DEFENCE INSTITUTE OF ADVANCED TECHNOLOGY (DU)
DEPARTMENT OF APPLIED CHEMISTRY
M.Sc. in Applied Chemistry

ABOUT THE DEPARTMENT:

The Department of Applied Chemistry started in 1976 with the aim to impart education and training to DRDO work force in the area of high energy materials and propellants. Over the years Department has moved on to cater to the need of DRDO and civilian students in order to bring the DRDO achievements closer to our society. The Department's aim is to contribute to our understanding of the chemical world through excellence in observational, theoretical and experimental science and to extend quantitative and other appropriate methodologies to address problems in the fields of applied chemical science. In Applied Chemistry, we are endowed with faculties who are dedicated teachers and distinguished researchers that carry out cutting-edge research in all modern areas of Applied Chemistry, as well as in inter-disciplinary areas like nanoscience and technology, high energy materials, polymer science and technology etc.

The first PhD of DIAT (DU) was from the Department of Applied Chemistry and currently it is amongst the Departments guiding very high number of PhD scholars and research publications in DIAT. In addition to PhD, there are numbers of M. Tech. students carrying their PG education. We provide a vibrant and creative learning environment for our students and researchers. We also participate extensively in R&D for various DRDO labs and industries.

In recent times, the Department has made significant contributions towards revenue generation through grant-in-projects and customized courses.

Description about the programmes:

M.Sc. in Applied Chemistry programme is designed to impart latest knowledge in the field of chemistry to defence personnel and civilian students. The course contents are related to concepts of chemistry, practical applications and skill development.

Eligibility:

Bachelors of Science (B.Sc.) in Chemistry, Physics, Mathematics or Biology.

DEFENCE INSTITUTE OF ADVANCED TECHNOLOGY (DU)
DEPARTMENT OF APPLIED CHEMISTRY
M.Sc. in Applied Chemistry
(Syllabus Effective from Acad. Year July 2025 as per NEP)
Batch 2025-2027

SEMESTER I			
No	**Course Code**	**Courses**	**Credit**
1	AC 501	Inorganic Chemistry-I	4
2	AC 502	Organic Chemistry-I	4
3	AC 503	Physical Chemistry-I	3
4	AC 504	Analytical Chemistry	3
5	AC 512	App Chemistry Laboratory-I	2
6	RM 501	Research Methodology	4
		Total Credit of I Semester	**20**
SEMESTER II			
No	**Course Code**	**Courses**	**Credit**
1	AC 521	Inorganic Chemistry-II	4
2	AC 522	Organic Chemistry –II	3
3	**PE-I**	**ELECTIVE -I**	3
4	**PE-II**	**ELECTIVE -II**	3
5	**PE-III**	**ELECTIVE -III**	3
6		On Job Training/Internship/Field Project (120 Hrs.)	4
		Total Credit of II Semester	**20**
LIST OF ELECTIVE COURSES FOR SEMESTER- II (Students are requested to selected any **THREE** courses from the following list of electives as PE –I, PE-II and PE-III with **equal credit ONLY**)			
1	AC 523	Molecular Spectroscopy-I	**3**
2	AC 524	Polymer Chemistry	**3**
3	AC 525	Recent Advances in Chemistry	**3**
4	AC 526	Forensic Chemistry and Toxicology	**3**
5		Elective from Applied Chemistry Dept with equal credit	**3**
6		Elective from any Department with **equal credit only**	
7		Online courses from NPTEL, MOOC. SWAYAM (equal credit)	**3**

		SEMESTER III	
No	**Course Code**	**Courses**	**Credit**
1	AC 531	Physical Chemistry-II	4
2	AC 532	Industrial Chemistry	3
3	**PE-IV**	**ELECTIVE IV**	3
4	**PE-V**	**ELECTIVE V**	3
5	**PE-VI**	**ELECTIVE VI**	3
6	RP 541	PROJECT - I	6
		Total Credit of III Semester	**22**
LIST OF ELECTIVE COURSES FOR SEMESTER- III (Students are requested to selected any **THREE** courses from the following list of electives as PE –I, PE-II and PE-III with **equal credit ONLY**)			
1	AC-533	Organo-metallic Chemistry and Catalysis	**3**
2	AC-534	Molecular Spectroscopy -II	**3**
3	AC-535	Defence Chemistry	**3**
4	AC 536	Paints, Pigments and Varnishes	**3**
5	AC- 537	Drug Design and Pharmacology	3
6		Elective from Applied Chemistry Dept with equal credit	**3**
7		Elective from any Department with **equal credit only**	**3**
8		Online courses from NPTEL, MOOC. SWAYAM (equal credit)	**3**

SEMESTER IV			
1	RP 542	PROJECT - II	18
		Total Credit of IV Semester	**18**

- On Job Training (OJT) evaluation to be conducted at the end of first year.
- Maximum of 6 credits to be awarded for Professional Electives (Approved by BoS for ONLINE courses NEPTL during II and III Semester.

DETAILED SYLLABUS OF SEMESTER –I

Course Code	Course Name	Credits
AC 501	**INORGANICCHEMISTRY-I**	**4**

Course Objectives:

- To develop an insight into the basic knowledge of inorganic chemistry
- To understand chemical bonding, coordination compounds, f-block elements and their theories
- To apply the knowledge and understanding in the areas of chemical bonding, coordination compounds and f-block elements for solving existing challenges faced in various chemical and industrial area

UNIT I: MAIN GROUP ELEMENTS

Hydrides, halides, oxides, oxoacids, nitrides, chalcogenides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon, phosphorous and sulphur. Industrial synthesis of compounds of main group elements. Chemistry of noble gases, pseudo-halogens, and interhalogen compounds. Acid-base concepts and principles

UNIT II: TRANSITION ELEMENTS

Coordination chemistry – structure and isomerism, theories of bonding. Energy level diagrams in various crystal fields, CFSE, applications of CFT. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, nephelauxetic effect and Racah parameter, charge-transfer spectra. Magnetic properties of transition metal complexes. Metal-metal multiple bonds

UNIT III: LANTHANIDES AND ACTINIDES

Recovery, Periodic properties, spectra and magnetic properties.

UNIT IV APPLICATION OF INORGANIC CHEMISTRY IN INDUSTRY

Manufacture of inorganic products on a large scale such as the heavy inorganics (chloralkalis, sulfuric acid, sulfates) and fertilizers (potassium, nitrogen, and phosphorus products

Course Outcomes

After completing this course, the students will be able to:

- To understand structure and bonding of main group elements,
- Students can familiarize with transition metals and their applications
- To understand the basic properties of rare earth elements
- Use of inorganic chemistry knowledge for application in Industry(heavy inorganics, fertilizers)
- Overall students can solve the problems related to Inorganic chemistry

Text Books

1. Concise Inorganic Chemistry - J. D. Lee. Wiley India
2. Inorganic Chemistry -Meissler & Tarr, Pearson New International
3. Mechanism of Inorganic Reactions – Fred Basolo, Ralph G. Pearson

Reference Books

Inorganic Chemistry: Principles of Structure and Reactivity – James E. Huheey

Course Code	Course Name	Credits
AC 502	**ORGANIC CHEMISTRY-I**	**4**

Course Objectives

- To develop an insight the basic knowledge of organic chemistry
- To understand structure and reactivity, aromatic nucleophilic substitution, stereochemistry of compounds
- To apply the knowledge and understanding in the areas of structure and reactivity, aromatic nucleophilic substitution, stereochemistry of organic compounds for solving existing challenges faced in various chemical and industrial areas

UNIT I: STEREOCHEMISTRY

Chirality and symmetry of organic molecules with or without chiral centres and determination of their absolute configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism and optical isomerism. Configurational and conformational effects, atrop isomerism, and neighbouring group participation on reactivity and selectivity/specificity.

UNIT II: REACTION MECHANISMS

Basic mechanistic concepts – kinetic versus thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through kinetics, identification of products, intermediates and isotopic labelling. Linear free-energy relationship – Hammett and Taft equations. Nucleophilic and electrophilic substitution reactions (both aromatic and aliphatic). Addition reactions to carbon-carbon and carbon-heteroatom (N and O) multiple bonds. Elimination reactions. Reactive intermediates – carbocations, carbanions, carbenes, nitrenes, arynes and free radicals. Molecular rearrangements.

UNIT III: ORGANIC SYNTHESIS

Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Concepts of multistep synthesis – retrosynthetic analysis, strategic disconnections, synthons and synthetic equivalents. Selectivity in organic synthesis – chemo-, regio- and stereoselectivity. Protection and deprotection of functional groups. Concepts of asymmetric synthesis – resolution (including enzymatic), de-symmetrisation and use of chiral auxiliaries, organo catalysis. Carbon carbon and carbon-heteroatom bond forming reactions through enolates (including boron enolates), enamines and silyl enol ethers. Stereoselective addition to C=O groups (Cram, Prelog and Felkin-Anh models).

Course Outcomes

After completing this course, the students will be able to:

- To understand the detailed aspects of Stereochemistry including optical and geometrical isomerism.
- To gain knowledge on methods of determination of reaction mechanism, various reaction intermediates

- Design and conceptualization of organic synthesis with several examples

Text Books

1. Stereochemistry Conformation and Mechanism -P.S. Kalsi
2. Stereochemistry of Organic Compounds - E. L. Eliel
3. A Guidebook to Mechanism in Organic Chemistry – Peter Sykes
4. Modern Methods of Organic Synthesis – William Carruthers, Iain Coldham
5. Organic Synthesis the disconnection approach – Stuart Warren
6. Advanced organic Chemistry: Jerry March, Wiley &Sons

Reference Books: Organic Chemistry -Clayden, Greeves, Warren and Wothers

Course Code	Course Name	**Credits**
AC 503	**PHYSICAL CHEMISTRY-I**	**3**

- To understand the concept of thermodynamics w.r.t. to entropy, free energy, temp etc.
- To understand chemical potential and their variation with Temperature and Pressure. Study of non-ideal systems, Gibbes Duhem equations and applications
- Study of thermodynamic criteria for non-equilibrium states, Basic Postulates and Methodology with different laws and relations.
- To understand the concept of distribution, corresponding distribution laws and applications
- Study of ideal and non-ideal solutions w.r.t to various laws and their applications.

UNIT I: THERMODYNAMICS

Brief description of the laws of thermodynamics, Concepts of Entropy and Residual Entropy, Free energy and its Temperature dependence, Thermodynamic Equilibria and Free Energy Functions, Physical Equilibria Involving Phase Transitions, Thermodynamic Maxwell Relations, Statistical Thermodynamics

UNIT II: EQUILIBRIUM THERMODYNAMICS

Partial molar quantities, Determinations of the partial molar quantities, Chemical potential and other thermodynamic functions, Variation of chemical potential with temperature and pressure, Chemical potential for Ideal gas mixture, Thermodynamic Functions of Mixing, Concepts of Fugacity and its determination, non-ideal systems: Excess functions for non-ideal solutions.

UNIT III: NON-EQUILIBRIUM THERMODYNAMICS

Thermodynamic criteria for non-equilibrium states, Basic Postulates and Methodology, Onsager's Theory, Phenomenological Laws and Equations, Transformations of the generalized fluxes and forces, Microscopic Reversibility and Onsager's Reciprocal Relations, Entropy Production and entropy flow, Theorem of Minimum Entropy Production, Chemical Reactions, Coupled Reactions and Electro-kinetic Phenomena.

UNIT IV: CHEMICAL EQUILIBRIUM

Ideal and Non-ideal solutions, Raoult's Law and Henry's Law, Chemical equilibria. Dependence of equilibrium constant on temperature and pressure. Ionic mobility and conductivity. Debye-Hückel

limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Nernst Equation and its application, relationship between Electrode potential and thermodynamic quantities.. Phase rule. Clausius- Clapeyron equation. Phase diagram of one component systems: CO2, H2O, S; two component systems: liquid- vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics.

Course Outcomes

After completing this course, the students will be able to:

- Understanding of basic chemical thermodynamics
- To familiarize equilibrium and non-equilibrium thermodynamics
- To understand and application of various laws of thermodynamics

Text Books

1. Elements of Chemical thermodynamics – Leonard Nash, Dover Publications
2. Chemical Thermodynamics–Peter A. Rock
3. A text book of Physical Chemistry (Vol-V) – K. L. Kapoor

Reference Books

Fundamentals of Molecular Spectroscopy – Colin N. Banwell

Course Code	Course Name	**Credits**
AC 504	**ANALYTICAL CHEMISTRY**	**3**

- To understand basic concept of instrumental methods of analysis, their advantages, disadvantages and applications.
- Study the principles and work of mass spectroscopy
- To understand the principles and working electroanalytical techniques
- Understand basic principles of differential pulse volumetry and coulometry and study applications of cyclic voltammetry in organic and inorganic chemistry.
- Study of florescence energy and their applications in measurement.
- To understand the basic principles of TGA and DSC and their inorganic applications.

Unit I: CONCEPTS OF ANALYTICAL CHEMISTRY

Classification of Analytical Methods: An overview of Classical methods, Types of Instrumental methods Selection of an analytical methods and their performance criteria. Concepts of optical methods: Electromagnetic spectrum, transitions, components in optical instruments, sources, description of LASER, wavelength selectors, mono chromator functioning, effective band width, detectors and description of diode array type detector. Atomic Absorption Spectrometry: Principle, interferences, use of electro thermal analyser,

Unit II: ELECTRO-ANALYTICAL TECHNIQUES

Electrochemistry, Nernst equation, Potentiometry, Amperometry, Electrochemical analysis, Standard hydrogen electrode (SHE), Calomel electrode, Ion selective electrodes (ISE), etc. and their applications.

Unit III: SPECTROCHEMICAL METHODS

Introduction, electronic spectra and molecular structure, Concepts of optical methods: Electromagnetic spectrum, transitions, components in optical instruments, General instrumentation for spectrometer, Absorbance and chromophores, Beer-Lambert's Law.

Unit IV: THERMAL ANALYSIS

Thermogravimetric analysis (TGA) and its applications to organic, inorganic and polymer material characterization. Differential scanning calorimetry (DSC) and its application.

Unit V: CHROMATOGRAPHY

Fundamental of chromatographic separations, retention time, retention volume, distribution ratio, K factor. TLC, High Performance Liquid Chromatography (HPLC) its application to organic compounds. Gas Chromatography (GC) and applications of chromatography.

Course Outcomes

After completing this course, the students will be able to:

- To understand the basic concepts of analytical chemistry
- To understand various types of spectroscopic techniques and their applications
- To thermal analysis
- To understand the detailed aspects of various separation methods

Text Books

1. Analytical Chemistry Skoog and Skoog,
2. Electroanalytical Methods, Fritz Scholz, Springer
3. Thermal Analysis Techniques and Applications, N.N. Kaushik and Shukla

Reference Books

Analytical Chemistry, Alka Gupta, Pragati Publication

Course Code	Course Name	**Credits**
AC 512	**APPLIED CHEMISTRY LABORATORY-I**	**2**

Course Objectives:

- Understand the process of synthesis and analysis of coordination complexes
- To develop an insight into the various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams
- Develop skill in synthesis of organic compound, their purification by systematic analysis
- Develop a skill of volumetric estimation of by titration methods

(ANY 10 PRACTICAL'S FROM THE FOLLOWING LIST)

(I) Introduction to chemical laboratory safety and personal safety

(II) PH METRIC TITRATIONS (Any Two)

1. To determine the amount of a strong acid (like HCl) present is the given solution by titration against a strong base (like NaOH) using a pH meter.
2. To determine the amount of a weak acid (like weak) present is the given solution by titration against a strong base (like NaOH) using a pH meter
3. To determine the ISO ELECTRIC POINT of glycine by titration it with strong acid and strong base

(III) CONDUCTOMETRIC TITRATION (Any Two)

1. Study of conductometric titration of a weak acid (CH_3COOH) against a strong base (NaOH)
2. Study of conductometric titration of a mixture of strong acid (HCl) and weak acid(CH3COOH) against a strong base (NaOH)
3. Estimation of Boric acid using NH_4OH by conductometric method.

(IV) INORGANIC SYNTHESIS (Any Two)

1. Tris (Acetyl-acetonate) Iron (III) complex
2. Hexa-ammine nickel (II) chloride/sulphate
3. Bis(ethylene-di-ammine) copper (II) sulphate
4. Synthesis of Ni-DMG complex
5. Synthesis of Copper acetyl acetonate (II) complex

(V) ORGANIC SYNTHESIS (Any Two)

1. To prepare benzoic acid from benzaldehyde by oxidation method
2. To prepare benzylidene aniline by condensation of benzaldehyde with aniline
3. To prepare cyclohexanone oxime from cyclohexanone
4. 2,4, Di nitro pheyl hydrazone derivatives of benzaldehyde
5. Anthracene to anthraquinone
6. Benzoin to benzil

(VI) VOLUMETRIC ESTIMATION (Any Two)

1. To determine the total hardness of given water sample
2. To determine the chemical oxygen demand of the given water sample
3. To determine the acidity of water from given water sample
4. To estimate the amount of nickel present in the given nickel sulphate solution

(V) INDUSTRIAL VISIT

Course Outcomes

After completing this course, the students will be able to:

- To under the operation of conductometry and pH metry
- To study various physic-chemical properties of mixtures
- To understand the methods of synthesis, volumetric analysis.
- To develop an insight into the various experimental techniques

Selected Text Books

1. Elias, A.J., A Collection of Interesting General Chemistry Experiments, Uni Press, (India) Pvt. Ltd., 2002.
2. Roesky, H. W.; Möckel, K., Chemical Curiosities: spectacular experiments and inspired quotes, VCH, 1996. Hand-outs prepared for the laboratory experiments: collections from various literature sources
3. l.G., Svehla, 'Vogel's Qualitative Inorganic Analysis',6thEdn., Orient Longman New Delhi, l987.
4. V.V., Ramanujam, 'Inorganic Semi-micro Qualitative Analysis', 3rd Edn., National Publishing Company, Madras, l990.
5. A. I. Vogel, Vogel's Text Book of Quantitative Inorg Analysis, 6th Ed., Pearson Ed 2000.

Reference Books

1. J. D. Woolins, Inorganic Experiments, Wiley-VCH Verlag GmbH and Co., 2003.
   W. G. Palmer, Experiments in Inorganic Chemistry, Cambridge University Press

DETAILED SYLLABUS OF SEMESTER -II

Course Code	Course Name	Credit
AC 521	**INORGANIC CHEMISTRY-II**	**4**

Course Objectives:

- To develop an insight into the basic knowledge of inorganic chemistry
- To understand the concept of bioinorganic chemistry with mechanism of oxygen transport
- To understand role of metal in biological fields.
- To understand applications of bioinorganic chemistry

UNIT I:. BIO-INORGANIC CHEMISTRY

Occurrence and availability of Inorganic elements in organisms, transport and storage of Inorganic elements, Dose response of an element, biological function of inorganic elements, beneficial and toxic elements, essential and tracemet

Sidrophore, phytosidrophores, ferretin, transferrin, hemosiderine, biomineralization, assembly of advanced materials e.g. calcium phosphate, calcium carbonate, ironbiominerals.

Oxygen transport and storage through hemoglobin and myglobin, Alternative oxygen transport in lower organisms.

UNIT II: Photosynthesis: Photochemistry, absorption spectra of photosynthetic pigments, photophosphorylation - energy conversion process Role of Alkali and alkaline earth metals in neuro sensation. Ion Channels, ion pumps, magnesium catalysis of phosphate, ubiquitous regulatory role of calcium.

UNIT III: Biological ligands for metal ions: Macrocycle, nucleobase, nucleotides and nucleic acids, coordination of metals by protein. Heme and nonheme protein, oxygen uptake, structure and function of haemoglobin, myoglobin, hemocyanin, hemotherine Principle involved and role of various metals viz. Zn, Fe, Cu and Co; carboxy peptidase, carbonic anhydrase, Alcohol dehydrogenase, Zinc Fingures, other gene regulatory Zinc proteins, cobalomine, mutase activities of coenzyme B12.

UNIT IV: APPLICATIONS OF BIO-INORGANIC CHEMISTRY

Medicinal therapy; metal deficiency and disease, toxic effect of metals, metals used for diagnosis and chemotherapy, gold compound as Anti-Rheumatic agent. Nitrogen cycle; biological nitrogen fixation, metalloenzyme in biological nitrogen cycle, molybdenum nitrogenase, other nitrogenasemodel, Nanoparticles for antimicrobial applications

Course Outcomes

After completing this course, the students will be able to:

- The concept of Bioinorganic Chemistry and its biological applications
- To understand photosynthesis and other photochemical reactions
- Role of bioinorganic chemistry in nature
- Important Applications of Bio-inorganic chemistry

Text Books

1. The Organometallic Chem. of the Transition Metals, Robert H. Crabtree, Wiley 2014

2. Organo transition Metal Chemistry: From Bonding to Catalysis by John F. Hartwig, University Science Books, 2009
3. Organo transition Metal Chemistry, Anthony F. Hill, Royal Society of Chemistry, 1. Tutorial Chemistry Text, 2002. Chapters 1 to 7.
4. Inorganic Chem – Principles of Structure & Reactivity, J E Huheey, Elllen A Keiter &

Reference Books

5. Richard L Keiter, IV Edition(2005)

Course Code	Course Name	**Credits**
AC 522	**ORGANIC CHEMISTRY-II**	**3**

Course Objectives:

- To impart advanced knowledge of reactive intermediates, stereochemistry of organic compounds\ pericyclic reactions, heterocyclic compounds and applications in bimolecule
- To understand the chemistry of heterocylic compounds
- To understand structure and properties of bomolecules.
- To understand the applications of some instrumentation in analysis of organic compounds.

UNIT I: PERICYCLIC REACTIONS AND PHOTOCHEMISTRY

Electro cyclic, cyclo-addition and sigma tropic reactions. Orbital correlations – FMO and PMO treatments, Woodward-Hoffmann rule. Photochemistry of alkenes, arenes and carbonyl compounds. Photooxidation and photoreduction. Di-π-methane rearrangement, Barton-McCombie reaction, Norrish type-I and II cleavage reaction.

UNIT II: HETEROCYCLIC COMPOUNDS

Introduction to heterocyclic compounds and their applications, Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole, quinoline and iso quinoline.

UNIT III: BIOMOLECULES

Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, chemical structure determination of peptides and proteins, structural features of proteins, nucleic acids, lipids, steroids, terpenoids, carotenoids, and alkaloids.

UNIT IV: ANALYSIS TECHNIQUES IN ORGANIC CHEMISTRY

Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.

Course Outcomes

After completing this course, the students will be able to:

- Understanding of Electro cyclic /cyclo-additions and sigma tropic reactions
- To understand photo-oxidation and photo reduction and related rearrangements
- To understand hetero-cyclic and their applications in bio-molecules and drugs
- To familiarize students in various analysis techniques

Selected Text Books

1. A Guidebook to Mechanism in Organic Chemistry **– Peter Sykes**

2.	Organic Chemistry **-Clayden, Greeves, Warren and Wothers**
3.	Modern Methods of Organic Synthesis **– William Carruthers, Iain Coldham**
4.	Organic Synthesis the disconnection approach **– Stuart Warren**
5.	Pericyclic Reactions – R T Morrison, R N Boyd

Reference Books

Organic Photochemistry – James H. Coxon, B. Halton

LIST OF ELECTIVE COURSES FOR III SEMESTER

Course Code	Course Name	Credits
AC 523	**MOLECULAR SPECTROSCOPY-I**	**3**

Course Objectives:

- Students understand fundamental principles of Spectroscopy and theories involved
- Understand the concept of atomic spectra
- To ounder stand the concept of group theory
- To understand the concept of vibrational spectra

Basic elements of spectroscopy, Interaction of Radiation with matter, Time dependent perturbation. Einstein coefficients. Integrated absorption coefficients. Transition dipole moments and general selection rules based on symmetry ideas.

UNIT I: INTRODUCTION TO MOLECULAR SPECTROSCOPY

Rotational spectroscopy of diatomic molecules. Rigid rotor approximation. Determination of bond lengths and/ or atomic masses from microwave spectral data. Effect of isotopic substitution. Non-rigid rotator. Classification of polyatomic molecules. Energy levels and spectra of symmetric top molecules and asymmetric top molecules. First order Stark effect.

UNIT II: ATOMIC SPECTRA

Characterization of atomic states. Microstate and spin factoring methods. Hund's rules. Derivation of spin and orbital selection rules (based on recursion relations of Legand re polynomials). Spectra of complex atoms. Zeeman and Stark effects. Construction of hybrid orbitals using symmetry aspects. Atomic Spectroscopy: The energies of atomic orbitals; Hydrogen atom spectrum; Orbital and spin angular momenta, total angular momentum; the fine structure of hydrogen atom spectrum; The spectra of complex atoms: Singlet and triplet states; Russell-Saunders coupling; Term Symbols and selection rules. Franck-Condon principle, electronic and Raman spectroscopy of diatomic and polyatomic molecules.

UNIT IV: VIBRATIONAL SPECTROSCOPY

Homonuclear and heteronuclear diatomic molecules. Extension to polyatomic linear molecules. Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. Force constants and amplitudes. A harmonic oscillator. Overtones and combination bands. Introduction to normal coordinate analysis.

Dissociation energies from vibrational spectral data. Vibration-rotation spectra, P, Q and R branches. Breakdown of the Born-Oppenheimer approximation. Nuclear spin effect.

Symmetry of normal coordinates. Use of Group Theory in assignment of spectra and selection rules for simple molecules.

Course Outcomes

After completing this course, the students will be able to:

- To study understand the principles of atomic and molecular spectroscopy
- To understand theory of vibrational spectroscopy

Text Books

BOOKS (MOLECULAR SPECTROSCOPY)

1. Introduction to Spectroscopy, Donald Pavia,
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley & Sons, New York, 5th Ed.1991.
3. Electron Paramagnetic Resonance, Elementary Theory and Practical Applications, Weil, John A, J. R. Bolton, and Wertz, J. E, Wiley-Inter science, New York, (1994).
4. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin, & S. Cradock, 2nd Ed.1991, CRC Press, Boca Raton, Florida,
5. Principles of Fluorescence Spectroscopy, Lackowicz, Plenum Press, (New York,1983)

Reference Books

D. W. Williams and Flemming, Spectroscopic methods of organic compound

Course Code	Course Name	**Credits**
AC 524	**POLYMER CHEMISTRY**	**3**

Course Objectives:

- To understand fundamental concepts and techniques in polymer chemistry
- To understand reaction mechanism and characterization techniques of polymers
- To understand different types of polymers.
- Students get knowledge regarding commercial applications of polymers

UNIT I: FUNDAMENTAL CONCEPTS

Functionality - principle of polymerisation - addition, condensation polymerisation - ring opening polymerisation - classification - production from coal tar and petrochemicals - Techniques of polymerisation - gas polymerisation, - bulk, solution, suspension and emulsion - melt condensation. Mechanism of polymerisation and general characteristics - free radical - cationic, anionic and coordination polymerisation (Ziegler-Natta catalyst) auto acceleration - Kinetic chain length - degree of polymerisation, kinetics of polymerisation (Detailed study) - copolymerisation.

UNIT II: POLYMER CHARACTERISATION

Molecular weight, MWD - Mn, Mw, Mv and Mz - end group analysis - viscometry - osmometry - Light scattering - spectral analysis-Thermal properties – Polymer rheology, Electrical properties,

Mechanical and dynamic properties - polymer degradation. Phase transitions of polymers, crystallization and glass transition, mechanism of glass transition, methods of determining Tg.

UNIT III: STUDIES OF INDIVIDUAL POLYMERS

Plastics - polyolefins, polystyrenes, acrylics, polyesters, polyamides, cellulose, polyurethanes, Inorganic polymers, FIR plastics – GR plastics. alkyd resins, epoxy resins - phenolics - Melamine resins - compounding of plastics - rubber - elastomer - vulcanisation, compression mouldings - injection mouldings - lamination. Biopolymers - Biomaterials - medicinal applications of polymers - High temperature and fire-resistant polymers. Polymer concrete - polymer impregnated concrete - conducting polymers - polymeric reagents.

UNIT IV: POLYMER FOR COMMERCIAL APPLICATIONS

Technology of Production, Properties and Applications of Chain growth polymers Polyethylene such as HDPE, MDPE, LDPE, LLDPE, HMWPE, UHMWPE, EVA, crosslinked PE, chlorinated PE, Polypropylene (PP), Polyisobutylene (PIB)), Acrylics (PMMA & PAN), Poly-vinyles like PVC, PVDC & CPVC, Polystyrene & Co-polymer (HIPS, SBR, SAN & ABS), Poly(vinyl acetate).

Course Outcomes

After completing this course, the students will be able to:

- To understand fundamental concepts and techniques in polymer chemistry
- Methods of characterization of polymers.
- learn various important polymers.
- Familiarize polymers having commercial applications

Text Books

1. P.J. Flory, 'Principles of Polymer Chemistry', Cornell Press, (Recent Edition).
2. Jr. Billmeyer, 'Test Book of Polymer Science', Fred, W. John Wiley & Sons, N. York, l984.
3. Dan Campbell, Richard A. Pethrick, Jim R. White, Polymer Characterization: Physical Techniques, 2nd Edition, CRC Press, 2012.
4. F. Rodrigues, 'Principles of Polymer Systems', M. Elpaw Hill Book Company, 2nd Ed., l982.
5. K.J. Saunders, 'Organic Polymer Chemistry', Chapman & Hall, London, l973.

Reference Books

Sabu Thomas & Dominique Durand, Handbook of Biopolymer-Based Materials: From Blends and Composites to Gels and Complex Networks, Wiley – VCH, 2013.

Course Code	Course Name	**Credits**
AC- 525	**RECENT ADVANCES IN CHEMISTRY**	**3**

Course Objectives:

- To understand background and discoveries of recent advances chemical technologies
- To understand the concept of green chemistry and its methods synthesis
- To understand the development in biochemistry and biotechnology
- To understand the concept of smart materials and applications.

UNIT-1. INTRODUCTION

Background and eminent discoveries in Chemical Technology, Frontiers in Electrochemistry: Equilibrium properties of electrolytes, electrode potential, electro analytical techniques.

UNIT-2 : GREEN CHEMISTRY

Principals of green chemistry, sustainability, selected examples of green synthesis.

UNIT-3: BIOCHEMISTRY & BIOTECHNOLOGY:

Cell Biology and Physiology, Bioenergetics, Industrial Biotechnology.

UNIT-4. CHEMISTRY OF SMART MATERIALS:

Smart materials, their properties, distribution by type chemistry of macromolecules, phase change materials

Course Outcomes

After completing this course, the students will be able to:

- To familiarize students in important discoveries of chemical technologies
- To understand electrochemical techniques
- To understand biochemistry and biotechnology
- To understand the chemistry of smart materials

Text Books

a. Electrochemistry for Chemists, Sawyer, Sobkowiak, & Roberts, John Wiley, 1995.
b. Concepts in Transition Metal Chemistry, Crabb, Eleanor, Moore, Elaine, Smart, Lesley E.RSC Publishing, 2010
c. Highlights in Bioorganic Chemistry, Carsten Schmuck, Helma Wennemers, Wiley-VCH, 2004.

Reference Books

Essentials of Pharmaceutical Chemistry, D. Cairns 5. Intelligent Materials, M. Shahinpoor, H.-J. Schneider, RSC, 2008

Course Code	Course Name	**Credits**
AC 526	**FORENSIC CHEMISTRY AND TOXICOLOGY**	**3**

Course Objectives

- To understand the concept of forensic chemistry
- To understand the standard methods and general instrumental techniques Understand the concept of explosives and classifications.
- To understand toxicology and pharmacology along with drugs types and classifications.

UNIT I: Introduction to Forensic chemistry, sampling of chemical evidences, presumptive, screening (colour/ spot test), inorganic analysis. Chemistry of fire, searching of fire scene, collection, preservation and examination. Adulteration in Petroleum products. Standard methods and general instrumental techniques based on Spectroscopy (UV, PL, Atomic, Raman, IR, xrd), Electrochemistry (Potentio, conducto, Voltammetry) , Chromatography (GC,TLC, HPLC), analysis of beverages- alcoholic and non-alcoholic, country made liquor and medicinal preparations containing alcohol as constituents. Significance of alcohol in breath and breath screening devices. Analysis of Fertilizers/ insecticides/ pesticides/ biocides.

UNIT II: Explosives Classification of explosives, synthesis and characteristics of Tri-nitro toluene (TNT), Pentaerythritol tetranitrate (PETN) and Research and Development Explosives (RDX). Explosion process, blast waves, searching of scene of explosion. Post blast residue collection and analysis, blast injuries and detection of hidden explosives. Improvised explosive devices.

UNIT III: Toxicology and Pharmacology Definition, classification of poisons- organic, inorganic, metallic, non-metallic etc. Acute and chronic poisoning, Accidental, homicidal and suicidal poisoning, Extraction and identification of commonly used poisons. Dosage, Frequency, Route of administration, Absorption, distribution and metabolism and factors affecting metabolism and excretion. Toxicological techniques.

UNIT IV: Drugs of Abuse Natural and synthetic drugs of abuse. Drug dependence, classification of drugs- Narcotics, Hallucinogens, Depressants, Stimulants, Anabolic steroids. Psychotropic and Psychedelic drugs of abuse. Field and laboratory tests of drugs of abuse. Instrumental methods of analysis, collection, preservation and transportation of drug evidences

Course Outcome

- Students get knowledge regarding forensic chemistry
- Knowledge of methods and general instrumental techniques based on Spectroscopy
- Understand the concept of explosives and classifications.
- Clear the concept of toxicology and pharmacology along with drugs types and classifications.

References:

1. Niesink, RJM; Toxicology- Principles and Applications, CRC Press,1996 2. Modi, JP, Textbook of Medical Jurisprudence & Toxicology, N.M. Tripathi Pub,2001
2. Chadha, PV; Handbook of Forensic Medicine & Toxicology, Jaypee Brothers, New Delhi,2004
3. Morrison R.T and Boyd R. N;Organic Chemistry 6th Ed Prentice Hall, 2003
4. Lab Procedure Manual-Petroleum Products ,Dir. of Forensic Science, MHA, Govt. of India, 2005
5. Working Procedure Manual on Chemistry; Directorate of Forensic Science MHA Govt. of IndiA
6. Bureau of Indian Standard Specifications related to Alcohols and Petroleum Products.
7. Standard Methods of Chemical Analysis, 6th Ed.Van Nostrand Reinhold, New York, 1969

- The students can optd **ANY THREE P**rofessional **E**lectives (**PE**) from the program of Applied Chemistry Department as well as all the program of another department of DIAT (with equal credit ONLY)
- Also, can optd online courses from NPTEL, MOOC. SWAYAM (equal credit)
- Maximum of 6 credits to be awarded for Professional Electives (Approved by BoS) for ONLINE courses NEPTL during II and III Semester.
- On Job Training (OJT) evaluation to be conducted at the end of first year.

DETAILED SYLLABUS OF SEMESTER -III

Course Code	Course Name	Credits
AC 531	**PHYSICAL CHEMISTRY-II**	**3**

Course Objectives:
To apply the knowledge and understanding in the areas of solid-state chemistry
To understand concept of chemical kinetics
To understand surface chemistry for solving existing challenges faced in various chemical and industrial areas

UNIT I: CHEMICAL KINETICS

Elementary, parallel, opposing and consecutive reactions. Steady state approximation. Mechanisms of complex reactions. Uni-molecular reactions. Potential energy surfaces and classical, Activated Complex Theory, Potential energy surfaces- attractive and repulsive forces, Chain reactions and oscillatory reactions, Photochemical reactions. Enzyme kinetics: Michaelis-Menten mechanism-single and double intermediates, Enzyme inhibition- reversibility and products inhibition, Molecular beams, principle of crossed-molecular beams. Molecular encounters and principle parameters, e.g. Impact parameter, Collision cross-section, Reaction cross section and relation between reaction cross-section and reaction rate (single velocity). Dependence of collisional cross-section on translational energy. Probing the transition state, Dynamics of barrier-less chemical kinetics in solution, dynamics of uni-molecular reactions. Luminescence and energy transfer processes, study of kinetics by stopped-flow technique, relaxation method, flash photolysis and magnetic resonance method. Kinetics of solidstate reactions.

UNIT II: SURFACE CHEMISTRY

Surface tension, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET adsorption isotherm, Surface films (Electro-kinetic phenomenon), Catalytic activity at surfaces. Catalysis on metal surfaces, Metal oxide surfaces. General characteristics of catalytic reactions, Acid-base catalysis, Enzyme catalysis, Mechanism and kinetics of enzyme-catalysed reactions, Michaelis-Menten equation, Heterogeneous catalysis, Surface reactions, Autocatalysis and Oscillatory reactions. Surface active agents, Classification of Surface active agents, Co-surfactants, Micellization, Microemulsions, Aggregate structures of surfactants, Critical Micellar Concentration, Surfactant packing parameter, Factors affecting the CMC of surfactants, Counter ion binding to micelles, Hydrophobic interaction, Thermodynamics of micellization, Mass action models, Solubilization and Phase diagram of ternary microemulsion system

UNIT III: SPECTROSCOPY

Atomic Spectroscopy: The energies of atomic orbitals; Hydrogen atom spectrum; Orbital and spin angular momenta, total angular momentum; the fine structure of hydrogen atom spectrum; the spectra

of alkali metal atoms. The spectra of complex atoms: Singlet and triplet states; Franck-Condon principle, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Relationship of transition moment integral with molar extinction coefficient and oscillator strength electronic spectra of polyatomic molecules. Electronic spectra of transition metals Emission spectra: radiative and non-radiative decay, internal conversion, spectra of transition, metal complexes, charge-transfer spectra.

Course Outcomes

After completing this course, the students will be able to:

- Understanding rate laws based on Chemical Kinetics
- Understanding different aspects of surface chemistry
- To understand various phenomena of group theory and spectroscopy

Text Books

1.Chemical Applications of Group Theory – F. Albert Cotton

2.Fundamentals of Molecular Spectroscopy – Colin N. Banwell

Reference Books

Physical Methods – Russel S. Drago

Course Code	Course Name	**Credits**
AC 532	**INDUSTRIAL CHEMISTRY**	**3**

Course Objectives:

- To understand the scalability of laboratory reactions in Industry
- To understand proper operations and safety in industry
- To understand reduction process by use of ammonia
- To understand different types of reactions in industry

UNIT I: CHEMICAL INDUSTRY

Introduction, Chemical production, Raw materials and their sources, Parameters of Chemical Industry, Plant location, Safety, Construction of plant, Management for productivity and creativity, Training for plant procedure and labour, Chemical process technology, Important chemical processes, Classification of chemical reactions, Batch and continuous operations, Industrial chemical reactions, Conversion, Selectivity and Yield, From Chemistry Laboratory to Industrial Scale

UNIT II: INDUSTRIAL PROCESSES AND THEIR SAFTEY:

Introduction, Unit operations- Conveying, Crystallization, Distillation, Drying, Evaporation, Filtration, Leaching, Liquid-liquid extraction, Membrane separation, Particle size reduction and enlargements, Solid -solid separation.

Introduction, Industrial unit processes- Definition and examples of Alkylation, Amination by amino lysis, Calcination, Carbonylation, Double decomposition, Esterification, Halogenation, Hydro formulation, Hydrolysis, Nitration, Oxidation, Polymerisation, Sulphonation.

UNIT III: AMINATION BY REDUCTION:

Introduction and definition, Methods of reduction, Metal and acid Reductions, Metal and alkali reductions, Amination by amino-lysis, aminating agents, physical and chemical factors affecting amino lysis, manufacture of aniline by reduction of nitrobenzene, p-phenylenediamine, aniline by continuous ammonolysis.

UNIT: IV IMPORTANT INDUSTRIAL REACTIONS

A. **INTRODUCTION AND TYPES** of Alkylation, alkylating agents, factors controlling alkylation, equipment for alkylation, alkylation methods for i) Alkyl-aryl sulphonates, ii) Ethylbenzene, iii) Dimethylaniline.

B. **HYDROLYSIS:** Definition and scope, hydrolyzing agents, materials susceptible to hydrolysis, kinetics, thermodynamics and mechanisms of hydrolysis, Equipment for hydrolysis, Technical operations involving hydrolysis.

C. **OXIDATION:** Liquid and vapour phase oxidations, apparatus for Oxidation, technical oxidation of acetaldehyde, iso-propyl alcohol, naphthalene, and naphthalene sulphonic acid. Esterification: Esterification of organic acids and derivatives, esters by addition.

D. **HYDROGENATION:** Catalytic hydrogenation, Apparatus, Industrial processes, Hydrogenation of fatty oils, Synthesis of methanol. Nitration: Introduction, Nitrating reagents, Aromatic nitration, Nitration of paraffinic hydrocarbons, nitrate esters, N-nitro-compounds, process equipment for technical nitration, Mixed acid nitration,

UNIT V : Chemical biology, artificial intelligence in industrial chemistry etc.

Course Outcomes

After completing this course, the students will be able to:

- To understand the scalability of laboratory reactions in Industry
- To understand operations and safety in Industrial reactions
- In-depth study of Amination/Alkylation reactions

Text Books

1. Unit Processes in Organic Synthesis- P. H. Groggins, Tata McGraw-Hill, 5th Edition, New Delhi, 2010.
2. Dryden's Outline of Chemical Technology, M. Gopal Rao, Marshall Sittig East-West Press Pvt. Ltd., 3rd Edition, 2014.
3. Chemical Process Industries- B. Shreve., Tata McGraw Hill, New Delhi, 2012.
4. Comprehensive Industrial Chemistry, P. G. More, Pragati Edition, Meerut, 2010.

Reference Books

1. Encyclopaedia of Chemical Technology, Kirk and Othmer, John Wiley & Sons, 2000

SYLLLABUS OF ELECTIVE COURSES FOR III SEMESTER

Course Code	Course Name	Credits
AC 533	**ORGANO-METALLIC CHEMISTRY AND CATALYSIS**	**3**

Course Objectives:

- To understand the basic of organometallics and their synthesis.
- To understand bonding, properties and their applications
- To understand the role of organometallic reagent in organic synthesis.
- To understand importance of organo metallic reagent

UNIT I: ORGANOMETALLICS

18-Electron rule, Oxidation state, co-ordination number and geometry. Effect of complexation with different metals (4d and 5d); Alkyls and hydrides: alkyls and aryls (metal alkyls stabilized carbanion, β-elimination, stable alkyls, agostic alkyls, reductive elimination, preparation of metal allyls). metal hydrides: characterization, synthesis, reactions, bridging hydrides.

UNIT II: SYNTHESIS, BONDING, PROPERTIES & APPLICATIONS OF ORGANOMETALLICS

Pi complexes, synthesis, bonding. Properties and application of alkenes and alkynes, allyls, diene, cyclopentane, dienyl, arenes. Distinctive organometallic Reactions - Addition and abstraction: Nucleophilic addition to CO, Nucleoplic addition to polynes and polyenyls, nucleophilic abstraction in hydrides, acyls, electrophilic addition and abstraction, single electron transfer and radical reactions, Oxidative – Addition reactions, Insertion reaction – at MC bond & M-H bond, Trans-metallation reaction and Cyclization reaction, Ring Expansion reaction, Condensation reaction, Sigma-pi rearrangement reaction, Ligand & Metal exchange reactions.

UNIT III: ORGANOMETALLIC REAGENTS IN ORGANIC SYNTHESIS

Alkene isomerisation, hydrogenation, hydroformylation, hydrocyanation, hydroboration, coupling reaction. Carbon-carbon bond formation through coupling reactions – Heck, Suzuki, Stille, Sonogoshira, Negishi, Kumada, Hiyama, Tsuji-Trost, olefin metathesis and McMurry.

UNIT-IV:IMPORTANT ORGANOMETALLIC REACTIONS

Homogeneous catalysis –Catalytic applications of organometallic complexes - Alkene hydrogenation, Synthesis gas (H2/CO), Hydroformylation, Mosanto-acetic acid process, Wacker- Schmidt process and Ziegler-Natta catalysis. Bioorganometallic chemistry and surface organometallic chemistry.

Course Outcomes

After completing this course, the students will be able to:

- To understand fundamentals of Organometallic chemistry
- To familiarize with the synthesis, property studies and application of Organometallic chemistry
- Applications of Organometallic reagents in Organic Synthesis

Text Books

1. Organometallics: A concise Introduction, Ch.Elshebroicn and A Salzer, VCH, 2006.

2. transition Metal Chemistry: Applications to Organic Synthesis, S.G. Davies, Pergamon 1982.

Reference Books

Basic Organometallic Chemistry, Anil Elias

Course Code	Course Name	**Credits**
AC 534	**MOLECULAR SPECTROSCOPY II**	**3**

Course Objectives:

- To understand and apply various spectroscopic techniques for characterization.
- To understand concept of electronic spectroscopy
- To understand difference between various spectroscopic techniques.

UNIT I: RAMAN SPECTROSCOPY

Stokes and anti-Stokes lines. Polarizability of molecules. Rotational and Vibrational Raman spectroscopy. Selection rules. Polarization of Raman lines.

UNIT II: ELECTRONIC SPECTROSCOPY

Diatomic molecules. Selection rules. Breakdown of selection rules. Franck-Condon factors. Dissociation energies. Photoelectron spectroscopy of diatomic (N2) and simple polyatomic molecules (H2O, formaldehyde). Adiabatic and vertical ionization energies. Koopmans' theorem. Qualitative ideas of solvent effects- viscosity, polarity, hydrogen bonding.

UNIT III: NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (NMR)

General introduction and definition; chemical shift; spin–spin interaction; shielding mechanism of measurement; chemical shift values and correlation for protons bonded to carbons [aliphatic; olefinic; aldehydic and aromatic] and other nuclei [alcohols; phenols; enols; acids; amines; amides and mercaptans]; chemical exchange; effect of deuteration; complex spin-spin interaction between two; three; four; and five nuclei [first order spectra]; virtual coupling. Stereochemistry; hindered rotation; Karplus curve variation of coupling constant with dihedral angle. Application of ^{1}H and ^{13}C NMR spectroscopy including COSY, NOESY, NOE techniques in the structural determination of complex organic systems. Application in conformational analysis. Multinuclear NMR of various inorganic and organometallic compounds. Data Interpretation, case studies.

UNIT IV: ELECTRON SPIN RESONANCE

Electron spin and Magnetic moment, Resonance condition in ESR and significance of 'g' value. ESR spectra of organic free radicals, Electron Exchange reactions, applications of ESR.

UNIT V: PRINCIPLES OF MOSSBAUER SPECTROSCOPY

Basic principles, a chirality of nucleus, Isomer shifts. Quadrupole and Nuclear Zeeman splittings. Applications in structure determination.

UNIT VI: ELECTRIC AND MAGNETIC PROPERTIED OF MOLECULES

Polarizability, polarization of a molecule in an electric field (electronic, atomic and orientation polarization), Clausius-Mossotti equation, variation of molar polarization with temperature: Debye equation, bond moments, dipole moments and molecular structure. Magnetic susceptibility, molecular

interpretations of diamagnetism and paramagnetism, Ferro, ferri and antiferromagnetic behavior, Curie and Neel temperatures, Measurements of magnetic susceptibility by Faraday and Gouy Technique.

Course Outcomes

After completing this course, the students will be able to:

- To understand the principles of RAMAN spectroscopy
- To understand the principles of electronic spectroscopy
- To understand the principles of NMR spectroscopy
- To understand the principles of Mossbauer spectroscopy

Text Books

1. C. N. Banwell and McCagh, "Fundamentals of Molecular Spectroscopy", Fourth Edition, Tata McGraw Hill Publishing Co.Ltd, 1994.
2. Donaid L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vyvyan, "Introduction to Spectroscopy", Fourth Edition, Cengage Learning, 2009.
3. W. Kemp, "Organic Spectroscopy", Second Edition, ELBS MacMillan, 1987.

Reference Books

AC 535	**DEFENCE CHEMISTRY**	**3**

Course Objectives:

- To understand concept of Defence chemistry
- To understand the chemistry behind the explosive and pyro techniques.
- To understand the concept of nuclear energy in defence.
- To understand chemical and biological warfare agents

UNIT I: Explosives: Introduction, Classification, Nature of Explosives, Burning, Deflagration & Detonation, Initiation theories of explosives, Thermochemistry of explosives, various performance parameters of explosives, **Propellants:** Introduction, Rocket & Gun Propellants, **Pyrotechnics:** Definition, classification, Ingredient, Various compositions

UNIT II : Polymers and Nanocomposite for defence applications: Metal replacement polymers., High Performance Engineering Polymers, Lightweight polymers, Chemical Resistant polymers.

UNIT III : High Strength Materials, alloys for defence applications.

UNIT IV : Nuclear Science: Structure of nucleus, Mass defect, Binding energy, Nuclear reactions, fission & Fusion nuclear reactions, Controlled & uncontrolled release of nuclear energy, Concepts of critical mass & critical volume

UNIT V: Chemical & Biological Weapons: Different chemical and Biological warfare agents & their effects; Protection against biological, chemical warfare agents

Text/References:

1) Principles/Effects & Sensitivity, 1994, C.S. Grace, Brasey series
2) Chemical warfare agents, 1992, S.M.Somai
3) Biological weapons, 1999, Joshua Lederberg

Course Outcomes

After completing this course, the students will be able to:

- Study of chemistry of High Energy Materials
- To understand the applications of polymers and nanocomposites in defence
- To familiarize with High strength materials
- To understand NBC and their remediation

Text Books

1. J P Agrawal: High Energy Materials, Wiley VCH, 2012
2. N. Ramdani: Polymer Nanocomposites for advanced Aerospace and Military Applications, IGI Global, 2019.

Reference Books

1. NBC: Nuclear, Biological, and Chemical Warfare on the Modern Battlefield John Norris, Will Fowler, 1997.

Course Code	Course Name	**Credits**
AC-536	**PAINTS, PIGMENTS AND VARNISHES**	**3**

Course Objectives

- To understand the basic concept of paints, pigment
- To understand classifications of paints and pigment
- To understand basic concept, varnishes.
- To understand the various applications

UNIT I : Fundamental of PAINTS: - General, Classification, Theories for dye Structure, Principle Applications., Description of individual of class and synthesis of some commercial dyes. **Dying processes of textiles** -Pre-treatment of textile fibres, dyeing methods for various textiles, Textile finishes and Textile auxiliaries. Non textile dyes: Leather, Fur, Hair, Food, Ink, Photographic, indicator dyes.Environmental and health impacts of paints and varnishes.

UNIT II : PAINTS/ DYES for electro optical application- Molecular Orbital design, Synthesis and characteristics of functional dyes. Near infrared absorption (NIR) dyes: Introduction, Cyanine type chromophores, donar-acceptor chomophores, and applications. Colorants for high technology, Photocopying, LCD, Printing, Dye Sensitizer Solar Cells Photodynamic Therapy, Fluorescent Brightening Agents

UNIT IV Pigments- Pigments general idea, distinguish between dyes and pigments, important characteristics of organic pigments, Toners, Lakes, Classification of organic pigments with suitable examples, i.e. Ionic pigments-Lake of acid and basic dyes. Non-ionic pigments-Azo, Indigoid, Anthraquinone, Quinacridone, Phthalocyanine (Copper phthalocyanine)..

UNIT V : **Vanisheshes** - Definition, different types of classification, synthesis, Characterization and application.

Course Outcome

- Study of chemistry of paints, pigment and varnishes
- To understand the applications of pigment and pains
- To understand some chemistry and classifications of paints and varnishes
- To understand the concept of optical brighteners

References:

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
5. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
6. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
7. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

Course Code	Course Name	**Credits**
AC- 537	**DRUG DESIGN AND PHARMACOLOGY**	**3**

Course Objectives:

- Explain the fundamental principles of pharmacology
- Describe the concepts of toxicology and biotransformation's.
- To understand various routes of drugs administration
- To understand the concept of pharmacology.

Unit I : General Introduction to Drugs – Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action), Nomenclature of drugs: Generic name, Brand name, Systematic name, Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD50, ED50,GI50 Therapeutic Index, Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.

Unit II : **Routes of Drug Administration and Dosage Forms**, Oral and Parenteral routes with advantages and disadvantages. Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets). Drugs for Respiratory System General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives

UNIT III: Drugs and Environmental Aspects, Impact of Pharma-industry on environment, , International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration".

UNIT IV**: Pharmacology:** Drugs and Drug Targets - Enzymes: active sites, mechanism of catalysis, Enzyme inhibitors, Enzyme selectivity, and Receptors ligand gated ionic channels, G-Protein coupled receptors, and Kinase linked receptors. Carrier Proteins, Structural Proteins, Nucleic acids, Lipids and carbohydrates and DNA as drug targets, Pharmacokinetic Principles: absorption, distribution, metabolism and excretion of drugs. Dose of drugs and routes of administration. Drug dosing, drug half-life, Steady state concentration, Drug tolerance, Bioavailability, Drug delivery.

Course Outcomes

- Students understand concept of drugs and pharmacology
- Understand various routes of drug administrations.
- Under stand the various environmental aspects of drugs

Reference

1. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
2. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
3. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley
4. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
5. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
6. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
7. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.

- The students can opt **ANY THREE P**rofessional **E**lectives from the Applied Chemistry Department as well as all the courses of another department of DIAT (with equal credit ONLY)
- Also, can opt online courses from NPTEL, MOOC. SWAYAM (equal credit)
- Maximum of 6 credits to be awarded for Professional Electives (Approved by BoS) for ONLINE courses NEPTL during II and III Semester.