inhibitors,

Module-4

Drugs that target receptors- Agonists, Antagonists, Partial agonists. Drugs that target nucleic acids-Antimetabolites, Enzyme inhibitors, Intercalation agents, Alkylating agents, Antisense drugs, Chain cleaving agents, Antiviral drugs-Nucleic acid synthesis inhibitors, Host cell penetration inhibitors, Inhibitors of viral protein synthesis.

Module-5

Drug receptor Interaction and Adverse Drug receptor: Introduction, history, affinity - the role of chemical bonding, conformation, stereochemistry of labetalol.Drug receptors, Drug action, sites of drug action, Mechanism of drug action, drug receptors, types of receptors-ligand gated ion channels, voltage gated ion channels, G-protein coupled receptors, intracellular receptors, dose response relationship, adverse drug relationship. Drug allergy.

References

1. Principles of medicinal Chemistry-Foye,Vargheese and Co.
2. Text Book of Medicinal Chemistry-Wilson and Gisvold's.
3. Comprehensive Medicinal Chemistry-Series 1-VI , (Academic press)
4. Fundamentals of medicinal chemistry-Gareth Thomas John Wiley & Sons Ltd.
5. Organic Synthesis, The disconnection approach, Stuart Warren and Paul Wyatt,2nd edition,
6. Natural Products-Gurdeep and Chatwal, Himalya Publishers.
7. Terpenoids-V. K. Ahluwalia

8. Biochemistry-Jain
9. Pharmacology and Pharmacotherapeutics-Satoshkar et al.
10. Drug Discovery and Evaluation: Pharmacological assays, 3rd edition, Vol 2. H. G. Vogel.

Course Outcomes:

CO1	Explain the mechanisms by which drugs exert their effects on specific targets.
CO2	Analyze specific drugs to illustrate their mechanisms of action and therapeutic uses.
CO3	Analyze how changes in chemical structure affect drug efficacy and safety.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**	**X**	**X**				
CO3	**X**	**X**	**X**		**X**	**X**	**X**

MEDICINAL CHEMISTRY OF NATURAL PRODUCTS			
Course Code	22MSCP4	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To learn the significance of natural products in medicinal chemistry and their historical role in drug discovery.
- To understand techniques for the isolation and characterization of natural products, including chromatography and spectroscopy.
- To explore the structures, properties, and biological activities of alkaloids, flavonoids, and terpenoids, highlighting their medicinal applications.

Module-1

Study of Natural products as leads for new pharmaceuticals for the following class of drugs a) Drugs Affecting the Central Nervous System: Morphine Alkaloids b) Anticancer Drugs: Paclitaxel and Docetaxel, Etoposide, and Teniposide c) Cardiovascular Drugs: Lovastatin, Teprotide and Dicoumarol d) Neuromuscular Blocking Drugs: Curare alkaloids e) Anti-malarial drugs and Analogues f) Chemistry of Macrolide antibiotics: (Erythromycin, Azithromycin, Roxithromycin, and Clarithromycin) and β - Lactam antibiotics (Cephalosporins and Carbapenem)

Module-2

a) Alkaloids: General introduction, Classification, Isolation, Purification, Molecular modification and Biological activity of Alkaloids, General methods of Structural determination of alkaloids, structural elucidation and stereochemistry of ephedrine, morphine, ergot, emetine and reserpine.

b) Flavonoids Introduction, isolation and purification of flavonoids, General methods of structural determination of flavonoids; Structural elucidation of quercetin.

c) Steroids General introduction, chemistry of sterols, sapogenin and cardiac glycosides. Stereochemistry and nomenclature of steroids, Chemistry of contraceptive agents, male & female sex hormones (Testosterone, Estradiol, Progesterone), adrenocorticoids (Cortisone), contraceptive agents and steroids (Vit – D).

Module-3

a) Terpenoids Classification, isolation, Isoprene rule and General methods of structural elucidation of Terpenoids; Structural elucidation of drugs belonging to mono terpenoids (citral, menthol, camphor), di terpenoids (retinol, Phytol, taxol) and tri terpenoids (Squalene,Ginsenoside) carotinoids (β carotene).

b) Vitamins Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin.

Module-4

a). Recombinant DNA technology and drug discovery rDNA technology, hybridoma technology, New pharmaceuticals derived from biotechnology; Oligonucleotide therapy. Gene therapy: Introduction, Clinical application and recent advances in gene therapy, principles of RNA & DNA estimation

b). Active constituent of certain crude drugs used in Indigenous system Diabetic therapy – Gymnema sylvestre, Salacia reticulate, Pterocarpus marsupiam, Swertia chirata, Trigonella foenum graccum; Liver dysfunction – Phyllanthus niruri; Antitumor – Curcuma longa Linn

Module-5

Structural Characterization of natural compounds Structural characterization of natural compounds using IR, 1HNMR, 13CNMR and MS Spectroscopy and of specific drugs e.g., Penicillin, Morphine, Camphor,

Vit-D, Quercetin and Digitalis glycosides.

References

1. Modern Methods of Plant Analysis, Peech and M.V.Tracey, Springer – Verlag, Berlin, Heidelberg.
2. Phytochemistry Vol. I and II by Miller, Jan Nostrant Rein Hld.
3. Recent advances in Phytochemistry Vol. I to IV – Scikel Runeckles, Springer Science & Business Media.
4. Chemistry of natural products Vol I onwards IWPAC.
5. Natural Product Chemistry Nakanishi Gggolo, University Science Books, California.
6. Natural Product Chemistry "A laboratory guide" – Rapheal Khan.
7. The Alkaloid Chemistry and Physiology by RHF Manske, Academic Press.
8. Introduction to molecular Phytochemistry – CHJ Wells, Chapmannstall.
9. Organic Chemistry of Natural Products Vol I and II by Gurdeep and Chatwall, Himalaya Publishing House.
10. Organic Chemistry of Natural Products Vol I and II by O.P. Agarwal, Krishan Prakashan.
11. Organic Chemistry Vol I and II by I.L. Finar, Pearson education.
12. Elements of Biotechnology by P.K. Gupta, Rastogi Publishers.
13. Pharmaceutical Biotechnology by S.P.Vyas and V.K.Dixit, CBS Publishers.
14. Biotechnology by Purohit and Mathur, Agro-Bios, 13th edition.
15. Phytochemical methods of Harborne, Springer, Netherlands.
16. Burger's Medicinal Chemistry.

Course Outcomes:

CO1	Demonstrate understanding of synthetic methods for producing alkaloids, flavonoids, and terpenoids.
CO2	Demonstrate knowledge of the significance of natural products in drug discovery and their medicinal properties.
CO3	Describe the processes involved in developing drugs from natural products, including testing and regulation.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**						
CO2	**X**		**X**				
CO3	**X**	**X**				**X**	**X**

ADVANCED MEDICINAL CHEMISTRY			
Course Code	22MSCP5	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning Objectives:

- To gain a comprehensive understanding of advanced concepts in medicinal chemistry, including contemporary drug design methodologies.
- To investigate detailed mechanisms of action of various drug classes at the molecular and cellular levels.
- To analyze complex structure-activity relationships to predict drug efficacy and optimize lead compounds.
- To explore advanced synthetic methodologies for the development of novel therapeutic agents, including asymmetric synthesis and combinatorial chemistry.

Module-1

Fundamental aspects of drugs: Forms, application, biological action, placebo effect, metabolism, drug interactions, adverse effects, classification of drugs, nomenclature of drugs, drug combinations, selection of essential drugs.

Physicochemical properties of drug molecules in relation to biological activity; solubility, partition coefficient, hydrogen bonding, protein binding, chelation, p_{ka} values, isomerism, Geometrical and optical isomers, steric effect, ionization.

Module-2

SAR and QSAR: SARs, Changing size and shape, introduction of new substituents-the introduction of a group in an unsubstituted position, the introduction of a group by replacing the existing group. QSAR- Lipophilicity, partition coefficient (log P), lipophilic substitution constants(π). Electronic effect (Hammet constant σ), steric effect, Taft's steric parameter (Es), Hansch analysis and application, craigs plot, Free-Wilson analysis and application.

Module-3

Prodrugs: Enzyme activation of drugs, Utility of prodrugs, types of prodrugs, mechanism of drug activation-Carrier linked prodrugs, carrier linkages for various functional groups, carrier linked bipartite prodrugs. Bioprecurssor prodrugs(Proton activation, hydrolytic activation, elimination activation, oxidative activation, reductive activation, nucleotide activation, phosphorylation activation, sulfation activation, decorboxylation activation

Module-4

Combinatorial Chemistry: Introduction, the design of combinatorial synthesis, the general techniques used in combinatorial synthesis, the solid support method, parallel synthesis, Furka's mix and split techniques, Encoding methods-Sequential chemical tagging method, stills binary core tag system, computerized tagging, combinatorial synthesis in solution, screening and deconvolution.

Module-5

Drug metabolism: Introduction, sites of drug biotransformation, phase-I and phase-II reactions, role of Cytochrome P-450, Factors affecting drug metabolism.

References

1. Introduction to quantitative Drug Design-Y.C.Martin.
2. Comprehensive Medicinal chemistry-Crowin and Hansch.
3. Medicinal Chemistry-Burger.
4. Principles of Drug Design-Smith.

5. Principles of Medicinal Chemistry- William Foye.
6. Drug design volumes-Ariens.
7. Strategy of drug design-Brucell.
8. The Organic Chemistry of drug design and drug action-Richard. B. Silverman.
9. Fundamentals of medicinal chemistry-Gareth Thomas. John Wiley and sons England.

Course Outcomes:

CO1	Demonstrate an in-depth understanding of advanced concepts in medicinal chemistry and their application in drug discovery.
CO2	Understand and articulate the regulatory processes involved in drug approval, including the significance of clinical trials.
CO3	Demonstrate proficiency in advanced synthetic methodologies, including combinatorial chemistry, for the development of novel therapeutic agents.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**X**	**X**					
CO2	**X**	**X**	**X**				
CO3	**X**	**X**				**X**	**X**