NOTIFICATION

No. 39 / 2018 Date: 7 / 6 / 2018

Subject : Introduction of new syllabi for M.Sc. (Chemistry) Part-II (Sem. III & IV), which to be implemented from the academic session 2018-19.

1) It is notified for general information of all concerned that the authorities of the University has introduced new syllabi for M.Sc.(Chemistry) Part-II (Sem. III & IV), which to be implemented from the academic session 2018-19. Hence the page Nos. 26 to 91, appearing in prospectus No. 2015125 be substituted respectively by the **"APPENDIX"**, which is appended with this notification.
2) The authorities further provided two additional chances for the failure students of M.Sc.(Chemistry) Part-II (Sem.III & IV) after implementation of the aforesaid new syllabi.

Sd/-
(Dr.A.P.Deshmukh)
Registrar,
Sant Gadge Baba Amravati University

APPENDIX

SEMESTER –III
Paper IX SPECTROSCOPY-I

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : **12L**

A) Unifying principle: Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorbance emission, transmission, reflection, refraction, dispersion ,polarization and scattering, Diffuse Reflectance (DRIFT), reflection absorption (RAIRS), multiple internal reflection (MIR) Uncertainty relation and natural line width and line broadening, transition probabilities, transition moment, selection rule, intensity of spectral lines. rotational, vibrational and electronic energy level. Fourier Transform spectroscopy.

B) Microwave spectroscopy: Classification of molecules, rigid rotor model, Rotation and Vibration of Diatomic Molecules: effect of isotopic substitution on the trasition frequencies, intensities, non rigid rotor, ,nuclear and electron spin interaction and effect of external field, energy eigenvalues and Eigen states Classification of polyatomic rotors and the non-rigid rotor, Electronic transitions, Franck-Condon principle. Fluorescence and phosphorescence.

C) Reactivity and Characteristics of Nanoparticles: Increased reactivity of nanoscale materials, reasons for high reactivity, effect of size and shape of nanocrystals on reactivity, comparison of nanocrystalline versus macro-crystalline materials in terms of reactivity

Unit-II **12L**

A) Ultraviolet and visible spectroscopy : Various electronic transition (185-800nm), Beer-Lambert law, effect of solvent on electronic trasition, UV band for cabonyl compounds, unsaturated carbonyl compound,diene,conjugated polyenes. Fisher-Woodward rules for conjugated dienes and carbonyl compounds, UV spectra of aromatic and heterocyclic compounds. , Fieser-Kuhn rules for polyenes, Sterric effects in biphenyls.

B) Infrared spectroscopy : Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength, unhormonicity, Morse potential energy diagram, vibration of polyatomic molecules, selection rules, normal modes of vibration, group frequencies, overtone band, factors effecting the band position and intensities, far IR region, metal ligand vibrations, Instrumentation and sample handling characteristics. Vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols,amines. Detail study of vibrational frequencies of carbonyl compounds, (ketones, aldehydes, esters, amides, acids, acid chlorides and anhydrides, lactones, lactums and conjugated carbonyl compounds).Effect of hydrogen bonding and solvent on vibrational frequencies, overtones, combinations bands and Fermi resonance. FT-IR, IR of gaseous solids and polyatomic materials. applications of vibrational spectroscopy in investigating (i) symmetry and shapes of simple AB2, AB3 and AB4 molecules on the basis of spectral data, (ii) mode of bonding of ambidentate ligands (thiocyanate, nitrate, sulphate and urea). mode of bonding of ambidentate ligands, Cynides, Ethylenediamine and Diketone complexes..

Unit-III : **12L**

Mass spectrometry: Introduction, theory, measurement techniques (EI,CI,FD,FAB) recording of mass spectrum. types of ions, isotopic contribution, fragmentation process, factors affecting fragmentation ,ion analysis, ion abundance. Mass spectral fragmentation of organic compounds of various types, common functional groups, molecular ion, metastable ions, Mcllaferty rearrangement. Retro-Diels Alder fragmentation, nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structural determination. studies of inorganic/coordination and organometallic representative compounds Fingerprint applications and the interpretation of Mass spectra Elementary study of GCMS, FTMS, high resolution MS, ESI-MS, MALDI-MS, examples from macromolecules and supramolecules, study of in-organic co-ordination & organometallic compounds.

Unit-IV **12L**

A) Nuclear Magnetic Resonance Spectroscopy: General introduction and definition of nuclear spin, nuclear resonance shielding of magnetic nuclei, chemical shift, factors influencing chemical shift, shielding and deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nulei.(alcohols, phenols, enols, acids, amides, and mercaptans), basic idea about instrument, mechanics of measurement, chemical exchange, effect of duteration, spin spin coupling(n□1) rule, copmplex spin spin interaction between two ,three, four, and five nulei(first order spectra) factors effecting coupling constant □□□classification of spin system like A□,A□2,AB□,AM□,ABC,A2B2 etc. Stereochemistry, hindered rotation Karlplus curve-variation of □□□with dihydral angle..

B) Carbon$^{1□}$ NMR spectroscopy : General consideration, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl),coupling constants, proton decoupled off resonance.

Unit-V : **12L**

Characteri□ation of Organic Molecules: General idea about two dimensional NMR spectroscopy □ C□S□,N□ES□, HETC□R- DEPT techniques, INPET, APT, INADE□UATE SM-4: simplification of complex spectra, nuclear magnetic double resonance, contact shift reagent, solvent effects, nuclear over hauser effect (N□E). Spin-spin, spin-lattice relexations. □ff resonance decoupling Lanthanide shift reagents, Aromatic induced shifts, deuterium exchange, spectra at higher fields.. NMR Spectroscopy (Inorganic) solid state NMR. Study of dynamic processes by VT NMR, restricted rotation (DMF, DMA, biphenyls, annulenes), cyclohexane ring inversion, degenerate rearrangements (bullvalene and related systems). Multinuclear NMR of B, Al, Si, F and P nuclei□structure and dynamics of representative inorganic molecules, deriving activation and thermodynamic parameters□ application of NMR to magnetism and magnetic susceptibility measurements of paramagnetic metal complexes. □uantitative applications of NMR: Drug Analysis **Magnetic Resonance Imaging (MRI):** Introduction to Magnetic Resonance - Principles of Spatial encoding in Magnetic Resonance.

Books Suggested:

1. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1st Edn.(1987), Blackwell Scientific Publications, □xford, London.
2. R. S. Drago, Physical Methods for Chemists, (1992), Saunders College Publishing, Philadelphia. (30)
3. R. S. Drago, Physical Methods in Inorganic Chemistry, 1st Edn.(1971), Affiliated East-West Press, New Delhi.
4. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 4th Edn. (1986), □ohn Wiley & Sons, New □ork.
5. W. Kemp, □rganic Spectroscopy, 3rd Edn. (1991), MacMillan, London.
6. G. Aruldhas, Molecular Structure and spectroscopy, (2001) Prentice Hall of India Pvt. Ltd., New Delhi. □rganic Chemistry Specialization MC

Semester III

Paper X Analytical Chemistry-I Thermal & Electroanalytical Methods

Total Lectures: 60Hours, 4Hours per week, 12Hours/unit **Total Marks: 80**

Unit-I : Thermal methods of analysis and thermometric titrations: 12L

Introduction to thermal analysis: Thermogravimetric analysis (TGA), Differential thermogravimetric analysis (DTG), Differential thermal analysis (DTA) □Principles and methods, presentation of thermal data. Implication of combinational TG-DTAtechnique. Differential Scanning Calorimetry (DSC): a brief outline and a comparative discussion of DSC with DTA. Instrumentation TG-deflection and null point balances, recording devices, design principles of the instrument□DTA-Schematic diagram and methodology of the instrument□DSC □Schematic diagram and methodology of the instrument. Factors affecting the results of thermal analysis. Applications, Solid state reaction - decomposition of inorganic and organic compounds. Desolvation/deaquation of inorganic compounds, automatic thermogravimetric analysis □ single, binary, ternary systems. □uantitative DTA, peak area and its equations. Development of Gravimetric analytical procedures, discovery of new chemical compounds. Evaluation of reaction kinetics (dynamic or Non-isothermal) parameters by thermal methods. Special applications of DSC □glass transition of polymers, determination of purity and crystallinity of sample. Problems.

Thermometric titrations: Principles, method, apparatus, applications □very weak acid, mixtures of weak and strong acid, complexometric and redox titration

Unit-II : **Electroanalytical Methods** **12L**

High fre□uency titrations: Principle, Instrumentation- Cells, oscillator circuit and high frequency titrimeters, theory, correlation of high frequency titration curves with low frequency titration curves. Applications- acid base, complexometric, measurement ofdielectric constant and analysis of mixture of organic compounds. Advantages and disadvantages of high frequency methods.

Electrogravimery: Theory,Principle and types of electrogravimetry, electrode reactions, over voltage, characteristics of deposits and completion of deposition, separation of metalsand applications.

Coulometry : Principal, coulometry at constant current, coulometry at constant potential coulometric method of analysis, instrumentation, coulometric titrations, Advantages of coulometric titrations, Applications of coulometric titrations,problems.

Unit-III : Chemical,biochemical and biosensors: 12L

Chemical Sensors, Chemical Sensor Characteristics, Electrochemical Sensor, Potentiometric Sensors, Conductometric Sensors, Amperometric Sensors, Chronoamperometry and Chronopotentiometry, Acoustic Wave Devices, Electrochemical Impedance Spectroscopy, Chemical and Biological Recognition, Application of Chemical Sensors in the Food Industry, Agriculture and Biotechnology, Biosensors and Their Principles, Types of Biosensors, Amperometric Immunosensors, Cholesterol Biosensor, Electrochemical Glucose Biosensors, Electrochemical biosensors, Drug Delivery Systems, Microbial Biosensors for Environmental Applications

Ion-selective electrode, Principle of ion-selective electrode, Types of ion-selective electrode Advantages and limitations of ion-selective electrode ,The glass electrode, glass electrodes for pH measurement, Solid-state electrode, Liquid-based electrode, Selectivity coefficients, Biopotential Electrodes, Uses of ion-selective electrode, Applications of ion selective electrode in determination of some toxic metals and some anions (F^-, Cl^-, Br^-, I^- and $N\square_3$), Biomedical Applications

Unit-IV : Electoanalytical Techni□ues: 12L

Polarography: Theory, Basics of polarography ,apparatus: Dropping mercury electrode. Supporting electrolytes. Effect of supporting electrolyte on the limiting current. Diffusion coefficient and its evaluation. Ilković equation, its derivation and applications Ilkovic equation-diffusion current constant and capillary characteristics determination. Half wave potential. Polarographic maxima. Interpretation of a polarographic curve .Role of temperature on diffusion current. Reversible, quasi reversible and irreversible electrode reactions and evaluation of parameters using various reactionsderivative polarography, modified polarographic techniques, AC polaography, Limitations of polarography, pulse polarography. Methods of quantitative analysis: absolute, comparative, the PIL□T I□N and kinetic methods

Voltammetry: Basic principles, Instrumentation, Cyclic voltammetry- Principle, Instrumentation and applications, Voltammograms, Stripping Technique: Anodic and cathodic stripping voltammetry and their applications in the trace determination of metal ions and biologically importants compounds . Enzyme catalyzed reactions and applications of voltammetry in monitoring such reactions.

Related Techni□ues : Amperometric titrations and chronopotentometry, Principal, methodology andtheir application in qualitative and quantitative analysis.

Unit V : Bio-analytical chemistry: 12L

Application of spectrophotometry in the quantitative estimation of biological macromolecules. Application of spectroflurimetry in detection and estimation of biomolecules (both flurocent and non-flurocent). Assay of very low quantity of vitamin B_1 in food stuffs□NADH, hormones, drugs, pesticides, cholesterol, porphyrin in biological samples and preparation of the sample for performing the above experiments.

Ultracentrifugation: principles of sedimentation, preparative ultracentrifugation and analytical ultracentrifugation. Application of ultracentrifugation in separating bio-molecules and determining their mass.

Gel electrophoresis: principles, nature of various types of gels, their applications in separating bio-macromolecules and determining their mass. 2D gel electrophoresis and its applications.Toxicology: introduction , chemical structure-toxicity relationships, heavy metals induced toxicity and its remedy.

Books Suggested :

1. Day and Underwood: □uantitative Analysis
2. A. I. Vogel: A text book of quantitative analysis.
3. Flaschka: EDTA Titration
4. Meites and Thomas: Advanced Analytical Chemistry.
5. G. W. Ewing: Instrumental Methods of Chemical Analysis.
6. R. S. Draga: Physical Methods in Inorganic Chemistry
7. G. D. Christian: Analytical Chemistry
8. S. M. Khopkar: Basic Concept of Analytical Chemistry.
9. Kolltath and Ligane: Polarography
10. Braun: Instrumental methods of chemical Analysis
11. Willard, Merritt and Dean: Instrumental methods of Analysis
12. Strouts, Crifillan and Wison: Analytical Chemistry.
13. □ W. T. Spinks and R. □ Woods: Introduction to Radiation Chemistry.
14. S. A. Skoog and D. W. West: Fundamental 0f Analytical Chemistry
15. R. V. Dilts: Analytical Chemistry

Semester III
Paper XI
Special Paper-I
Inorganic Chemistry (Bio-inorganic Chemistry)

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : **12L**

A) **Essential trace elements in biological systems**: Perspective of essential trace elements,. Influence of excess and difficiency of V, Cr, Mn, Fe, Co, Cu & n. Genetic defects in the absorption of trace elements. Regulation and storage of trace elements. Role of minerals. Toxic effects of metals, biological ligands for metal ions. Coordination by proteins, Tetrapyrrole ligands and other macrocycle. Biological functions of alkali cations and ligands for alkali cations, metal storage, transport and biomineralization with respect to ferritin, transferrin and siderophores, Na^{+}/K^{+} pump. Role of calcium in transport and regulation in living cells.

Unit II : **12L**

A) Transport & Storage of Dioxygen: Heme proteins & oxygen uptake, structure and functions of haemoglobin, myoglobin, hemocyanins & hemerythrin. Perutz mechanism showing structural changes in porphyrin ring system. xygenation and deoxygenation. Model compounds. Cyanide poisoning and treatment. Vanadium storage and transport.

B) Transport of Oxygen, Electrons and Metal Ions: Transport of Electrons: Iron-Sulphur Proteins: Rubredoxins and Ferredoxins (2Fe, 3Fe, 4Fe,8Fe Proteins) - High Potential Iron-Sulphur Proteins Structural and Spectral features ofIron-Sulphur Proteins - Electron-transport by Cytochromes, Azurin and Plastocyanin -Importance of Structures of Azurin and Plastocyanin in facilitating Rapid Electron Transport.Transport and Storage of Metal Ions: Iron-Transport by Transferrin and Siderophores-Ferritin in Iron Storage - Transport of Na and K across Cell Membranes by Na^{+}- K^{+} ATPase-Transport of Calcium across Sarcoplasmic Reticulam by Ca^{2+}-ATPase.

Unit-III : 12L

A) Bio-energetics and ATP cycle: DNA polymerization, metal complexes in transmission of energy, chlorophylls, photosystem I and photosystem II in cleavage of water, Model systems.

B) Electron transfer in Biology: Structure and functions of metalloproteins in electron transfer proteins, cytochromes & Fe-S proteins, Non-heme iron proteins Rubredoxins, Synthetic models. Biological Nitrogen fixation (in vitro and in vivo)

Unit IV : Metallo enzymes **:**

Apoenzymes, Haloenzyme & Coenzyme. The principle involved and role of various metals in-

i) n-enzyme:- Carboxyl peptidase & Carbonic anhydrase.
ii) Fe-enzyme:-Catalase Peroxidase & Cytochrome P-450
iii) Cu-enzyme:-Super xide dismutase
iv) Molybdenum:-xatransferase enzymes, anthine oxidase,Co-enzyme
Vit.B_{12}, Structure of vitamin B_{12} Co-C bond cleavage, Mutase activity of co- Enzyme B-12, Alkylation reactions of Methyl Cobalamin. Synthetc model of enzyme action, stability and ageing of enzyme.
v) Nickel Enzyme**:** Urease, Hydrogenase and Factor F430: Reactions Catalysed , Mechanistic Aspects

Unit V : **Chelate therapy and metallotherapy:** **12L**

A brief introduction to chelate therapy and its types, Therapeutic spectra of different chelating drugs in metal ion detoxification: chelating drugs containig sulphydryl group, the polyaminocarboxylic acids, polyethyleneamines, desferrioxamines. Radioprotective chelating drugs, limitations and hazards in chelation therapy.

Medicinal use of metal complexes as antibacterial and anticancer, anticancer activity of platinum(II) and platinum(IV) complexes, mechanism of the anticancer activity of platinum complexes, anticancer activities of rhodium, gold, copper and cobalt complexes. Antibacterial and antiviral activities of metal complexes. Gold therapy in rheumatoid arthritis.

Books:

1. Das A. K. : A Text Book on Medicinal Aspects of Bio-inorganic Chemistry.
2. Akhmetov, N.: General and Inorganic Chemistry.
3. Aylett, B. and Smith, B.: Problems in Inorganic Chemistry, (English University Press)
4. Bertini, et al: Bioinorganic Chemistry (Viva)
5. Charlot, G and Bezier, D.: uantitative Inorganic Analysis (john Wiley).
6. Douglas, B. E. McDanirl, D. H. et al: Concept and Models of Inorganic Chemistry (4th edt.) Wiley
7. Dutt P. K.: General and Inorganic Chemistry.(Sarat Books House)
8. Fenton, David E.: Biocoordination chemistry, xford
9. olly, W. L. : Inorganic Chemistry (4th edn.) Addison-Wesley.
10. Katakis, D. and Gordon, G.: Mechanism of Inorganic Reactions.(Wiley).
11. Leigh, G. : IUPAC Nomenclature of Inorganic Chemistry (1990 ain-Interscience)
12. Massey, A. G.: Main Group Chemistry.
13. Porterfield, W. W.: Inorganic Chemistry-A unified approach (Holt Saunders)
14. Banerjee,D.:Coordination Chemistry,TMH
15. Lee D.:Concise Inorganic Chemistry,ELBS
16. Lippard S. and Berg, M.: Principal of Bioinorganic Chemistry,University Sci.Book.,Mill Valley
17. Hay R.W.:Bioinorganic Chemistry, Ellis Horwood, Chichester and N
18. Das A.K.: Text Book of Medicinal Aspects of Bioinorganic Chemistry,CBS
19. Sigel H.:Metal ions in Biological systems,Marcell Dekker,N(Vol.1-31)
20. Reddy K.H.,Bioinorganic Chemistry,New Age Int.Pub.
21. Kaim W.and Schwederski B.:Bioinorganic Chemistry:Inorganic elements in the Chemistry of Life, ohnWiley & Sons.
22. Medicinal Inorganic Chemistry, Edited by onathan L.Sessler, xford University Press.

Semester III
Paper XII
Special Paper-II
Inorganic Chemistry (Solid state Chemistry)

Total Lectures:60 Hours,4Hours/week, 12Hours/unit Total Marks-80

Unit-I : Crystal Structure of Some Simple Compounds: 12L

i) Ionic Crystals &Their structures, radius ratio rule, effect of polarization on crystals.
ii) Covalent structure type-Diamond, Sphalerite & Wurtzite.
iii) Geometry of simple crystal AB type: NaCl, CsCl & NiAs &Wurtzite, reasons for preference for a particular structure in above AB type of compounds.
iv) AB_2 type: Fluorite, antifluorites, Rutile structures. Li_2□, Na_2□, etc. $CdCl_2$, CdI_2 structures, difference between them. AB_2 type: Re□$_3$, BiI_3, $CrCl_3$, A_2B_3 type:Fe_2□$_3$,Corundum Al_2□$_3$,Mn_2□$_3$.
v) Ternary Compounds AB□$_3$ type: Perovskite, Barium titanate, lead titanate, CaTi□$_3$ Tolerance factor, charge neutrality &deviation structures. FeTi□$_3$.
vi) AB_2□$_4$ type compounds- Spinel, Normal & inverse,2-3 and 4-2 spinel ,packing of oxygen in tetrahedral & octahedral sites, sites occupancy number of site surrounding each oxygen, application of charge neutrality principles, site preferences in spinel, distorted spinel.Hausmannite(□ahn-Teller distortions),Factors causing distortion in spinel.

Unit-II : 12L

Lattice Defects: Perfect &Imperfect crystals, point defects**,** Interstitial, Schottky defect, Frenkel defect, line defect & other entities, thermodynamics of Schottky & Frankel defects. Dislociation, theory of dislocation, plane defects-Lineage boundary, grain boundary, stacking fault, 3D defects. Defects & their concentrations, ionic conductivity in solids, Non stoichiometric compounds. Electronic properties of Non-stoichiometric oxides, , pyknometric & electrical conductivity methods of study of defects, radiation effects on solid nature and properties, photography, colour centers, order-disorder changes, imperfection equilibrium, solid electrolytes ,atom movements, and defect interactions.

Unit-III : 12L

Electronic Properties of materials: Metals, Insulators and Semiconductors, Electronic structure of solid, band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap, temperature dependence of conductivity, Seebeck effect and Hall effect ,carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization, photoconductors, photovoltaic cells, solar batteries. Types of ionic conductors, mechanism of ionic conduction, diffusion, superionic conductors, phase-transitions & mechanism of conduction in super ionic conductors, applications of ionic conductors,Metal complexes as semiconductors.
Dielectric polari□ation: Introduction, Piezo-electricity, pyroelectricity, ferrielectricity, antiferroelectricity, ferroelectricity & their applications

Unit IV : 12L

Superconductivity: Introduction, discovery magnetic properties of super conductor, theory of super conductivity, Meissner effect, type I&II superconductors, □osephson effects, Hc-temperature superconductor, crystal structure of high temperature semiconductors, & their applications.

Magnetic Properties of Materials: Introduction, Magnetization, Electronic Spin and Magnetic Moment,Classification of materials, magnetic susceptibility, paramagnetism in metal complexes, diamagnetism, ferromagnetic metals, ferromagnetic compounds (Cr□$_2$), Antiferromagnetism- transition metal monoxides, ferrimagnetisms(ferrites), magnetic anisotropy, magneto striction, cooperative phenomena- magnetic domains, Domain Theory, hysteresis loops (hard & soft magnets) magnetic storage & applications of magnetic materials. Spin glasses

Unit V : Lasers in Chemistry: 12L

General principles of laser action. Stimulated emission. Rates of absorption and emission. Einstein coefficients. Population inversion. Three-level and four-level laser systems. Pumping. Laser cavity □ resonant modes. Characteristics of laser light. Laser pulses and their characteristics. Pulse production, □-switching. Pulse modification, mode-locking. Practical lasers. Solid-state lasers, gas lasers, chemical and excimer lasers. Examples. Applications of lasers in chemistry. Femtochemistry. The pump-probe technique. Time-resolved spectroscopy. Photodissociation of ICN. Formation and dissociation of C□-hemoglobin complex. Conversion of ethylene to cyclobutane. Bond selectivity in chemical reactions □the reaction between hydrogen atoms and vibrationally excited HD□ molecules.
Lasers and multiphoton spectroscopy □ underlying principles. Two-photon spectra of dipheny loctatetraene. Lasers in fluorescence spectroscopy and Raman spectroscopy. 12L

Books:
1. Azaroff L.V.,Introduction to Solids,TMH
2. West A.R.,Solid state Chemistry and its Applications,Plenum
3. Rao C.N.R,Solid State chemistry,Dekkar
4. Hagenmuller,Preprative methods in solid state chemistry
5. Keer H.V.,Principal of the Solid state,Wiley Eastern.
6. Hannay N.B,.Solid state chemistry
7. Chakrabarty D.K.,Solid state chemistry,New Age Int.
8. West A.R.,Solid state Chemistry,□ohn Wiley
9. Pillai S.□.,Solid state Physics,Academic press
10. ReyT.□,The Defects Solid state,Interscience
11. Azoroof L.V.Brophy □□, Electronic Process in Materials, McGraw Hills
12. Anderson and Leaver, Materials Science
13. Kirkendale ,Analytical Methods of Materials Investigations
14. Greenwood N.N.Ionic Crystals, Lattice Defects and Nonstoichiometry, Butter worth
15. Kroger Chemistry of imperfect crystals, Holland
16. Callister W.D.□r., Material Science and Engineering An Introduction, Wiley India
17. Van Bueren H.G.,Imperfection in Crystals,Wiley-Interscience
18. Brandon D and Kaplan W.D.Microstructural Characterization of Materials,Wiley N□.
19. Hummel R.E.Electronic Properties of Materials,Springer-Verlag
20. Solymar L.andWalsh D.,Electrial properties of Materials,□xford UniversityPress
21. □iles D.,Introduction to Magnetism and Magnetic Materials,Nelson Thornes,Cheltenham
22. Kotz □.C.,and Treichel,P.□r.Chemistry AND chemical Reactivity,Saunders
23. Masterton W.L.and Hurley C.N. chemistry,Principals and Reactions,Harcourt

SEMESTER III
Paper XI
Special Paper-I
Organic Chemistry (Organic Synthesis-I)

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : O□idation-Reduction **12L**

I) O□idation: oxidation of Hydrocarbos, Epoxidation, Shi Epoxidation, □acobsen Epxidation perhydroxylation by KMn□4 and □s□4, ozonolysis, □xidative cleavage by Lemieux reagent, formation of ketones by Wacker process, □xidation of aromatic ring by chromic oxide, □xidation of alcohols (PCC, PDC, Chromic acid, Swern oxidation, Silver carbonate, Manganese dioxide , oppenauer oxidation, CAN)□xidation of 1,2- Diols (Lead tetra-acetate, CAN, Periodates), Selective oxidation of alkyl side chain in aromatic compounds, alcohols and acid using Cr (IV and VI),

II) Reduction: Selectivity in reduction, Hydrogenation of aromatic rings, Noyori asymmetric hydrogenation, reduction of nitro and nitroso compounds, dissolving metal reduction, Metal based reductions using Li/Na/Ca in liquid ammonia, Hydride transfer reagents from Group III and Group IV in reductions, reduction of aldehydes, ketones to alcohols, reduction of carbonyl group to methylene, reduction of alkene to alkane (diimide), **Non-Metalic Reduction:** Wolf-Kishner & diimide reduction, Metal Hydride reduction using LiAlH4, NaBH4, BH3, Birch Reduction, Enzyme Catalyzed Reduction, Stereo/enantioselectivie reductions (Chiral Boranes, Corey-Bakshi-Shibata)

Unit-II : **12L**

A) Polynuclear Hydrocarbons: Introduction, Comparative study of the aromatic character of linear and nonlinear □rtho fused Polynuclear Hydrocarbon. General synthetic routs, reactivity□s, utilities and wherever possible spectral analysis of fluorine, anthracene and phenanthrene. carcionogenic polycyclic hydrocarbons

B) Construction of Ring Systems: Different approaches towards the synthesis of three, four, five and six-membered rings ketene cycloaddition (inter- and intramolecular), Pauson-Khand reaction, Bergman cyclization□ Nazarov cyclization, cation-olefin cyclization and radical-olefin cyclization, inter-conversion of ring systems (contraction and expansion)□construction of macrocyclic rings, ring closing metathesis

C) Non Aromatic Heterocycles: Synthesis reactivity and importance of Azirines, □xiranes and Thiziranes.

Unit-III : **12L**

Formation of C-C bond Principle, disconnection□synthons, electrophilic and nucleophilic carbon species, use of following reaction in carbon carbon bond formation, base catalysed condensation including Claisen, Dieckmann reaction, Perkin, Stobbes, Knoevengel use of malonic and acetoacetic esters., Darzens reaction,prins reaction, use of acetylides,acid catalysed condensation of olefins,FC reaction,Fries reaction and diels alder reaction.

Unit-IV : **12L**

A) Umpolung concept: Dipole inversion, generation of acyl anion ,use of 1,3-dithiane, ethyl ethylthio methylsulphoxide bisPhenylthiomethane. metallated enol ethers, alkylidene dithiane. ketene thioacetals,2-propenethiobismethyl thioallyl anion.

B) Phosphours, and sulphur ylide: Preperation and their synthetic applications with stereochemistry, Petersons □lefination.

C) Enamines : Chemistry of enamines and their synthetic applications, Stark-Enamine reaction.

Unit-V : 12L

A) Selective Oraganic Name Reaction Favorski reaction, Mannich reaction, Sharpless asymmetric epoxidation , Baeyer Villeger reaction, Barton and Shapiro reaction Bamford-Stevens ,Hoffmann Loffler-Freytag,

B) Modern Synthetic Methods: Suzuki, Stille, Sonogishira cross coupling, Buchwald-Hartwig and Negishi-Kumada coupling reactions. Nef reaction, ulia-Lythgoe olefination, Ugi, , Biginelli,Brook rearrangement, Pausan-Khand reaction, Bergman cyclisation, Sharpless azides cycloadditions. Baylis-Hilman reaction, Eschenmo Ullmann coupling reactions,

Books Suggested:

1) Principle of organic synthesis. R C Norman & M coxon
2) Modern synthetic reaction. H. .House W.A.Benjamin
3) rganic synthesis,The disconnection approach-S.Warren
4) Designing organic synthesis-S.Warren
5) Some modern methods of organic synthesis-W.carruthers,
6) Advance organic reaction.Mechanism & structure- erry march
7) Advance organic chemistry Part-B-F.A.caray & R
8) sundberg,plenum P.
9) rganic reaction and their mechanism-PS kalsi
10) Protective group in organic synthesis-TW Greene,& PGM
11) The chemistry of organo phpsphorous-A kirbi,&SG Warren
12) rgano silicon compound-C.Eabon
13) rganic synthesis via Boranes-HC.Brown
14) rgano borane chemistry-TP onak
15) rganic chemistry of boron-W. gerrard
16) rganic Chemistry:C layden, Greeves, Warren and Wothers
17) rganic Synthesis: agdamba Singh And adav
18) rganic chmistry Reactions: Mundy

SEMESTER III
Paper XII
Special Paper-II Organic Chemistry (Natural Products)
Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit Total Marks-80

Unit-I : 12L

A) Carbohydrates : Types of naturally occurring sugars, deoxy sugars, amino sugars, branched chain sugars, methyl ethers and acid derivatives of sugars, general methods of structure and ring size determination with reference to maltose, lactose, sucrose, starch and cellulose

B) Lipids: Fatty acids, essential fatty acids, structures and function of triglycerides, glycerophspholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoprote ions composition and function, role.

Unit-II: 12L

A) Amino acids, proteins and peptides Amino acids ,protein and peptides. Amino acids,structural characterstics, acid base property, stereochemistry of amino acids, optical resolution, stecker synthesis, peptide and proteins. structure of peptide and protein, primary, secondary, tertiary and quaternary structure. Reaction of polypeptide ,structure determination of polypeptide, end group analysis, purines and nucleic acids, chemistry, structure and functional relation to gene of DNA and RNA. Biosynthesis of amino acids (Lysine and phenyl alanine).

B) En ymes: and identification of active sites by the use of inhibitors, mechanism of enzyme action, orientation and steric effect(,ribonuclease and carboxypeptidase) Enzyme catalysed reactions carboxylation, decarboxylation, rearrangement and isomerization)

Unit-III : Alkaloids and Terpenoids : 12L

Classification, Nomenclature, ccurence, isolation, isoprene rule general methods of structure determination of the following-

A) Alkaloids: Papaverine, Morphine, Reserpine, Nicotine.
B) Terpanoids: Camphor, Geraniol, Abietic acid, Squalene.
C) Biosynthesis of Terpens, alkaloids

Unit-IV : 12L

A) Steroids and Hormones : ccurence, Nomenclature, Basic skeleton, Diel s Hydrocarbon and stereochemistry. Biosynthesis of steroids. Structure determination and synthesis of Cholesterol, Testosterone, progesterone , Estrone and Cortison

B) Prostaglandins, pyrethoids, rotenones and pheromones

ccurrence, classification. Biogenesis, physiological effects and synthesis of $PGE_2$and $PGE_{2a.}$ Natural and synthetic pyrethoids, rotenones and pheromones

Unit-V : Vitamins and Natural Pigments 12L

Vitamins: A) Classification, ccurrence, Chemistry of vitamins A, C, D, E and K. biotin and vitamin B2, synthesis of vitamin B1, biologicalfunctions of B6, B12, folic acid and thiamin. Structure elucidation and synthesis, deficiency syndromes, etc.

B) Natural Pigments: Chemistry of Carotenes, anthocyanines, general study of porphyrins, structure and synthesis of Haemoglobin and Chlorophyll.

Books suggested :

1) Chemistry of alkloids-SW Pelletier.
2) Chemistry of steroids-LF fisher & M fisher.
3) The molecules of nature-□B hendricsion.
4) Biogenesis of natural compound-benfield
5) Natural product chemistry & biological significance,□Mann,RS Devison,□B hobbs,DV Banthripde & □B horborne.
6) Introduction to flavonoids-BA Bohm, Harwood
7) Chemistry of naturally occurring quinines-RH Thomson
8) The systematic identification of flavonoids-marby, markham, &thomos
9) Text book of organic medicinal chemistry-wilson,geswold
10) Medicinal chemistry Vil I &II-Burger
11) Synthetic organic chemistry-Gurudeep chatwal.
12) □rganic chemistry of natural products Vol I &II-□P agrawal
13) Vitamins and Co enzymes: Woguer
14) The total synthesis of natural products: Apsimon
15) Chemistry of Terpenes: A.A. Newmen
16) □rganic chemistry Vol. II and I: Finar
17) Principles of Biochemistry, A. L. Lehinger, Worth Publications.
18) Biochemistry, L. Stryer, W. H. Freeman

Semester III

Physical Chemistry Special Paper I

Paper XI

60 Hours (4-Hours/week) **80 Marks**

12 hours/Unit

Unit-I : Solid-state chemistry:

A) Solid state reactions: General principles, experimental procedures, co- precipitation as a precursor to solid state reactions, other precursor methods, kinetics of solid state reactions. 6L.

B) Crystal Defects & Non-Stoichiometry: Intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schotcky defects and Frenkel defects. Thermodynamics of Schotcky and Frenkel defect formation, color centers. Non- Stoichiometry and defects. Numericals. 6L.

Unit-II : Electronic properties and Band Theory:

A) Metals, insulators and semiconductors, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, semiconductor p-n junctions. Color in inorganic solids, 6L.

B) Magnetic properties- Behavior of substances in magnetic field. Effect of temperature: Curie and Curie-Weiss Laws.Calculation of magnetic moments, magnetic materials, their structures and properties. Applications: structure / property relations. Numericals. 6L.

Unit-III : Glass, Ceramics and Multiphase materials:

A) Factors influencing glass formation, kinetics and thermodynamics of glass formation, electrical (ionic) Conductivity of glasses, metallic glasses. Composition, properties and applications of glass-ceramics. 6L.

B) Properties and applications of ferrous and non-ferrous alloys. Phase diagram of iron-carbon system. Ceramic Matrix composites, carbon and hybrid composites. 6L.

Unit-IV : Photochemistry:

A□Photophysical phenomenon: Introduction, prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photoexcited donor and acceptor systems. Stern- Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and analytical significance, bimolecular collisions, quenching and Stern-Volmer equation. 6L

B□Photochemical reactions: photoreduction, photooxidation, photodimerization, photochemical substitution, photoisomerization, photosenitisation, chemiluminescence, photochemistry of environment, Green house effect. 6L.

Unit-V : Superconductivity:

A) High Tc Materials: Superconductivity in cuprates, preparation and characterization of 1-2-3 and 2-1-4 materials. Normal and Superconducting state of cuprates. The BCS theory. Applications of Low-temperature and Hightemperature Superconductors. 6L.

B) Thin Films: Preparation techniques: evaporation/sputtering, chemical processes, M□CVD, sol-gel etc. Growth techniques, properties and applications of thin films. 6L.

Books Suggested:

1) Physical chemistry by P.W.Atkins & dePaula 7Th Edition
2) Industrial Chemistry by. B.K.Sharma, Goel Publication House.
3) Physical Chemistry of Surface, by A.W. Admson, □ohn Wiley and Sons 1990.
4) Electronic structure and Chemistry of Solids by P.A.Cox , □xford University Press. 1991.
5) Solid State Chemistry by D.K.Chakraburti, New Edge Internation Publication 1996.
6) Principles of Solid State by. H.V.Kirr, Wiley Estern Publication.
7) Material Science & Engineering an Introduction, by W.D. Callister
8) Material Science by □C. Anderson, K.K.Leaver, □M. Alexander & R.D. Rawlings. ELBS.
9) Solid state physica by N A Wahab, Narosa Publications.
10) Fundamentals of Photochemistry by K K Rohatagi and Mukherjee.

Semester III
Physical Chemistry Special Paper II
Paper XII

60 Hours (4-Hours/week) **80 Marks**
12 hours/Unit

Unit-I : **Polymers:**
A) Basic concepts: Monomers, repeat unit, degree of polymerization, linear branch, and network polymers, classification polymers, Polymerization: condensation, addition, radical chain ionic and coordination and copolymerisation.polymerization condition and polymer reaction, polymerization in homogeneous and heterogeneous system. 6 L
B) Polymer processing: Plastic, elastomer and fibers. Compounding, processing technique: Calendaring, die casting, rotational casting, film casting, injection molding, glow molding, extrusion molding, thermoforming, foaming, reinforcing and fibers spinning. 6L

Unit-II : **Polymer characteri□ation:**
A) Polydispersion, average molecular weight concept. Number, weight and viscosity average molecular weight. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weight. End group, viscosity, light scattering, osmotic and ultra centrifugation method. 6L
B) Analysis and testing of polymers: chemical analysis of polymer, □-ray diffraction study, microscopy. Thermal analysis and physical testing-tencile strength. Fatigue impact. Tear resistance. Hardness and abrasion resistance. 6L

Unit-III : **Structure and properties of Polymers:**
A) Morphology and order in crystalline polymers, configuration of polymers chains. Crystal structure of polymers. Morphology of crystalline polymers, strain induced morphology, crystallization and melting. 6L.
B) Properties and structure: Physical properties, crystalline melting point, Tm-melting point of homogeneous serious, effect of chain flexibility and other steric factors. Entropy and heat of fusion, the glass transition temperature, the relation between Tg and Tm. Effect of molecular weight, diluents, chemical structures, chain topology, branching and crossing linking. Property requirements and polymer utilization. Numericals. 6L

Unit-IV : A) Polymer composites: Polymer matrix material, reinforcement, properties of composite and compost system. Fabrication of polymer composite, processing science and quality assurance of composites, environmental effect on composites, Smart composites. 6L
B) Polyethylene, polyvinyl chloride, polyamide, polyester, phenolic resin, epoxy resin and silicon polymer, Functional polymer: electrically conducting polymer. 6L

Unit-V : A) Polymer degradation: Definition, Types: thermal, mechanical, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiations, oxidative and hydrolytic degradation. 6L
B) Polymer reactions: Hydrolysis, acetolysis, aminolysis, hydrogenation, addition and substitution reaction, reaction o0f various specific groups, cyclation reaction and cross linked reactions, reaction leading to graft and block copolymers, miscellaneous reactions. 6L

Books Suggested:
1) A Text Book of Polymer Science by Billmeyer, □r. Wiley
2) Polymer Science by V.R.Gowarikar, N. V. Vishwanathan & □ Sreedhar, Wiley Estern.
3) Physical Chemistry Polymers by D.D. Deshapande, Tata McGraw Hill
4) Principles of Physical Chemistry by P.□Flory, Cornal University Press
5) Introduction to Polymer Chemistry by R.B. Seymour, McGraw Hill.
6) A Practical Course in Polymer Chemistry by S.□ Pnnea, Program press.
7) Polymer Composite by M.C. Gupta & A.P. Gupta. New Age International Publication.

Semester III
Paper XI
Special Paper I
Industrial Chemistry (Heat Transfer, Mass Transfer and Unit Processes)

60 Hours (4-Hours/week) **80 Marks**
12 hours/Unit

Unit – I : **12 L**
A) Fundamentals of Heat transfer: Methods of heat transfer, Fourier□s law, Newton□s law, heat transfer by conductance, by convection and by radiation. Heat exchanger, types of heat exchanger, overall heat transfer co-efficient, double pipe heat exchanger, Shell & tube type etc.
B) Fluid flow : Fluid flow phenomenon, introduction, Laminar flow, Turbulant flow, Reynolds number, Bernoulli equation, fans, blowers, compressors, pumps etc.

Unit – II : **12 L**
A) Distillation: Flash distillation, differential distillation, rectification, plate columns, packed columns.
B) Gas Absorption: Introduction, equipments, packed columns, spray column mechanically agitated contactors.

C) Evaporation: Introduction, short tube evaporator, forced circulation evaporator, falling film, climbing film, agitated evaporators.

D) Filtration: Introduction, Filter media, filter aids, equipments sparkler filter, sand filters, bag filters, rotary drum filter.

E) Crystallization: Introduction, solubility, super-saturation, nucleation, crystal growth, equipments tank crystallizer, Swenson-Walker crystallizer, oslo crystallizer.

F) Drying: Introduction, free moisture, bound moisture, drying curve, equipments: tray dryer, fluid bed dryer, drum dryer, spray dryer.

G) Extraction: Introduction, selection of solvent, single stage and multistage extraction, spray column, packed column, mixer settler, centrifugal extractor

Unit–III : Material Balances: **12 L**

Material balance without chemical reactions, flow diagram, without recycle or by-pass for above processes. Problems based on above.

Material balances involving chemical reactions, Concept of limiting reactant, excess reactant, yield and selectivity, stoichiometric coefficient and stoichiometric equation conversion, purge operation and Problems.

Unit – IV : **12 L**

A) Nitration: Introduction, nitrating agents, equipment for nitration, manufacturing and mechanism of nitrobenzene, ortho and para nitrochlorobenzene

B) Amination by reduction: Introduction, methods of reduction, metal & acid, sulphide reduction, metal & alkali reduction, manufacturing and mechanism of aniline, meta nitro aniline.

C) Halogenation: introduction, reagents of halogenation,aromatic halogenation, manufacturing and mechanism of chlorobenzene, dichlorofluromethane

Unit – V : **12 L**

A) Sulphonation: Introduction, sulphonating agents, factors affecting sulphonation, equipment, manufacturing and mechanism of benzene sulphonic acid, sulphonation of anthraquinone

B) Oxidation: introduction, oxidizing agents, vapour & liquid phase oxidation, manufacturing and mechanism of acetic acid, acetaldehyde, benzoic acid

C) Alkylaion: Introduction, alkylting agents, factors affecting alkylation, manufacturing and mechanism of ethyl benzene, phenyl ethyl alcohol

Books Suggested:

1) Heat transfer By Arora and Damkondwar, Pune
2) Heat and Mass transfer by A, G. Gavane, Nirali Prakashan. Pune VOL I & II.
3) McCabe and Smith, Unit operations of Chemical Engineering, McGraw Hill.
4) Budger and Banchero, Introduction to Chemical Engineering McGraw Hill.
5) Text Book of Industrial Chemistry Pragti Agencies Pune.
6) Engineering Chemistry By Dr. S. S. Dara.
7) Unit Process in organic Synthesis, by P. H. Grogins.
8) Shreve's Chemical Process Industries edited by Austin, McGraw-Hill.
9) Dryden's outlines of Chemical Technology, edited by M.Gopal Rao and M.Sittig,
10) Industrial Chemistry by B.K.Sharma
11) Hand book of industrial chemistry Vol I & II K. H. Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers

Semester III Paper XII
Special Paper II
Industrial Chemistry (Fuels and Heavy Chemicals)

60 Hours (4-Hours/week) **80 Marks**

12 hours/Unit

Unit – I : **12 L**

Fuels: Introduction, History of Fuels, History of solid fuel, Definitions and properties of solid fuels, classification of Fuels on the basis of occurrence, physical state, Formation of coal. Coal mining, proximate and ultimate analysis of coal, determination of calorific value by using Bomb calorimeter, Coal tar distillation, problems on calculation of calorific value. ecofriendly fuels, environment aspects.

Unit – II : **12 L**

Petroleum oils: Introduction, occurrence, composition of petroleum, processing of petroleum, thermal cracking, catalytic cracking, visbreaking, octane rating (octane number), cetane number, knocking, antiknock compounds, flash point, and aniline point, petrochemicals applications, synthetic petroleum,.

Lubrication oils-: Properties and uses of refrigeration oils, transformer oils and gear oil. Additives for lubrication oils antioxidant passivators, pour point depressants, detergents, adhesives and emulsifiers.

Unit – III : Manufacture of Heavy Chemicals : **12 L**

Chemical processes for the manufacture of Heavy chemicals like- soda ash, bicarbonates, chlorine, caustic soda, bleaching power, calcium carbides, Silicon Carbide, Lime and acids like H_2SO_4, HCl, HNO_3, H_3PO_4 and their applications.

Unit-IV : **12 L**

A) Cement: Types of cement, manufacture- processes (Wet and Dry), setting and Hardening of cement, cement additives.
B) Glass: Types, their composition & properties, manufacture of glass, optical glass, coloured glasses, lead glass and neutron absorbing glass.
C) Ceramics: Introduction, types, manufacturing process, applications & refractories.

Unit –V : Sugar Industries **12 L**

Manufacturing of sugar from sugarcane: Introduction, agriculture, harvesting, preparation of cane for mealing, juice extraction, diffusion, juice purification, evaporation, crystallization (production of raw sugar), centrifugation, sugar refining, decolouring, purification, filtration, crystallization grade analysis. Analysis of bagasse and molasses, byproducts of sugar industries.

Books Suggested:

1. Engineering Chemistry By Dr. S. S. Dara.
2. Modern Petroleum Technology by G. D. Hobson and W. Pohl.
3. Petroleum refining and engineering by W. L. Nelson.
4. Petroleum refining technology and economics by H. Gary and G. E. Hardwork.
5. The Petroleum chemical industry by Goldsteim and Waddams.
6. Petroleum processing handbook by W. E. Bland and R. L. Davidson.
7. The Text book on Petrochemical by Dr. B. K. Bhaskar Rao, Khanna Publishers NewDelhi.
8. Modern Petroleum refining Processes by Dr. B. K. Bhaskar Rao, xford, IBH, 1984
9. Petroleum product handbook.
10. Charles E. Dryden, utline of Chemical Technology Edited by M. Gopal Rao and
11. Marshall Siting, East West press 2nd Edition 1973.
12. Chemical Process Industries by R. N. Shreves and M. A. Brink. McGraw Hill Ltd. 4th Edition.
13. Manual of Chemical Technology V L I & II by Venketesharul Educational Development Center. IIT Madras,1977.
14. Material science, . P. Khanna, Khanna Publishers, Delhi

Semester III
Practical V
Inorganic Chemistry Practical

Total Hours: 90 hrs. (9 Hours per week) (26 Laboratory Session) **Total Marks: 100**

uantitative Inorganic Analysis:

1) Detection and determination of Ascorbic acid from biological sample.
2) Determination of Phosphates from plant samples by spectrophotometry.
3) Determination of iron from pharmaceutical samples and coordination compounds.
4) Determination of Calcium from given drug sample by complexometry.
5) Determination of Iron, Calcium and Phosphorus from milk powder.
6) Drug Analysis: Aspirin, benzyl benzoate etc.
7) Practicals based on food analysis: honey, oil, tea-leaves, turmeric powder etc.
8) Analysis of stainless steel (Cr/Ni)
9) Determination of Ca content in chalk / milk powder as Ca-oxalate by permagnetometry
10) Simultaneous Spectrophotometric determination of-
    i) Chromium and Manganese
    ii) Titanium and Vanadium.
    iii) Cobalt and Chromium
11) To determine the stability constant and stoichiometry of Ferric-thiocyanate complex by spectrophotometrically.
12) To study the stoichiometry and stability of Fe 3 salicylate complex by jobs and mole ratio method spectrophotometrically.
13) Estimate the amount of copper (II) with EDTA photometric titration
14) Determination of capacity of anion and cation exchange resin by column method.
15) **To estimate the amount of magnesium and inc in the given sample solution by ion e change chromatography method.**
16) Separation and estimation of Fe^{2}, Co^{2} and Ni^{2} by anion exchanger.
17) Separation and estimation of Halide by anion exchanger.

18) Separation and estimation of-
    i) Cobalt and nickel
    ii) Calcium and inc and
    iii) inc and Magnesium by anion exchange.
19) Separation and estimation of Fe3 and Mg2 by solvent extraction
20) Solvent extraction by binary mixtures i. e. Al/Mg, Mg/U$_2$, Cu/Ni, Cu/Co etc. and quantitative determination by spectrophotometry.
21) Nickel / Molybdenum / tungston/vanadium / Uranium etc by extractive spectrometric method.

22) Separation, identification and quantitative determination of metal ions by paper chromatography.
23) Separation and identification of sugars/ honey/halides by paper chromatography and determination of Rf values
24) Thin layer chromatographic separation, identification and determination of Rf values
    a. Metal ions (Mn, Co, Ni, Cu, n, Cd, Pb, alkali metals etc)
    b. Amino acids/ rganic compounds
    c. Sulpha drugs in tablets and ointments.
25) Estimation of zinc/metals by fluorimetrically.
26) Nephelometric determinations of sulphate, phosphate, silver.
24) Potentiometric determination of the percentage of sodium carbonate in commercial washing soda.
25) Water analysis:
    1. Determination of sodium and potassium by flame photometry.
    2. Determination of hardness, alkalinity, salinity,Chloride, Fluoride, Nitrite, Nitrate, phosphate and Sulphate.
    3. Determination of D , C D and B D.
    4. Determination of toxic metals viz As, Cd, Pb, Hg, and Ni in water and wastewater by suitable method.

The Practical e amination will be based on the Inorganic Chemistry.
Time: 6-8 hours (one day e amination) Marks: 100

I)	Exercise -1 (Based on Instrumental)	- 40 Marks
II)	Exercise-2 (Based on Separation Method)	- 40 Marks
III)	Record	- 10 Marks
IV)	Viva- Voce	- 10 Marks
Total		**- 100 Marks**

List of Books-

1. Day and Underwood: uantitative Analysis
2. Vogel A.I: A textbook of quantitative Inorganic analysis, Longman.
3. Flaschka: EDTA Titration
4. Meites and Thomas: Advanced Analytical Chemistry.
5. Ewing,G.W.: Instrumental Methods of Chemical Analysis,McGraw-Hill
6. Drago,R.S: Physical Methods in Inorganic Chemistry
7. Christian G.D.: Analytical Chemistry
8. Khopkar S.M.: Basic Concept of Analytical Chemistry.
9. Kolltath and Ligane: Polarography
10. Braun: Instrumental methods of chemical Analysis
11. Willard, Merritt and Dean: Instrumental methods of Chemical Analysis,Van Nostrand
12. Strouts, Crifillan and Wison: Analytical Chemistry.
13. Skoog S.A.and West D.W.: Fundamental of Analytical Chemistry
14. Dilts R.V.: Analytical Chemistry
15. ahagirdar D.V.- Experiments in Chemistry
16. Chondhekar T.K.- Systematic Experiments in Physical Chemistry,Rajbog S.W.,Anjali Pubn.
17. Wlehov G. - Standard methods of Chemical analysis, 6th Ed.
18. Ramesh R&Anbu M,Chemical Methods for Environmental Analyss:Water & Sedient, Macmillion India.

SEMESER III
Organic Chemistry Practical - VI

Total Hours: 90 hrs. (9 Hours per week) Marks: 100

A- Multistage Preparations. (Total Laboratory Session 14) (45 marks)

i) Preparation of p-nitroaniline from aniline
ii) preparation of p-bromo aniline from aniline
iii) Benzaldehyde → chalcone → chalcone epoxide
iv) Flavnone
v) Coumarine
vii) Fisher Indol Synthesis
viii) Skrup- uinoline synthesis
viii) Synthesis of Carbohydrates (any one)
ix) Hippuric acid → Azalactone → 4-Benzylidene 2-phenyl oxazol-5-one
x) Benzophenone → benzopinacol → benzopinacolone
xi) Benzoin → benzil → benzilic acid (By Green Synthesis)
xii) Acridone from anthranilic acid

Note: 1. Synthesis is carried out in molar quantities (Less than 2 gm). 2. Reaction with possible mechanism. 3. Calculate Theoretical and practical yield. 4. Product conformation by Physical constant and TLC. 5. Give expected spectral data (IR and NMR) of starting material, intermediate and final product(Therotically differences). 6. All the prepared organic compounds should be stored as a sample and present at the time of University examination.

Scheme of Marking:

i)	Synthesis of products of. (each steps)	09
ii)	ield of the crude product (each steps)	09
iii)	MP of the recrystallized product (each steps)	09
iv)	TLC of the recrystallized product (each steps)	09
v)	Prediction of Spectral data for product of each step	09

B- Estimations: (0□Laboratory Session) **(20 Marks)**

i) Nitrogen
ii) Halogen
iii) Sulphur
iv) Soxhlet extraction of oil from oil seeds and determination of saponification value, iodine value of the same oil
v) Soxhlet extraction of piperine from black pepper
vi) Spectrophotometric/UV estimations of Caffeine.
vii) Spectrophotometric/UV estimations of Cholesterol.
viii) Analysis of Lindane in BHC powder
ix) Analysis of some common pesticides,insecticides,plastics and detergents.

C- Purification of Solvents (Total Laboratory Session 5) (15 marks)

Practical-VI
Organic Chemistry

Time : 6-8 Hrs. (One day E□amination) Marks : 100

(1) Exercise-1 (□rganic Synthesis) - 45 Marks
(2) Exercise-2 (□ualitative Analysis) - 20 Marks
(3) Exercise-3 (□ualitative Analysis) - 15 Marks
(4) Record - 10 Marks
(5) Viva-Voce - 10 Marks

Total - 100 Marks

Books Suggested:

1) Modern Experimental □rganic Chemistry-Royston M. Robert, □ohn C. Gilbert, Lyu B. Rodewald, S.
2) Experimental □rganic Chemistry- L. M. Harwood, C. I. Moody□
3) Semi-microqualitative □rganic analysis-N. D. Cheronis, □ B. Entrikin, E.M. Wodnett.
4) The Systematic identification of □rganic compounds-R.L. Shrine, D.□. Curtin.
5) □uantitative Chemical analysis □A.I. Vogel.
6) Vogel□s textbook of quantative analysis (Revised)-□ Bassett, R.C. Denney, G.H. □effery and □
7) Experiment and technique in □raganic chemistry-D. Pasto, C. □ohnson and M. Miller.
8) Hand book of organic analysis □qualitative and quantitative-H. Clark, Adward Arnold.

SEMESTER –IV
Paper XIII SPECTROSCOPY-II

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : **12L**

A) Raman spectroscopy: Classical and quantum theories of raman effects , Normal, Resonance and Laser Raman spectroscopies, Pure rotational and vibrational and vibrational rotational raman spectra, selection rules, mutual exclusion Raman spectroscopy, coherent antistokes Raman spectroscopy (CARS).Applications for the study of active sites of metalloproteins. Structure determination by symmetry selection rules (Normal Coordinate analysis). , Rotational Raman- spectra, Vibrational Raman ,Spectra, polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy, applications in structure elucidation,Application of Raman spectroscopy to structural chemistry.

B) Photoelectron spectroscopy: Basic principle, classification of electron microscopy methods ,photoelectric effect, ionization process, Koopemanss theorem PES and □-PES, PES spectra of simple molecule, ESCA, chemical information from ESCA. Auger electron spectroscopy-basic idea. Scanning electronmicroscopy, working of SEM instrument surface characterization by spectroscopy and microscopy, (SEM/TEM). atomic force microscopy(AFM), application AFM, comparison of electron microscopy with electron Inversion photo emission, multi photo ionization, spin resolved photoionization.

Unit-II : 12L

A) X-ray diffraction :Interaction of x-ray with matter, scattering and diffraction. Brags method Debye-Sherrer method of □ray structural analysis of crystals, index reflection, identification of unit cell from systematic absence in diffraction pattern structure of simple lattice and x-ray intensities structure factor , its relation to intensity of electron density procedure for x-ray structure analysis.

B) Electron diffraction : Scattering intensity Vs scattering angle, wierl equation, measurement techniques, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surface.

C) Neutron diffraction: Scattering of neutrons by solids and liquids magnetic scattering, measurement techniques. Elucidation of structure of magnetically ordered unit cell.

Unit-III : **12L**

Electron Spin Resonance Spectroscopy : Introduction ,basic principle. zero field splitting and Kramer□s degeneracy, factors effecting the □g□ values, hyperfine splitting, hyperfine and super hyperfine coupling constants, determination of □g□ values. Instrumentation, working of instruments, sensitivity, concentration, choice of solvent. presentation of ESR spectra, application of ESR to study the free radicals, structure determination, reaction velocities, McConnel relation, application to inorganic compounds including biological system and to inorganic free radicals such as PH4 -,F2 -,□BH3□-,determination of oxidation state of metals, Eldor and Eldor techniques The EPR of triplet states□Structural applications to transition metal complexes. ESR spectrum when one electron is influenced by a single proton and one electron delocalized over two equivalent protons, difference between ESR and NMR

Unit-IV : **12L**

Mossbauer spectroscopy: Basic principle, spectral parameters and spectrum display. Doppler shift. recoilless emission of radiation. The Mossbauer effect, isomer shift, quadrupole splitting, Nuclear quadrupole moment and EFG tensors, quadrupole coupling constants and asymmetry parameters, magnetic hyperfine splitting. Application of the techniques to the studies of 1. Bonding and structure of Fe2,and Fe3 compounds including those of intermediate spin (2) Sn2 and Sn4 compounds - Nature of M-L bond, coordination number, Structure and Detection of oxidation state and in equivalent MB atoms. Elucidation of structure of $I_2Br_2Cl_4$, I_2Cl_6, Structural problems, Mossbauer spectroscopy of Biological Systems. pure NR and eeman spectra of spin 1and spin 3/2 systems the Towners-Dailey theory and interpretation of NCC in terms of bond characteristics. NCCs 57Fe spectra of complexes, other Mossbauer nuclei, applications.

Unit-V : **12L**

Determination of Structures of Complex rganic Molecules by Spectroscopic Means: Problems based on IR, Mass, UV, PMR, ^{1}H NMR, ^{13}C NMR data and structure determination of organic molecules / inorganic compounds.

Books suggested

1) Spectroscopic identification of organic compound-RM Silverstein,GC Bassler and TC Morril, ohn Wally
2) Introduction to NMR spectroscopy-R Abrahm, Fisher and P loftus Wiely
3) Application of spectroscopy to organic compound- R Dyer,Printice Hall
4) rganic spectroscopy-William kemp,ELB with McMillan
5) Spectroscopy of organic molecule-PS Kalsi,Wiley,Esterna,New Delhi
6) rganic spectroscopy-RT Morrison,and RN Boyd
7) Practical NMR spectroscopy-ML Martin, Delpench, and D Martyin
8) Spectroscopic methods in organic chemistry-DH Willson,I Fleming
9) Fundamentals of molecular spectroscopy-CN Banwell
10) Spectroscopy in organic chemistry-CNR Rao and R Ferraro
11) Photoelectron spectroscopy-Baber and Betteridge
12) Electron spin resonance spectroscopy- Wertz and R Bolten
13) NMR Basic principle and application-H Guntur
14) Interpritation of NMR spectra-Roy H Bible
15) Interpritation of IR spectra-NB Coulthop
16) Electron spin resonance theory and applications-W gordy
17) Mass spectrometry organic chemical applications , H Banyon

Semester IV
Paper XIV
General Analytical Chemistry

Total Lectures: 60Hours, 4Hours per week, 12Hours/unit **Total Marks: 80**

Unit-I : Radiochemical methods of analysis: **12L**

(A) Radiation detection and measurement : principle and working of ionization chemicals. multiplicative ion collection. reasons of multiplicative operation. proportatinal counters and Geiger Muller (GM) counters. principle and working of scintillation counters. semiconductors dectors (eg. HPGe). Gamma ray spectrometer.

(B) neutron activation analysis : principle and methodology of neutron activation analysis, application of NAA in following branches of science.

(i) Material science,(ii) Geochemistry(iii) Archacology(iv) Life sciences / Biomedical science(v) Food and Nutration(vi) Environmental science(Vii) Forensic science(viii) Cosmochemistry advantages of NAA. Sources of errors and limitations of NAA.

(C) isotopic dilution analysis (IDA) : principle and method of isotope dilution analysis (IDA). substoichio metric IDA. comparision of IDA with NAA. Applications of IDA for the measurement of trace quantatites of organic and inorganic components in a given complex mixture. sources of errors and limitations of IDA.

(D) Radiometric titrations : principle and method of radiometric titrations. types of radiometric titrations. applications of radiometric titrations.source of errors and limitations of radiometric titrations. Radioactivity tracers- Principal and applications

Unit II :

Molecular photofluorescence and phosphorescence spectrometry: 12L

Basic theory, instruments, different photonic and deactivation process (interval conversion, vibration, relaxation, intersystem crossing fluorescence, phosphorescence, external conversion etc.), their inter-relation ships and differences energy level diagram, Morse curve principal types of electronic transitions, principal types of linkages in fluorimetric reagents, reagents, effect of substitution (on aromatics) upon photoluminescence, structural and environmental effects on photoluminescence, quenching and non-quenching extinction of fluorescence and probable mechanism for quenching, characteristics of π-π states, spectra, mirror image file, its violation and causes of violation delayed fluorescence, charge transfer process, structural factor favourable for fluorogenio reagents, fluorescence, immunoassay and its advantage over Radio-immunoassay, cations favouring fluorescent metal chelate formations. Fields of applications, merits and demerits of fluorometry, assessment as an ultratrace analysis technique. Principal types of reactions used in fluorimetric analysis. Analytical Applications. Phosphorimetry: Low temperature phosphorescence, Room temperature phosphorescence (RTP). Advantages and disadvantages. Applications. Chemiluminescence:Theory,measurement of chemiluminescence, mechanisms in analytical applications.

Unit III : Optical Methods & Flow Injection Analysis : 12L

RF: Basic principle, instruments, excitation sources, energy dispersive and wavelength dispersive RF techniques their advantages and disadvantages, matrix effects and their suppression, health hazards and safety. Applications.

Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES):
Principles, atomization and excitation, ICP-source, Instrumentation and applications

Flow Injection Analysis: Introduction, principal, theoretical aspects of FIA, techniques, pretreatment of sample in packed reactiors, components of FIA apparatus, Factors affecting FIA and applications.

Unit-IV : Food and Cosmetic Analysis: 12L

A) The chemical analysisof food: Importance of food analysis, Determination of approximate composition: Moisture, fat, protein, fiber,carbohydrate, etc. uantitative analysis for food quality and safety - Determination of minerals, vitamins, anti-oxidants, toxins and preservatives. General idea of the properties of drugs for their characterization and quantification. uantitative methods of analysis - Gravimetric and volumetric analysis, potentiometry, coulometry and amperometry titrations, colorimetry, fluorimetry and polarimetry methods, Analysis of artificial sweeteners in food and colouring agents.

B) Analysis of Cosmetics-Composition of creams and lotions- determination of water,propylene glycol, non-volatile matter and ash content. Determination of borates,carbonates, sulphates, Phosphates, chlorides, titanium and zinc oxides.

Analysis of face powder- estimation of boric acid, Mg, Ca, n, Fe, Al and Ba.

Analysis of deodorants and antiperspirants-composition, analysis of fats and fattyacids, boric acid, magnesium, calcium, zinc, iron,titanium, alluminium, phenol,hexachlorophenone, methanamine, sulphonates and urea

Unit V : Forensic &Fuel analysis: 12L

ForensicAnalysis: Special features of forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD-50 andLC-50. general discussion of poisons with special reference to mode of action of cyanide, organophosphate and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological samples.

Fuel analysis :Solid, Liquid and gaseous fuels. Characteristics of ideal fuels. Ultimate and proximate analysis of coal, heating values, grading of coal, liquid fuels-flash point, aniline point, knocking, antiknock compounds, octane number, cetane number and carbon residue. Gaseous fuels, producer gas and water gas, determination of calorific value. Analysis of fuel Gas. Numerical problems.

Books Suggested:

1. Day and Underwood: uantitative Analysis
2. A. I. Vogel: A text book of quantitative Inorganic analysis.
3. Flaschka: EDTA Titration
4. Meites and Thomas: Advanced Analytical Chemistry.
5. G. W. Ewing: Instrumental Methods of Chemical Analysis.

6. R. S. Drago: Physical Methods in Inorganic Chemistry
7. G. D. Christian: Analytical Chemistry
8. S. M. Khopkar: Basic Concept of Analytical Chemistry.
9. Kolltath and Ligane: Polarography
10. R.D.Braun: Instrumental methods of chemical Analysis
11. Willard, Merritt and Dean: Instrumental methods of Analysis
12. Strouts, Crifillan and Wison: Analytical Chemistry.
13. □ W. T. Spinks and R. □ Woods: Introduction to Radiation Chemistry.
14. S. A. Skoog and D. W. West: Fundamental 0f Analytical Chemistry
15. R. V. Dilts: Analytical Chemistry
16. Nuclear and radiochemistry by Friedlander, Kennedy and Miller.
1□ **Essentials of nuclear chemistry by H. □ Arnikar**

Semister IV
Paper-XV
Special Paper-III
Inorganic Chemistry (Photoinorganic & Organometallic Chemistry)

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit Total Marks-**80**

Unit-I : **12L**

A) Basics of Photochemistry: Absorption, excitation, photochemical laws, quantum yield, electronically excited states-life times-measurements of the times. Flash photolysis, stopped flow techniques, Energy dissipation by radiative and no-radiative processes, absorption spectra, Frank-Condon principles□photochemical stages-primary & secondary processes.

B) Properties of e□cited states: Photochemical kinetics, Calculation of rates of radiative processes.

Unit-II : **12L**

A) Ligand field photo chemistry of transition metal comple□es.. Electronically ligand field excited states of metal complexes containing d^1 to d^{10} configuration , , charge transfer spectra, charge transfer excitations, metods for obtaining charge transfer spectra Photochemistry Cr(III) of complexes : Photo-substitutions, properties of ligand field excited states ,Photo aquation reactions, photolysis rule , photoisomerization , photo recimization, photoanation reactions, Sensitizer, Types of sensitizer molecules, energy transfer process, Mechanism of photo sensitization, photo reactive excited state, The Doublet hypothesis, Role of quartet excited states, Photochemistry of Co(III) complexes : Introduction, energy level diagram, Photoaquations in Co(III) amine, Co(III) cynide complexes, Fe(II) low spin complexes., Ru(II) ammine derivative complexes, Photo redox properties of (Ru(III) complexes, Ce(III) and Ce(IV) complexes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants in to high-energy products, chemical energy in to light.

Unit III : **12L**

Photochemical reaction on solid surface: Introduction,Basic principle of Photocatalysis**,** Photocatalysts, Phoreactive oxides, relation between solar spectrum & band gap, acceptor and donor level of photocatalyst, generation of electron □holepair, Needs of modification of photo catalysts, semiconductor supported metal oxide systems, synthesis methods, Characterization ,water photolysis, application of photocatalytic materials for degradation of organic pollutants, end product of organic pollutants with suitable examples.Nnitrogen fixation & carbon dioxide reduction.

Unit-IV : **12L**

Organotransition metal chemistry: σ-Bonded transition metal-alkyls, - aryls, -alkenyls(vinyls), -alkynyls(acetylides), reactions in σ□organyls - homolytic cleavage, reductive elimination, electrophilic cleavage, insertion, β-metal hydrogen elimination, α-abstraction or α-elimination

Transition metal organyls with metal-carbon multiple bonding: Transition metal-carbenes, -carbynes, -bridging carbenes and -carbynes, reactions of carbene/ and carbyne complexes □ ligand substitution, nucleophilic, electrophilic attack, dismutation, ligand coupling reactions

Organotransition compounds with multicenter bonds (non-classically bonded): Concept of hapticity, transition metal complexes of alkenes, □iese salt, allenes, alkynes, allyls, butadienes□ cyclic π-metal complexes of cyclobutadienes, cyclopentadienyls, arenes, cycloheptatrienyls and cyclooctatetraenes□ reactions and bonding in ferrocene□ stereochemical non-rigidity in organometallic compounds and fluxional compounds, bimetallic and cluster complexes.

Unit-V : **12L**

Transition Metal Pi -Comple□es-Carbon multiple bonds: Transition metal complexes with unsaturated organic molecules like alkenes, alkynes, allyl, diene, dienyl, arene & trienyl complexes: Peparations,properties,nature of bonding and structural features.Important reactions relating to nucleophilic & electrophilic attack on ligands to organic synthesis.

Organometallics as catalysts: Bonding and structure transition metal complexes, applications in reactions such as hydrogenation, Hydrognation by Willkinsons catalyst, synthesis of chiral pharmaceuticals, □lefin metathesis, heterogeneous catalysis: □iegler Natta Polymerization, Water gas reduction ,carbonylation, coupling reactions - Suzuki coupling, Heck coupling and related cross coupling reactions. Alkene oligomerization and metathesis. Catalytic oxidations and reductions, epoxidation, dihydroxylations, decarbonylation, olefin isomerization, arylation, polymerization, asymmetric synthesis, heterogenised homogeneous catalysts, phase transfer catalysis, atalysis in green chemistry

Books:
1. Elschenbroich Ch.and Salzer A.: rganometallics,VCH,Weinheim,N.
2. Balzani Vand Cavassiti V.:Photochemistry of Coordination compounds,AP,London
3. Purcell K.F.and Kotz C., An Introduction to Inorganic Chemistry,Holt Sounder, apan.
4. Rohtagi K.K.and Mukharjee,Fundamentals of Photochemistry,Wiley eastern
5. Calverts G.and Pits. N.,Photochemicals of Photochemistry, ohn Wiley
6. Wells,Introduction of Photochemistry
7. Paulson, rganometallic Chemistry,Arnold
8. Rochow, rganometallic Chemistry,Reinhold
9. eiss, rganometallic Chemistry,Reinhold
10. Gilbert A.and Baggott, ,Essential of Molecular Photochemistry,Blackwell Sci.Pub.
11. Turro N. and Benjamin W.A.,Molecular Photochemistry
12. CoxAand Camp,T.P.Introductory Photochemistry,McGraw-Hill
13. KundallR.P.and GilbertA,Photochemistry, Thomson Nelson Coxon and Halton B., rganic Photochemistry,CambridgeUniversity Press.

Semester IV
Paper-XVI
Special Paper-IV
Inorganic Chemistry (Materials Chemistry)

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit Total Marks-**80**

Unit-I : Glasses, Ceramics & Composite materials: **12L**

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Glassy state, glass formers and glass modifiers.

Ceramics: Ceramic structure. . Mechanical properties.High technology ceramics and their applications.

Clays and refractory materials: Classification, structure and modifications of clays. Properties and applications of clays.

Refractories: Classification, properties and applications. Microscopic composites.

Composite materials: Definition, glass transition temperature, fibres, concrete and asphalt materials, polymer composites, application

Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

Unit II : 12L

A) Li uid Crystals: Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematics & smectic mesophases smectic-Nematic transition clearing temperature-homeotrpic, planer & schlieren textures twisted nematics, chiral nematics, molecular arrngement in smectic A & smectic C phases, optical properties of liquid crystals. Dielectric susceptibility & dielectric constants. Lyotropic phases & their description of ordering in liquid crystals.

B) Bio-materials: Biomineralisation, controlled formation of biological composits, bone & other mineralised tissues, materials of construction, applications (General aspect only).

Unit-III : Nano Chemistry: 12L

Introduction: Definition of nanoscale materials, different types, different physical and chemical synthetic routes, characterization of nanoscale materials by modern instrumental techniques.

Physical and Chemical Properties of Nanoscale Materials: Electrical properties, magnetic properties, optical extinction properties, unique optical signatures of various nanostructures, fluorescence, chemical reactivity, self-assembly of various nanostructures and its importance.

Catalytic Aspects of Nanoscale Materials: Catalysis using nanoparticles of metals and metal oxides with different sizes and shapes, useful chemical conversions using nanoparticles.

Nanoscale Materials in Emerging Technologies: Useful properties that can be exploited for applications, applications in the areas such as environmental remediation, adsorption, drug delivery, medical imaging, future prospects, precautions in using nanoparticles.

Unit IV : Nanoporous Materials: **12L**

Introduction, eolites & molecular sieves, Classifications, fundamental properties of zeolites, ualitative & quantitiave determination of surface acidity, Hydrothermal synthesis of zeolites, factors affecting the zeolite preparations, modification, methods of characterizations, & catalytic applications.

Catalysis: Basic principals, types, industrial requirements, classification, theories of catalysis, Types of homogeneous and heterogeneous catalysts, Advantages and disadvantages, thermodynamic and kinetic aspects .Essential properties of catalysts.Characterization of catalysts

Solid State Reactions: Types sintering nucleation Factors influencing the reactivity of solids Precursors to solid state reactions Tammann and Hedvall mechanism Wagner s diffusion theory ofreaction Material transport in solid state reaction counter diffusion, Kirkendall effect Huttig smechanism Kinetic model: Reaction in powder compact, parabolic rate law, ander s rate equation.

Unit V : 12L

A) **Fertili□ers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates□ polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate

B) **Coordination Polymers**: Homo and heterocatenated inorganic polymers. Polyphosphazenes: synthetic routes and bonding features, polymerization of organo/organometallic substituted phosphazenes and their applications. Polysilanes: sigma bond delocalization in polysilanes and its implications, synthesis and characterization of polysilanes. Polysiloxanes: synthetic routes via anionic and cationic polymerization, properties and environmental aspects. Dendritic macromolecules based on inorganic elements. Coordination polymers. Polymers based on Boron, Borazine ,polymeric compounds of sulphur ,polythiazoles,silicates with reference to preparation,properties,structures,bonding and applications .Natural polymers and reactions yielding coordination polymers. Synthesis of coordination polymers.

Books Suggested:

1. Barsoum ,M.W.,Fundamentals of Ceramics,McGraw Hill ,New Delhi
2. Ashcroft ,N.W. and Mermin,N.D.,Solid Stae Physics,Saunders College
3. Callister W.D.,Material Science and Engineering,An Introduction,Wiley
4. Keer,H.H,Principals of Solid State,Wiley Eastern
5. Anderson □C.,Lever K.D.,Alexander □M and Rawlings,R.D.,ELBS
6. Gray G.W.Ed.Thermotropic Liquid Crystals,□ohn Wiley
7. Kelkar and Hatz Handbook of Liquid Crystals,Chemie Verlag.
8. Kalbunde K.I.,Nanoscale Materials in Chemistry,□ohn Wiley,N□.
9. Shull R.D.,McMichael R.D. and Swartzendrub L.□.,Studies of Magnetic Properties of Fine particals and their relevance to Mataerials Science, Elsevier Pub.Amsterdam
10. Breck D.W.,□eolite Molecular Sieves:Structure Chemistry and Use,WileyChichester,Eng.
11. MorrishA.H.,HanedaK.,□hou□.□.InNanophase Materials:synthesis,properties,applications,Kulwer,London.
12. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina □verton, □onathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, □xford University Press (2011-2012)
13. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. □ohn Wiley & Sons, 1974.
14. Poole, C.P. & □wens, F.□ Introduction to Nanotechnology □ohn Wiley & Sons, 2003.
15. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Semester IV
Paper XV
Special Paper-III Organic Chemistry (Organic Synthesis: II)

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : 12L

Application of organometallics in organic synthesis

A) Organometallic Reagents □rgano Lithium, Magnesium, Mercury, zinc and copper reagents, preparation using transmetallation, functionalized zinc and copper reagents, synthetic applications And Cram rule. □rgano tin reagents, hydrostannation reaction and synthetic utility □rgano boron and aluminium reagents, alkyl and aryl derivatives, synthesis and examples of applications in C-C bond forming reactions.

B) Organo transition metal reagents: Metal (Fe, Cr, Mo, Ni, Co, Rh) carbonyl compounds in organic synthesis. Metal (Cr, Fe, Ru) arene complexes, synthesis and structure. Activation of arene nucleus and side chain. Nucleophilic substitution and addition of arene.

Metal (Fe, Pd) ene, diene and dienyl complexes, metal complexes as protecting groups, activation towards nucleophilic addition reaction synthetic utility. π-allyl palladium, nickel and iron complexes, synthesis and their synthetic utility.

Metal Cobalt alkyne complexes, protection of triple bond, Metal (Rh, Ir) catalyzed C-H activation reactions and their synthetic utility.

C) Metallocenes: Introduction, Synthesis and Chemical Reactivity of Ferrocene, Cobaltocene, Nickelocene, Copper and Rhodium Based Carbene & Nitrene Copmlexes

Unit-II : 12L

Designing the synthesis based on retrosynthetic analysis

A disconnection approach to the synthesis of organic compound. Different consideration in designing target molecule, concept of synthonss, FGI, Chemoselectivity, regioselectivity, specificity, stereoselectivity, general strategy choosing a disconnection. Types of bond disconnection, some of the applications of these concepts in designing the synthesis of common impotant class of the compounds.

Ring synthesis: Saturated heterocycles, synthesis of 3, 4, 5 and 6- membered rings. b) Synthesis of some complex molecules by Reterosynthetic analysis of following compounds: Camphor, Reserpine, and Vitamin-D2.

Unit-III : **12L**

A) Protection and Deprotection of functional groups Protection and deprotection of functional groups like, hydroxyl, amino, carbonyl and carboxylic acids groups, techniques employed for these.

B) Phase Transfer Catalysis: □uaternary ammonium and phosphonium salts, Crown ethers. Their methods of preparation and application in □rganic Synthesis, Mechanism of Phase transfer reaction. ozone phase transfer catalyst,

Unit-IV : **12L**

Reagents in Organic Synthesis: Use of following reagents in Synthesis and functional group transformations such as complex metal hydrides, Gillmen reagents, Lithium dialkyl cuprate LDA, DCC, Trimethyl silyl Iodide, Tributyl Tin hydride, Woodward and Prevost Hydroxylation, DD□,Chloranill, Peterson Synthesis, Becker □east. Periodic Acid and periodate, Diazomethane, Selenium Dioxide, Ru□4, IB□, DMP, Heck Reaction, Mukaiyama Reaction

Unit-V : **12L**

Heterocyclic Compounds: Nomenclature and familiarity with the heterocyclic ring (3- 7 members containing up to 3 heteroatoms). Detailed chemistry of Pyrozole, imidazole, oxazole, thiazole, thiazine, diazines, triazines pyrimidines, pyrazines and zepines, oxepines, Indoles, Benzofurans, □uinolines Flavones, Chromones, Coumarines, Phenithiazines, Azitidines

Books suggested :

1) Principle of organic synthesis. R□C Norman & □M coxon
2) Modern synthetic reaction. H.□.House W.A.Benjamin
3) □rganic synthesis,The disconnection approach-S.Warren
4) Designing organic synthesis-S.Warren
5) Some modern methods of organic synthesis-W.carruthers,
6) Advance organic reaction.Mechanism & structure-□erry march
7) Advance organic chemistry Part-B-F.A.caray & R□sundberg,plenum P.
8) □rganic reaction and their mechanism-PS kalsi
9) Protective group in organic synthesis-TW Greene,& PGM
10) The chemistry of organo phpsphorous-A□kirbi,&SG Warren
11) □rgano silicon compound-C.Eabon
12) □rganic synthesis via Boranes-HC.Brown
13) □rgano borane chemistry-TP onak
14) □rganic chemistry of boron-W. gerrard
15) □rganic Chemistry Reaction: Moondy
16) Heterocyclic chemistry :□oule & Smith (Van Nostrand).
17) Heterocyclic chemistry :R. K. Bansal: (Wiley E).
18) Principals of modern heterocyclic chemistry :L. A. Paquitte
19) The structure and reactions of heterocyclic compounds :M. H. Palamer.
20) Advances in Heterocyclic chemistry : A. R. Katritzky:
21) □rganic Chemistry: Clayden,Greeves, Warren & Wothers

SEMESTER –IV
Paper XVI
Special Paper-IV : ORGANIC CHEMISTRY (Applied and Medicinal Chemistry)

Total Lectures: 60Hrs, 4 Hrs per week, 12 Hrs/unit **Total Marks-80**

Unit-I : **Polymers, Dyes and Agrochemicals:** **12L**

A)Mechanism of polymerization, study of polyesters, polyamides, PVC, polystyrene, Polyvinyl acetate and polyvinyl alcohol, polythenes, viscous rayon. Synthesis of polyethylene, polypropylene.

Synthetic Rubber: Styrene-butadiene, Butyl polyisoprene, polyurathrene Vulcanization mechanism, phenol formaldehyde resin, stereo regulated polymers. Atactic, Isotactic and Syndiotactic polymers. Plasticizers, Foaming agents. Antioxidants for polymers,

B) DYES: General Introduction, . optical brighteners, thermal sensitive dyes, dispenses dyes. Fiber swelling in dyeing . Use of carriers in dyeing . Use of heat energy in dyein , study of quinoline yellow, cyamine dye, ethyl red, methylene blue, Alizarin, cyamine-green,fluorescein, cosin, erythrosine, Rhodomines and Indigo

C) Agrochemicals:

i) Carbamate pesticides: Introduction, Carbaryl, Bayon, □iram.

ii) Organophosphorous pesticides: Malathion, Monocroptophos, Dimethoate**.**

iii) Plant growth regulators: General survey synthesis of simple compounds.

Unit-II :: **12L**

General aspects of drug: Historical, Definitions used in drug chemistry-pharmacy, pharmacology, pharmacodynamics, pharmacodynamic agents, metabolite and antimetabolites, gram positive and gram negative Bacteria, Virus, Actinomucetes, Mutation, Chemotherapy, Nomenclature of medicinal compounds. Classification of drugs on basis of their Therapeutic actions. Chemotherapeutic agents Cancer chemotherapy, Synthesis of mechloraethamine, cyclophosphamide, Mephalan, uracils, mustards. Recent development in cancerchemotherapy. Pharmacodynamic agents Mechanism of Chemotherapeutic action: . Biological defences . Chemical defences, Surface active agents, Metabolic Antagonism Assay of Drugs: Chemical assay, Biological assay, Immunological assay

Unit-III **12L**

DRUGS DESIGN: Classification of Drugs, procedures followed in drug design. Concept □f lead compound and modification concept of Prodrugs and Softdrugs structure activity relationship (SAR) Factors affecting bioactivity resonance, inductive effect, isosterism, Biosterism, Spatial consideration, theories of drug activity occupancy theory, Rate theory induced tit theory, □uantitative structure activity relationship. History and development of □ASAR, Concept of drug receptor interaction, Physico-Chemical parameter. Lipophilicity, Partition coefficient Electronic ionization constants, Steric Shelton and surface activity parameters and redox potential. Free Wilson analysis, Hansch analysis LD-50,ED-50(Mathematical derivatives of equations included) Ligand-Based Drug Design, Diversity-□riented Synthesis for Drug Design, Structure-Based Drug Design, Fragment-Based Drug Design, Natural Products-Based Drug Discovery, Diversity-□riented Synthesis in Drug Discovery, Virtual Screening

Unit-IV : Classification of Drugs- I **12L**

Synthesis, mode of actions, Pharmacokinetics , pharmacodynamic data and secondary metabolism of following Drugs

A) **Antibiotics**: Introduction, Penicillin V And G, Streptomycin, Chloram phenicol, Tetracyclins.

B) **Antimalerial** : Chemotherapy of maleria, Aminoquinolines, pamaquine,chloroquineand sulphones.

C) **Antipyretic and Analgesic**: Aspirin, salol, phenacetin, antipyrin:

D)Anti- inflammatory: Ibuprofen, □xyphenylbutazone, Diclophenac, Indomethacin.

E) **Sedatives & Hypnotics:** Barbiturates, mode of action, diazepam, caffeine, Mescaline, hermine

Unit-V : Classification of Drugs- II **12L**

Synthesis, mode of actions, Pharmacokinetics , pharmacodynamic data and secondary metabolism of following Drugs

A) **Antitubercular & antileprotic** : Ethambutol, Isoniazide & Dapsone

B) **Anaesthetics** : Lidocaine, Thiopental.

C) **Antihistamines**: Phenobarbital, Diphenylhydramine.

D) **Tran□uili□ers:** Diazepam, Trimeprazine.

E) **Cardiovascular:** Synthesis of dilliazem, quinidine, methyldopa

Books Suggested:

1) Pesticides: R. Cleymlin
2) Chemistry of Pesticides: K. H. Buchel
3) The Chemistry of Pesticides and formulations: N. N. Melikov
4) Chemistry of Synthetic Dyes Vol- 1 to 7: K. Venkataraman
5) Colour Chemistry: Allan
6) Text book of organic medical and pharmaceutical
7) chemistry: Wilson, Gisvold & Dorque
8) Strategies for □rganic Drug synthesis and Design, D. Lednicer, □ Willey
9) Medicinal Chemistry: A. Kar
10) Text book of organic medicinal chemistry-wilson,geswold
11) Medicinal chemistry Vil I &II-Burger
12) Synthetic organic chemistry-Gurudeep chatwal.
13) A textbook of pharmaceitical chemistry-□ayshree Ghosh
14) Synthetic dyes series-venkatraman
15) Chemistry process industries-shreve & brink paquelte
16) Introduction to medicinal chemistry-A Gringuadge
17) The □rganic Chemistry of Drug design and Drug action, R. B. Silverman Academic press.
18) Text book of Polymer Science: F. W. Billmeyer
19) An introduction to drug design-SS pandey,& □R demmock
20) Goodman and Gilmans pharmacological basis of therapeutics-
21) Stragies for organic drug sythesis & design-D lednicer
22) Polymer science-v govarikar
23) Principle of polymer chemistry-P□flory
24) An outline of polymer chemistry-james q.allen
25) □rganic polymer chemistry-K□Saunders

Semester IV
Physical Chemistry Special Paper III
Paper XV

60 Hours (4-Hours/week) **80 Marks** **12 hours/Unit**

Unit-I : Li□uid Crystals: 12L

A) Liquid State: The vacancy theory of liquids, free volume of liquid, physical properties of liquids, Kelvin equation for Volume Pressure of droplet , Laplace equation and □oung Laplace equation. Viscosity, effect of Temperature on viscosity and Reynolds number. 6L

B) Liquid Crystal, VPT diagram, thermography, LCD and seven segment cell, classification of thermotropic crystals: Smectic, Nematic, Cholesteric, Disc shaped and polymer liquid crystal. Polymorphism in thermotropiuc liquid crystal, Pressure induced mesomorphism. 6L

Unit-II : Phase E□uilibria: 12L

Phase rule, derivation of Gibb□s phase rule, Liquid Helium system(one component), Two component system- Type A- simple eutectic system, Lead-silver , Bismuth-Cadmium system, potassium iodide water system. Type B- formation of compounds with congruent melting point, Ferric chloride water system, formation of compound with incongruent melting point, calculation of eutectic point and eutectic composition, Three component solid liquid system- Acetic acid chloroform water system and system containing two salt and water.

Unit-III : □inetics in Li□uid solutions: 12L

Introduction, Theory of Absolute Reaction rates in ideal solutions, theory of reaction rates for ions in solution, Linear Free energy relationship, Mechanistic Deductions used in Hammett Equation, Relaxation Time for simple reaction in solution, Kinetic Isotope effect, Diffusion controlled reaction, Full macroscopic and partial macroscopic diffusion controlled and ionic reaction.

Unit-IV : Chemical kinetic methods: 12L

A) Bioelectrrochemistry: Membrane Phenomena Applications of Donnans Membrane equilibria, Bioelectrodiscs, Electrocardiogram, Membrane Potentials. 6L

B) Electrocatalysis: Introduction, Electropower of electrolysis, Mechanism of Electrocatalysis, Bioelectrocatalysis, immobilization. 6L

Unit-V : Photochemical Reaction Dynamics:

Reaction Kinetics of thermal hydrogen-bromine reaction, reaction kinetics of photochemical hydrogen-bromine reaction and hydrogen chlorine reaction, reaction kinetics of decomposition of ethane, reaction kinetics of pyrolysis of acetaldehyde. □scillatory reactions, Homogeneous catalysis, Acid base catalysis, Enzyme catalysis. 12L

Books Suggested:

1) Physical chemistry by P.W.Atkins & dePaula 7Th Edition
2) Chemical Kinetics by K.□ Laidler. IIIrd Edition. Pearson Education.
3) Liquid State by □A. Pryde.
4) Theorotropic Liquid Crystals by G.W. Gray, Wiley
5) Hand Book of Liquid Crystals by Kelkar & Hatz, Chemie Verlag.
6) A Dynamic Liquid State, A. F.M. Barton, Longman.
7) Chemical Kinetics & Dynamics by □I. Steinfeld, □S. Francisco &W.L.Hase. Printice Hall. 1989.
8) Kinetic & Mechanism of Chemical Transformation by □ Rajaram & □ Kuriacose, McMillion.
9) Advanced Physical Chemistry by Gurdeep Raj, Goel Publications.
10) Physical Chemistry by Puri Sharma Pathania

Semester IV
Paper- XVI
Special Paper-IV
Physical Chemistry

60 Hours (4-Hours/week) **80 Marks** **12 hours/Unit**

Unit-I : Nuclear reactions: **12L**

Bathe□s notation, types of nuclear reactions, conservation in nuclear reaction, reaction cross section, compound nucleus theory, Experiments of Ghoshal, of Alexander and Simonoff specific nuclear reactions, trans uraniens, photonuclear reactions, thermonuclear reaction, fusion reactors

Unit-II : Nuclear fission: Process of nuclear fission, fission fragments and their mass and charge distribution. Fission energy, fission cross-section and threshold. Theory of nuclear fission, fission neutrons, other types of fissions. **12L**

Unit III : Nuclear Reactors

The fission energy, natural uranium reactor, the classification reactor , critical size of thermal reactor the breeder reactor, reprocessing of spent fuel, nuclear waste management , Nature□s nuclear reactors. **12L**

Unit-IV : Radiation Chemistry : Radiation chemistry, interaction of radiation with matter, passage of neutron through matter, interaction of gamma radiation with matter, unit of measuring radiation absorption, radiation dosimetery, and free radicals in water, radiolysis, and radiation induced colour centers in crystals. **12L**

Unit-V Applications of radioactivity and Dosimetry: Probing by isotope typical reactions involved in preparation of radioisotopes, the Szillard Chalmer□s reaction, cow and Milk system , Radiochemical principles in the use of tracers, typical applications of radioisotopes as a tracer, uses of nuclear reaction, radioisotopes as a source of energy. **12L**

Books Suggested:

1) Introduction to radiation chemistry by □W.T. Spinks and R.□Woods.
2) Essentials of Nuclear chemistry by H .□Arnikar.
3) A Dynamic Liquid State, A. F.M. Barton, Longman.
4) Chemical Kinetics & Dynamics by □I. Steinfeld, □S. Francisco &W.L.Hase. Printice Hall. 1989.
5) Kinetic & Mechanism of Chemical Transformation by □ Rajaram & □ Kuriacose, McMillion.
6) Advanced Physical Chemistry by Gurdeep Raj, Goel Publications.
7) Physical Chemistry by Puri Sharma Pathania

Semester IV Paper XV
Special Paper III
Industrial Chemistry (Polymers, Dyes and Paints)

60 Hours (4-Hours/week) **80 Marks 12 hours/Unit**

Unit – I : **12L**

Polymer Chemistry: Basic concepts, nomenclature, degree of polymerization, classification of polymerization reactions, thermodynamic. Types of polymerization: dendrimer, copolymerization, block copolymerization, graft copolymerization, stereo isomers, isotactic and syndiotactic polymers. Mechanism of polymerization: Free radical and ionic characterization and rheology of polymers, heterogeneous polymerization, eigler-Natta catalysis.

Unit – II : **12L**

A) Commercial polymers-: Manufacturing process, properties and uses of nylon-66, polyethylene, polypropene, polyvinylchloride, polystyrene, teflon and polybutene. Effect of stereochemistry on the structure and properties of polymers.

B) Degradation of polymers: xidation, thermal, photo and hydrolytic degradation methods.

Unit – III : **12L**

Dyes: Introduction, classification of dye on the basis of mode of application and structure dye intermediates, preparation of dye intermediates, structural features of a dye preparation and applications of picric acid, methyl orange, fluorescence, methyl red, indigo phthalenes, xanthenes, cyanine, anthraquinone.

Unit - IV: **12L**

Paper and Pulp: Raw materials, classification, methods of pulping, production of sulphate and sulphite pulp, general principles of some mechanical and chemical pulping kinetics. **Paper industry:** Production of paper, wet process, paper properties testing, process instrumentation Emission: Solid and gas waste Applied processes and techniques: Sizing, coating, dyeing, addition of chemicals, and calendering Fibre recovery: Broke system

Unit - V: **A) Paints and Pigments:** **12L**

Introduction of paints, ingredients and classification, new technologies properties of coatings solvents, plasticizers, dyes and bioactive additives paint formulations, testing and evaluation. Pigments: Introduction, classification and general physical properties.

B) Corrosion-: **12L**

Introduction, Principle of corrosion, Types of corrosion relevant to chemical industries, Mechanism of electrochemical corrosion, Factor influencing corrosion, Corrosion testing methods - Weight loss method, electrochemical approach, corrosion rate at short time intervals. Mechanism of corrosion and Corrosion prevention Methods- Galvanizing, tinning and electroplating. Corrosion Hazards and its industrial implications.

Books Suggested-

1) Textbook of polymer science by F. Bill Mayer, Wiley Inter Science.
2) Polymer Science by V. Govarikar, N. Viswanathan and . Sreedhar, New Age International (P) Ltd. Publishers New Delhi.
3) Plastic materials, A. Brydson, Newnes-Butterwarths (London)
4) Polymer science, Bill meyer, F. W. r. ohn Wiely & sons
5) Introduction to plastics, H. Brison and C.C. Gosselin, Newnes, London
6) Polymeric Materials, C. C. Winding and G. D. Hiatt McGraw Hill Book Co. Polymer Science by Gowarikar
7) Physical chemistry of polymers by D. D. Deshpande, Tata McGraw Hill.
8) Principles of polymer chemistry By P. . Flory, Cornell Univ. Press.
9) Introduction to polymer chemistry by R. B. Seymour McGraw Hill.
10) A Practical Course in polymer chemistry by S. . Pnnea, Pergamon press.
11) Labortary preparation of macro chemistry by E. M. M. Effery McGraw Hill.
12) Synthetic dyes by Venkatram (V L I &II)
13) Fundamental processes of dye chemistry, by Fietz.
14) Dyes and Intermediates by Adrahaedt.
15) Paints, coatings and solvents by D. Staye
16) Paints and surface coating theory and practice by R. L. Lambourna
17) Pigments handbook by T. C. Patton
18) Coating technology handbook by D. Satas

Semester IV Paper XVI
Special Paper IV
Industrial Chemistry (Chemical Process Industries, Green Chemistry and Process Economics)

60 Hours (4-Hours/week) **80 Marks 12 hours/Unit**

Unit – I : **12L**

Agrochemicals : General introduction, synthesis, structure and application:
Insecticides: DDT, BHC, aldrin, endosulfon, malathion, parathion.
Herbicides: 2,4-dichloro phenoxy acetic acid, dalapon, paraquat, banalin, butacarb, alachlor, suphonyl ureas.
Fungicides: Boardeaux mixture, copper oxychloride, benomyl.
Rodenticides: Warfarin, sodium monofluoroacetate, zinc phosphide.
Pesticides: Endosulphan, methyl parathion.

Unit – II : **12L**

A) Industrial Gases: Heavy chemicals and production of gases. Chemistry, manufacture, storage, hazards & uses.- Hydrogen, □xygen, nitrogen, carbon dioxide, chlorine, fluorine, $S□_2$, phosgene, acetylene, argon, neon & helium.

B) Fertili□ers: Fertilizer industries in India, Manufacture, uses and major engineering problems of Ammonium sulphate, Urea, Ammonium nitrates, Ammonia, Nitrogeneous fertilizers, Ammonium Phosphate, superphosphates, complex fertilizers.

Unit – III : **12L**

Pharmaceuticals : Product profile study of the following drugs and intermediates with particular stress on the manufacturing process engineering problems involved, quality control and equipment□

i) Sulpha drugs:- Sulphaguanidine, sulphamethoxazole.
ii) Antimicrobial:- chloramphenicol, streptomycin, Tetracyclines. Amoxiciline, Erythromycine
iii) Analgesic:- anti inflammatory, Acetyl Salicyclic acid, Ibuprofen, paracetamol.
iv) Vitamin □Vit, A. Vit. B6 , Vit. C
v) Barbiturates:- Pentobarbital
vi) Cardiovascular gent:- Methyldopa
vii) Antidepressants □Resperidone, sertraline.

Unit – IV : **12L**

Principles and Concepts of Green Chemistry : Introduction.

(a) Atom economic reactions - Rearrangement reactions, Addition reactions.
(b) Atom un-economic reactions - Substitutions reactions, Elimination reactions, Witting reaction
(c) Reducing toxicity - Measuring toxicity.

Synthesis involving basic principle of Green Chemistry - Introduction, Synthesis of Styrene, Adipic acid, Urethane, Aromatic amine, Selective alkylation of active methylene group, Synthesis of Acetaldehyde, Furfural from biomass, Synthesis of s-metalochlore (herbicide), Ibuprofane, Paracetamol.

Unit – V : **12L**

A) Chemical Process Economics : Cash flow for Industrial operation, factors affecting project cost and investment, cumulative cash position, salvage value, estimation methods employed for the estimation of capital investment. Interest, Methods of determining depreciation: Straight Line Method, Declining Balance Method and Sum of □ears digit Method. Economics of selecting alternatives. Break even point, production scheduling.

B) Safety: General occupational safety, flammable materials, Handling, fuel fighting equipments, control measures for Toxic chemicals. Safety with chemical engineering operations, hazardous chemicals process. Safety in Laboratories and pilot plant. Safety in transportation & storage of chemicals, management of safety & loss prevention.

Books Suggested :

1) Pesticites-Color Publications,P. L. Bombay.
2) Elements of Plant Protection by L. L. Pyenson, □ohn Wiley and sons.
3) Chemistry of Pesticides by N. N. Melnikov Springer-Verlag, New □ork.
4) Fungicites in Plant Disease control by □. L. Nines, □xford and IBH Publishing company New Dehli.
5) Methods of Pesticides Analysis by Sree Ramuly, U. I. □xford and IBH Publishers.
6) Chemical Process Industries by R. N. Shreves and M. □ A. Brink. McGraw Hill Ltd. 4th Edition.
7) Charles E. Dryden, □utline of Chemical Technology Edited by M. Gopal Rao and
8) Marshall Siting, East West press 2nd Edition 1973.
9) Indian Pharmacopoeia, 1985.
10) British pharamacopoeia, 1990.
11) Text book of □rganic Medicinal and Pharmaceutical Chemistry by Willson, □isvold,
12) Dejja, Lippinett Toppan.
13) Essentials of Medicinal Chemistry by Korolkovas and Burkhatter-Wiley-Inter science.
14) Pharmaceutical Dosage forms.
15) D. A. Crowl & □ F. Louvar, Chemical Process Safety (Fundamentals with applications), Prentice Hall
16) H. H. Fawcett and W. S. Wood, Safety and Accident Prevention in Chemical □perations, Wiley and sons.
17) Green Chemistry: Theory and PracticePaperback by Paul Anastas, □ohn Warner.
18) Introduction to Green Chemistry, Editors: Ryan, M., Tinnesand, M.
19) Green Chemistry: Environmentally Benign Reactions, Second Edition V. K. Ahluwalia.

Semester IV
Practical-VII
Inorganic Chemistry Special

Pracitcal Workload 9 Hrs./week **Time: 6-8 hours** **Marks: 100**

Unit-I :

1) Extraction and absorption spectral study of chlorophylls from green leaves.
2) Determination of Phosphates from cold drink samples by spectrophotometry.
3) Analysis of talcum and nyclin powders (Mg-complexometry, □n□/$H_3B□_3$)
4) Determination of iron in soap bar.
5) Analysis of N, P, K from fertilizer
6) Analysis of cement/paint/soil.

Unit II : Study of comple□formation:

1) To determine the formula and formation of a complex by spectrophotometry (□ob□s/ Mole/Slope ratio methods)
2) To determine stepwise proton-ligand and metal-ligand stability constant of complex by Irving-Rossotti method.
3) To determine the instability constant of complex by potentiometry ($AgNH_3$, Ag-thiosulphate)
4) To determine the composition and formation constant of a Fe-SSA complex by conductometry.
5) Determination of composition and stability constant of complex by polarography.
6) Cyclic Voltametric study of i) Potassium ferricyanide ii) Ferrocene

Unit-III : Inorganic reaction mechanism:

Kinetics and mechanism of following reactions:

1) Kinetics of Aquation/Isomerisation /Substitution reactions in octahedral complexes (Acid/Base hydrolysis)
2) Isomerization reaction of octahedral complexes.
3) Enzyme kinetics in presence of metal ions.
4) To determine the corrosion rate of metal strip.
5) To study the 1,10 phenanthroline as corrosion inhibitor for mild steel in sulphuric acid.
6) To study the adsorption and desorption of gases on heterogeneous catalyst.
7) Kinetics of substitution reaction of □Fe(Phen)$_3$□^{2}□
8) Synthesis and photochemistry of K_3□Fe(C_2□$_4$)$_3$□3H_2□

Unit-IV : Solid State:

1) Synthesis of oxides and mixed oxides : □inc Ferrite, □nMn_2□$_4$, Ni□, Nickel Ferrite, $CuMn_2$□$_4$ Nano particles of Mn□$_2$
2) Preparation of Gold Nanoparticals using Tea
3) Synthesis of nano size □n□, its characterization by UV-Visible spectroscopy and removal of dye by □n□-photocatalysis
4) Preparation of Silica and Alumina by sol-Gel technique.
5) To study the electrical conductivity and DRS of ferrites, Magnetites, doped oxides and pure samples and determine band gap.
6) Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Unit-V : Two/Three steps synthesis and characteri□ation:

Synthesis of metal complexes/Polymers and their structural characterizations by possible physical methods such as: elemental analysis (N, S, M □ etc.), m.p. Solubility, MW, molar conductance, magnetic moment, thermogravemetric analysis, IR and electronic spectral data, determination of crystal field parameters (minimum five)

1) Solvent free and one pot synthesis of Phthalocyanine complex of Copper (II).
2) □inc(II) /Copper(II)/ Cobalt(II)/ Nickel(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
3) Synthesis and characterization of coordination polymers of □inc(II) /Copper(II)/ Cobalt(II)/ Nickel(II) .
4) Magnetic Susceptibility and Thermogravimetric studies (3 samples).
5) Solution state preparation of □Ni(en)$_3$□S_2□$_3$, □Ni(H2□)$_6$□Cl_2, □Ni(NH_3)$_6$□Cl_2. Recordabsorption spectra in solution of all three complexes and analyse it. Arrange three ligands according to their increasing strength depending on your observations
6) Metal DNA interactions (Viscosity & spectrophotometry)

Book Suggested:

1. Synthesis and Characterization of Inorganic Compounds, W. L. □olly, Prentice Hall.
2. Inorganic Experiments, □ Derck Woollins, VCH.
3. Practical Inorganic Chemistry, G. Marrand, B. W. Rockett, Van Nostrand.
4. A Text Book of □uantitative Inorganic Analysis, A. I. Vogel,Longoman.
5. EDTA Titrations. F. Laschka
6. Instrumental Methods of Analysis, Willard, Merit and Dean (CBS, Delhi).
7. Inorganic Synthesis, □olly
8. Instrumental Methods of Chemical Analysis, □elri Lalikov
9. Fundamental of Analytical Chemistry, Skoog D.A. &West D.M Holt Rinehart &Winston Inc.
10. Experimental Inorganic Chemistry, W.G.Palmer, Cambridge.
11. Solid state Chemistry, N.B.Hanney
12. Introduction to Thermal Analysis, Techniques&Applications, M.E.Brown, Springer
13. Preparation and Properties of solid state Materials, Wilcox, Vol. I&II, Dekker
14. The Structure and Properties of Materials Vol.IV, □ohnWulff, Wiley Eastern.

The Practical e□amination will be based on the Inorganic Chemistry.

Time: 6-8 hours (One day e□amination) Marks: 100

I) Exercise -1 (Synthesis &Analysis)	- 40 Marks
II) Exercise-2 (Kinetics/complex)	- 40 Marks
III) Record	- 10 Marks
IV) Viva- Voce	- 10 Marks
Total	-100 Marks

SEMESER IV
Practical – VII
Organic Chemistry Special

Total Hours: 90 hrs. (9 Hours per week) Marks: 100
A- □ualitative Organic Analysis: (40 Marks) (12 Laboratory Session) Separation, purification and identification of ternary (three component) mixtures. The water soluble solid/liquid should also be given. Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the three compounds separated out.
Note : *Analysis of at least ten mixtures should be carried out.*

Scheme of Marking: Type of the mi□ture	**10**
i). Analysis of the individual components: (10 Marks for each component)	
ii). Detection of Elements	02
iii). Detection of functional groups	02
iv). Determination of MP/BP	02
v). Preparation of the derivative	02
vi). Identification (Spotting)	02

B- Spectral Interpretation and use of Chem draw software (Total Laboratory Session 6) (15 marks)

C: Miscellaneous E□periments (Mandatory) (Total Laboratory Session 8) (25 marks)
(1) Reduction reaction of 3-nitroacetophenone (Stereo selective synthesis)
(i) Reduction with Tin and Hydrochloric Acid
(ii) Reduction with sodium borohydride
(2) Grignard Reaction: Conversion of Benzophenone into triphenyl methanol.
(□) Synthesis of 5,5-Diphenylhydantoin from benzil, as an anticonvulsant.
(4) Extraction of Limonene (essential oil) from orange by steam Distillation.
(5) Synthesis of anaesthetic drug Benzocaine.
(6) Synthesis of anticancer drug 6-methyl uracil.
(□) Synthesis of α-Acetylaminocinnamic acid from glycine.
(8) Estimation of blood sugar,calcium ,and total nitrogen and non-protien nitrogen in blood.

Practical-VI
Organic Chemistry

Time : 6-8 Hrs. (One day E□amination) Marks : 100

(1) Exercise-1 (□rganic Synthesis) -	40 Marks
(2) Exercise-2 (□ualitative Analysis) -	15 Marks
(3) Exercise-3 (□ualitative Analysis) -	25 Marks
(4) Record -	10 Marks
(5) Viva-Voce -	10 Marks
Total	100 Marks

Books Suggested:
1. Textbook of practical organic chemistry qualitative and quantitative analysis (Vol I &II)- A.I. Vogel.
2. Elementary practical organic chemistry small scale preparation (Langman)- A.I. Vogel.
3. A handbook of organic analysis.-H.T.Clark.
4. Systematic qualitative organic analysis □H. Middeton.
5. Advanced practical organic chemistry-N. K. Vishnoi.
6. Small scale organic preparation-P.□ Hill
7 Practical organic chemistry-H. Dupont Durst & George W.Gokal.
8. Experimental organic chemistry Part I & II, P. R. Singh, D. S.Gupta & K.S. Bajpai.
9. Vogel□s textbook of practical organic chemistry-A.R. Tatchell

Semester IV
Practical-VII
Physical Chemistry Special

Pracitcal Workload 9 Hrs./week **Time: 6-8 hours** **Marks: 100**

USE OF COMPUTER PROGRAMES 5 TERMS OF PRACTICALS.
Treatment of e□perimental data, X-Y plots, programs with data preferably from physical chemistry practical. Students will operate two packages I) MS-Word and II) MS-E□cel.

Part-A
1) To find out Energy of activation & Temperature coefficient of hydrolysis of methyl / ethyl acetate
2) To find out Energy of activation of the reaction between potassium persulphate & potassium iodide.
□) Determination of partial molar volume of solute and solvent in binary mi□ture.
4) To study the variation of solubility of calcium sulphate with ionic strength and hence determine thermodynamic solubility product.
5) To study the adsorption of acetic acid on charcoal and prove the validity of Frendich and Langmuir adsorption isotherm.
6) To determine the critical micelle concentration of soap.
7) To determine the molecular weight of high polymer by viscosity measurement.
8) To find out partition coefficient of Iodine/Benzoic/Salicylic acid between benzene and water.

Part-B

1) **Determination of Half Wave potential of metal ions by polarography.**
2) **Simultaneous determination of suitable of metal ion by polarography**
3) **Analysis of aspirin conductometrically and potentiometrically**
4) **Determination of sodium , potassium, lithium and calcium by Flame photometric individually and mi□ture.**
5) **Elecronics measurement of resistance with multimeter and use of Wistone Bridge for accurate measurement of resistance.**
6) **Determine the dipole moment of given li□uid.**
7) **Plot the current voltage curve for copper sulphate and sulphuric acid using bridge platinum electrode.**
8) **Determine the transport number of ions by moving boundary method.**
9) **Determine the composition of binary mi□ture spectrophotometrically**

Physical Chemistry Practical :
Distribution of marks:

Two Days Examination - 6-8 Hrs.	100 Marks
Unit A □ □	40
Unit B □ □ □	40
Record	10
Viva-voce	10
T□TAL	100

Semester IV
Pratical-VII
Industrial Chemistry Special

Pracitcal Workload 9 Hrs./week **Time: 6-8 hours** **Marks: 100**

Multi step organic Synthesis (Minimum 20 practical should be performed):

1. Nitrobenzene - m-dinitrobenzene □m-nitroaniline- m-nitrophenol.
   Anthranilic acid □phenylglycine orthocarboxylic acid □indigo
2. Cyclohehanone □cyclohexanone oxime □caprolactum.
3. Preparation of P- bromoanaline from analine.
4. Preparation of Synthetic □eolites.
5. Determination of □N□ and □P□ nitrogen and phosphous containing fertilizer respectively by suitable methods.
6. Determination of Iron and Calcium from Cement by suitable methods.
7. Determination of Lead (Pb) from □pal Glass by suitable methods.
8. Experiments based on distillation under reduced pressure, fractional and steam distillation.
9. Measurment of flash point, ignition point, kinematic viscosity by U-tube method.
10. Estimation of Copper from □fungicides.
11. Determination of pesticide contents in the soil.
12. Preparation of Methyl orange, Methyl red, orange II, Fluorescin, □uinoline, Anthraquinone.
13. □uantitative estimations of important commercially available drugs.
14. □ualitative analysis of commercial available drugs including chromatographic technique.
15. Preparation of simple drugs involving two or three steps.
16. Preparation of melamine □HCH□ resin.
17. Determination of number average molecular weight (Mn) by end group analysis by conductmetric method.
18. Determination of average molecular weight of polymer by viscometric method.
19. Determination of reducing sugar in cane juice.
20. Determination of moisture content and ash content of wood sample.
21. Experiments based on simple & fractional crystallization.
22. Analysis of nonfibrous materials used in pulp industries such as caustic soda as Na_2□, Soda ash as Na_2□, lime as Ca□.
23. Extraction of essential oils from medicinal plants (Tikhadi).
24. Separation of Chromium (VI) & Chromium (III) by TLC in wastewater sample from electroplating industry.
25. Estimation of Manganese from Tea leaves-component
26. Preparation of selected pesticide formulations in the form of dusts, emulsions, sprays.
27. Preparation of biodiesel from vegetable/ waste cooking oil
28. Determination of calorific value of fuels.
29. Preparation and characterization of inorganic complexes comntaining Fe, Co, Ni, Cu, □n, with N, and P containing ligands. Applications of these complexes for □rganic coupling reactions like Heck, Suzuki, Stille and Sonogashira reactions

Distribution of marks:
The Practical e□amination will be based on the syllabus for Industrial Chemistry (Elective Paper).
Time: 6-8 hours (one day e□amination) Marks: 100

I) Exercise -1 (Based on Synthesis)	- 40 Marks
II) Exercise-2 (Based on □uantative Analysis)	- 40 Marks
III) Record	- 10Marks
IV) Viva- Voce	- 10 Marks
Total	-100 Marks

List Of Books-

1. Practical Engineering by S. S. Dara.
2. Labortary Preparation of Microchemistry by E. M. M. Effery, McGraw Hill.
3. Practical Course in Polymer Chemistry by S. □ Pnnea, Pargaman Press
4. Practical Pharmacognosy by T. B. Willis.
5. Practical Pharmacognosy by T. N. Vasudevan.
6. Indian Pharmacopea-1985, British Pharmacopea-1990.
7. Handbook of Drugs and Cosmetics by Mehrotra
8. Methods of Pesticide Analysis by Sree Ramuly U. I. □xford and IBH Publishing Co.
9. Methods of testing for petroleum and petroleum products. IS 1448-1960 Part I to Part IV. Published by ISI New Delhi 1967
10. IP Stands for Petroleum and products Published Applied Service Publisher Ltd. London, 33rd Edition 1974.
11. American Stds. For testing Materials, New □ork 1967.
12. Textbook of Inorganic Chemistry by A. I. Vogel.
13. Instrumental Methods of Analysis by Willard, Merit and Dean
14. Industrials Chemicals, Faith et. al. Wiley Interscience New □ork
15. Textbook □f Practical □rganic Chemistry by I. C. Voley.
16. Industrial □rganic Chemistry by □ K. Sttille
17. Unit □perations by Kale
18. Reagents for □rganic Synthesis Fisher and Fisher.
19. Technique of □rganic Chemistry Vol I, Part I- IV A. Weishberger.

SEMESER IV
Practical – VII
Project Work

Total Hours: 90 hrs. (9 Hours per week) Marks: 100

The students will develop utilities such as analytical spectra, simulation programs that will supplement laboratory exercises in their subject of specialisation. Literature survey, Studies of reactions, synthesis, mechanism, isolation of natural products, standardization of reaction conditions, new methods etc. External and internal examiners will examine this jointly at the time of practical examination. (Students should present his/her work in power point presentation. □pen Viva is compulsory. Soft Copy of presentation in CD should be submitted with dissertation.)

Study Tour:
Educational/Industrial tour is compulsory for M.Sc. Chemistry.

(i) Semester I/II: Visit to local Industry/Institute.
(ii) Semester III/IV: Education tour to visit the industry/Research laboratory (Long Tour).
Students should submit their tour report at the end of Semester II and Semester IV respectively with proof of visiting (Photo etc.).

- **List of e□uipments/appratus re□uired for the M.Sc. Chemistry Semester-I to IV Practicals.**

1.	Rotaevaporater	01 no./batch
2.	Crycooler	01 no./batch
3.	Sonicator bath	01 no./batch
4.	Stirrer With Hot Plate	04 nos./batch
5.	Eye Washer	01 no./batch
6.	Chemdraw Software (version12)	01 no./batch
2.	Conductivity meter	03 nos./batch
2.	pH meter	03 nos./batch
3.	Potentiometer	03 nos./batch
4.	Polariometer	02 nos./batch
5.	Centrifuge machine	02 nos./batch
6.	Vaccum Pump	01 no./batch
7.	Hot air oven	01 no./batch
8.	Blower hot & cold	03 nos./batch
9.	Stop watch	10 nos./batch
10.	Weight box con.100 gm.	10 nos./batch
11.	Analytical double pan balance	10 nos./batch
12.	□ne pan electronicl balance	02 nos./batch
13.	Tripple beam balance	02 nos./batch
14.	Melting point apparatus	02 nos./batch
15.	Spectrophotometer	02 nos./batch
16.	Water still	01 no./lab

17.	Colorimeter	02 nos./batch
18.	Thermostate	01 no./batch
19.	Electrodes platinum	03 nos./batch
	Silver, □n,Cu	03 nos./batch
	Glass	03 nos./batch
	Reference	03 nos./batch
20.	Heating mentle	02 nos./batch
21.	Glass double distillation unit	01 no./lab
22.	Flame Photometer	01 no./batch
23.	High Resistivity meter	01 no./lab
24.	Polarpgraph with recorder	01 no./lab
25.	U.V.visible spectrophotometer(Double beam)	01 no./lab
26.	Infrared Spectrophotometer	01/class
26.	Standard cell	02 nos./batch
27.	Muffle furnace	01 no./lab
28.	D.C.Voltmeter	01 no./lab
29.	Infrared lamp	05 nos./lab
30.	Refrigerator	01 no./lab
31.	Magnetic stirrer 2 ml, 5 ml.	02 nos./batch
32.	Dimmer state	01 no./lab
33.	Abbe□s refractometer	01 no./batch
34.	Sodium lamp for polarimeter	02 nos./batch
35.	T.L.C. Kit	01 no./lab
36.	Calorimeter	01 no./lab
37.	Bomb Calorimeter	02 nos./batch
38.	B□D analyser	01 no./lab
39.	Water analysis kit	01 no./lab
40.	Computer-386/486	01 no./lab
41.	U.V.Lamp	02 no./lab
42.	Ice making machine	01 no./lab
43.	LCR bridge(Four Probe Method)	01 no./lab
44.	Gas Chromatograph	01 no/course
44.	HPLC	01 no./course
45.	Deioniser	01 no./lab
46.	Ion exchange column□	04 no./lab
47.	Turbidity meter	01 no./lab
48.	□ptical densitometer	01 no./lab
49.	□rsat apparatus (gas analysis)	01 no./lab
50.	Interferometer (ultrasound)	01 no./batch
51.	Magnetic Susceptibility balance	01 no./lab
52.	Hydraulic press	01 no./lab
53.	TGA, D.T.A. Apparatus	01 no./course
53.	Shaking machine	01 no./lab
54.	G.M.Counter	01 no./lab
55.	Electrophorasis apparatus	01 no./lab
56.	Karl-Fisher Titration apparatus	01 no./lab
57.	Power supply (regulator)	01 no./batch
58.	Regulated furnace	01 no./lab
59.	Thermocouple	01 no./lab
60.	Vaccum oven	01 no./lab
61.	Top pan balance	01 no./lab
62.	UV Chamber	01 nos/batch
63.	Fume Hude	01 no/class
64.	Gaussian softwere(version 9)	01 no/class

List of glasswares (main) for M.Sc. Chemistry Semester-I to IV Practicals

1.	Glass Column	10 nos./batch
2.	Dean-Stark Apparatus	02 nos./batch
3.	Addition funnel	10 nos./batch
4.	Round bottomed flask	10 nos./batch
5.	Sintered funnels	03 no./batch
6.	Pressure bottle	02 nos./batch
7.	Cannula	01 no./batch
8.	Rubber septum	10 nos./batch
9.	□-adaptor	03 nos./batch
10.	Vacuum adaptor	03 nos./batch
11.	Thermometer adaptor	02 nos./batch
12.	Claisen adaptor	02 nos./batch
19.	Flow control adaptor	03 nos./batch
13.	Side-arm flask	02 nos./batch
14.	Buchner funnel	02 nos./batch
15.	Crystallizing dish	04 nos./batch

16.	Versatile clamp	02 nos./batch
17.	3-Prolonged clamp	02 nos./batch
18.	Ring clamp	05 nos./batch
19	Soxhlet set	02nos/batch
20	Kjeldahl□s apparatus set (for Nitrogen element estimation)	02 nos./batch
21	Distillation unit	04 nos./batch
22	Separating funnel	10 no./batch
23	Steam distillation unit	02 nos./batch
24	Vaccum desicator	01 no./batch
25	Paper chromatography chamber	03 nos./batch
26	TLC chamber	05 nos./batch
27	Silica crucibles	20 nos./batch
28	Sintered glass crucibles g4/g5	20 nos./batch
29	Spot test plates	10 nos./batch
30	Wash bottles	10 nos./batch
31	Density bottles	10 nos./batch
32	Viscometer	10 nos./batch
33	Kipp□s apparatus	01 nos./batch
34	Beakers, capacity :50 ml, 100 ml, 250 ml, 400 ml, 500 ml, 1000ml	10 nos/batch
35	Conical flask : 100 ml, 250 ml	10nos /batch
36	Burettes with stop cock, capacity : 2ml, 5 ml, 10ml, 25 ml.	10nos/batch
37	Lambda pipette	02 nos./batch
38	Voumetric flasks, capacity : 10 ml, 25 ml, 50 ml, 100 ml, 250 ml, 500 ml, 1000ml.	10nos /batch
39	Measuring cylinder, capacity : 10 ml, 25 ml 50 ml, 100 ml, 500 ml, 1000 ml	10nos/batch
40	Pipette, capacity : 1 ml, 2 ml, 5 ml, 10 ml, 25 ml.	10nos/batch
41	Stalagnometer	10 nos./batch
42	Thermometer (b-24) 0 to 360^0C (quick fit)	05 nos./batch
43	Water suction pump (glass)	05 nos./batch
44	Filtration flasks with buckner funnels 50 ml ,100ml,250ml,500ml	10 nos./batch
45	China dishes	10 nos./batch
46	Dessicators	10 nos./batch
47	Platinum/Nickel Crusible	02 nos./batch
47	Thiel□s tube for melting point	10pkt./batch
48	□uick fit water condensors b-19, b-24	10 nos./batch
49	□uick fit flasks, Capacity 50 ml, 100 ml, 250 ml, 500 ml, 1000 ml.	10 nos./batch
50.	Microanalysis Kit	10 nos/batch

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