MASTER OF SCIENCE (CHEMISTRY)
REGULATIONS

ELIGIBILITY

A candidate who has passed B.Sc., Degree Examination with Branch IV Chemistry as main subject of study of this university or any of the B.Sc., degree examination with specialization such as Industrial chemistry, Polymer Chemistry, Applied Chemistry, Pharmaceutical Chemistry or any other specialization in Chemistry of some other University accepted by the syndicate as equivalent thereto, subject to such condition as may be prescribed therefore shall be permitted to appear and qualify for the M.Sc., degree in Chemistry after a course of study of two academic years.

DURATION OF THE COURSE

The course shall extend over a period of two years comprising of four semesters with two semesters in one academic year. There shall not be less than 90 working days for each semester. Examination shall be conducted at the end of every semester for the respective subjects.

OBJECTIVES OF THE COURSE

- To impart knowledge in fundamental aspects of all branches of chemistry (Organic chemistry, Inorganic Chemistry and Physical Chemistry).
- To acquire deep knowledge in the study of physical, chemical, electrochemical and magnetic properties, structure elucidation using various techniques and applications of various organic and inorganic materials and
- To acquire basic knowledge in the specialized areas like Polymer chemistry, Industrial Chemistry, Agricultural Chemistry, Pharmaceutical Chemistry etc.

SCHEME OF EXAMINATION

Subject Code	Subject	Hours of Instruction	Exam Duration (Hours)	Max Marks			Credit Points
				CA	CE	Total	
FIRST SEMESTER							
PART A							
15PCHM101	Core I: Organic Chemistry I	5	3	25	75	100	5
15PCHM102	Core II: Inorganic Chemistry I	5	3	25	75	100	5
15PCHM103	Core III: Physical Chemistry I	5	3	25	75	100	5
15PCHM104	Core IV: Spectroscopy (100% Internal evaluation)	3	3	100	-	100	3
15PCHMP101	Core Practical I: Organic Chemistry Practical I	5	6	25	75	100	3
15PCHMP102	Core Practical II: Inorganic Chemistry Practical I	5	6	40	60	100	3
NON CREDIT							
15PLS101	Career Competency Skills I	1	-	-	-	-	-
Total		**29**				**600**	**24**
SECOND SEMESTER							
PART A							
15PCHM201	Core V: Organic Chemistry II	5	3	25	100	100	5
15PCHM202	Core VI: Inorganic Chemistry II	4	3	25	75	100	4
15PCHM203	Core VII: Physical Chemistry II	4	3	25	75	100	4
15PCHEL201	Elective I: Polymer Chemistry	4	3	25	75	100	4
15PCHMP201	Core Practical III: Organic Chemistry Practical II	5	6	40	60	100	3
15PCHMP202	Core Practical IV: Physical Chemistry Practical I	4	6	40	60	100	3
PARTB							
15PVE201	Value Education: Human	2	3	25	75	100	2

	Rights						
NON CREDIT							
15PLS201	Career Competency Skills II	1	-	-	-	-	-
	Total	**29**				**700**	**25**
THIRD SEMESTER							
PART A							
15PCHM301	Core VIII: Organic Chemistry III	5	3	25	75	100	5
15PCHM302	Core IX: Inorganic Chemistry III	5	3	25	75	100	5
15PCHEL301	Elective II: Photochemistry	4	3	25	75	100	4
15PPHCHI301	IDC I: Solid State Physics	4	3	25	75	100	4
15PCHMP301	Core Practical V: Inorganic Chemistry Practical II	5	6	40	60	100	3
15PCHMP302	Core Practical VI: Physical Chemistry Practical II	5	6	40	60	100	3
Total		**28**				**600**	**24**
FOURTH SEMESTER							
PART A							
15PCHM401	Core X: Analytical Chemistry	5	3	25	75	100	5
15PCHM402	Core XI: Physical Chemistry III	5	3	25	75	100	5
15PCHPR401	Project & Viva -Voce	-	-	50	150	200	8
Total		**10**				**400**	**18**
Grand Total						**2300**	**91**

For course completion

- Students shall opt two Elective subjects.
- Students shall opt one IDC in third Semester
- Students shall complete one Value Education in Second Semester

TOTAL CREDIT DISTRIBUTION

Subjects	Total Marks		Credits
PART A			
Core subjects	8x 100	800	8X5=40
Core subjects	2x100	200	2x4=8
Core subject (Internal Evaluation)	1x100	100	1x3=3
Elective subjects	2 x 100	200	2X4=8
Core Practicals	6 x 100	600	6X3=18
Inter Disciplinary Course (IDC)	1 x 100	100	1X4=4
Project & Viva-Voce	1 X 200	200	1X8=8
Part-B			
Value Education-Human Rights	1x100	100	1x2=2
Total		**2300**	**91**

15PCHM101	CORE I : ORGANIC CHEMISTRY I	SEMESTER - I

Total hours: 50

OBJECTIVES:

1. To understand the basic principles of carbenes and intermediates.
2. To understand aliphatic and aromatic nucleophilic substitution reaction.
3. To understand the chemistry of antibiotics, vitamins and stereochemistry.
4. To study the stereochemistry and aromaticity.
5. To learn possible reaction pathways in molecular rearrangement reactions.

CONTENTS

UNIT I **(10 Hours)**

Basic Concepts: Formation, stability and reactions of carbenes and nitrenes. Non-classical carbonium ions. Kinetic and thermodynamic control of chemical reactions; Methods of determining reaction mechanism - kinetic methods – Primary and secondary kinetic isotopic effects; Non-kinetic methods – Study of intermediates, product analysis, isotope labeling, Stereochemical studies and cross over experiments; Principle of microscopic reversibility; Hammond postulate. Linear free energy relationship; Hammett equation – Significance of reaction and substituent constants (σ and ρ); Taft equation.

UNIT II **(10 Hours)**

Aliphatic and Aromatic Electrophilic Substitution Reactions: The arenium ion mechanism, typical reactions like nitration, sulphonation, halogenation, Friedel – Crafts alkylation, acylation and diazonium coupling, electrophilic substitution on monosubstituted benzene, orientation and reactivity – ortho, meta and para directing groups, ortho-para ratio, ipso attack, Gatterman, Gatterman- Koch, Vilsmeir, Reimer – Tiemann reaction. SE_1 and SE_2 mechanism – keto enol tautomerism– HVZ reaction-aliphatic diazonium coupling-acylation at an aliphatic carbon-vilsemeyer Hack reaction at aliphatic carbon-Stork-enamine reaction.

UNIT III **(10 Hours)**

Vitamins and Antibiotics: Chemistry of the following antibiotics: penicillin, streptomycin, chloromycetin, oxytetracycline and griseofulvin; Detailed chemistry and physiological action of Vitamin A, ascorbic acid, thiamin, riboflavin and elementary aspects of Vitamin B12.

UNIT IV **(10 Hours)**

Stereochemistry and Aromaticity: Homotopic, enantiotopic, diastereotopic H atoms, groups in organic molecules. Fischer, Newman and Sawhorse projections and their interconvertion. Optical activity in the absence of chiral carbon – biphenyls, allenes and spiranes. E – Z isomerism of olefins containing one double bond and more than one double bond. Stereospecific and stereoselective synthesis with suitable examples, asymmetric synthesis – Crams rule. Aromaticity of benzenoid, heterocyclic and non-benzenoid compounds, Huckel rule, aromatic systems with pi electron compounds other than six pi electrons, non–aromatic (cyclooctatetraene) and anti aromatic systems (cyclobutadiene) systems with more than 10 pi electrons – annulenes

UNIT V **(10 Hours)**

Molecular Rearrangements: A detailed study of the mechanism of the following rearrangements: Nucleophilic, Electrophilic and Freeradical rearrangements – memory effects, migratory aptitudes, Wagner – Meerwin, Phenacol-Phenacalone, Dienone-Phenol, Favorski, Baeyer–Villiger, Wolff, Stevens, Von – Richter, Hofmann, Schmidt and Fries rearrangements.

TEXT BOOKS:

1. *Jerry March*. 1992. **Advanced Organic Chemistry: Reactions, Mechanisms, and Structure,** [Fourth edition], John Wiley & Sons, New York.
2. *Kalsi*, *P.S.* 2002. **Organic Reactions and Mechanisms**, [Second edition], New Age International Publishers, New Delhi.
3. *Ernest Eliel*. 1995. **Stereochemistry of Carbon Compounds**, [Second edition], Tata McGraw-Hill Publishing Company, New Delhi.

REFERENCE BOOKS:

1. *Kalsi P.S.* 1994. **Stereo Chemistry and Mechanism through Solved Problems,** [Second edition], New Age International Publishers, New Delhi.
2. *Nasipuri D.* 1994. **Stereo Chemistry of Organic Compounds,** [Second edition], New Age International Publishers, New Delhi.
3. *Morrison R.T* and *Boyd R.N*. 1992. **Organic Chemistry**, [Sixth edition], Prentice-Hall, New Delhi.
4. *Jagdamba Singh* and *Yadav L.D.S.* 2010. **Advanced Organic Chemistry**, [Second edition], Pragati Prakashan, Meerut.

15PCHM102	CORE II: INORGANIC CHEMISTRY I	SEMESTER - I

Total hours: 50

OBJECTIVES:

On successful completion of the course the students should have an exposure to

1. Basic idea about the structure and bonding
2. Analytical tools which are used in nuclear chemistry
3. Properties of solids

CONTENTS

UNIT I **(10 Hours)**

Structure and Bonding: Hard and Soft acids and bases - classifications, Acid-Base strength, symbiosis, Theoretical basis of Hardness and Softness, applications of HSAB. Rings- Phosphazenes - Structure, Craig and Peddock model, Dewar model, Poly organo phosphazenes, Polysulphur - nitrogen compounds. Inorganic polymers- Silicates - structure. Polyacids - Isopoly acids of V, Cr, Mo and W; Hetero polyacids of Mo and W (only structural aspects).

UNIT II **(10 Hours)**

Nuclear Chemistry - I: Nuclear properties - Nuclear spin and moments, features of the liquid drop and the shell models of the nucleus; Modes of radioactive decay-orbital electron capture nuclear isomerism, internal conversion; Detection and determination of activity - GM, Scintillation and Cherenkov counters. Nuclear reactions - Types, reaction cross section, Q-value, threshold energy, compound nuclear theory, high energy nuclear reactions, nuclear fission and fusion reactions as energy sources, direct reactions, photo nuclear and thermo nuclear reactions, Stellar energy.

UNIT III **(10 Hours)**

Nuclear Chemistry-II: Applications relating to Nuclear Chemistry - Neutron activation analysis, Radio pharmacology, Radiation protection and safety precautions, Isotope dilution analysis. Radiation Chemistry - radiation dosimetry, radiolysis of water, the hydrated electron.

UNIT IV **(10 Hours)**

Solid - State chemistry: Defects in solids - Point defects, line defects and surface defects; Non-stoichiometric compounds; Use of X-ray powder data in identifying inorganic crystalline solids; Details for cubic systems; Structures of NiAs, CdI_2, Pervoskite, rutile, fluorite and antifluorite- zinc blende and wurtzite.

UNIT V **(10 Hours)**

Properties of Solids: Electrical properties of solids - Band Theory, semiconductors, superconductors, solid state electrolytes; Magnetic properties - dia, para, ferro, antiferro and ferrimagnetism - hysterisis; Optical properties - Solid-state lasers and Inorganic phosphors. Reactions in solid state, diffusion mechanism, formation of spinels; solid solutions, order-disorder transformations.

TEXT BOOKS:

1. *Cotton F.A.* and *Wilkinson G.* 1988. **Advanced Inorganic Chemistry**, [Fifth edition], Wiley Eastern Co, New Delhi.
2. *Arniker H.J.* 1987. **Essentials of Nuclear Chemistry,** [Second edition], Wiley Eastern Co, New Delhi.
3. *West A.R.* 1991. **Basic Solid State Chemistry**, John Wiley, New York.

REFERENCE BOOKS:

1. *Huheey J.E., Keiter E.A* and *Keiter R.L.* 2002. **Inorganic chemistry principles of structure and reactivity, [**Fourth edition], Pearson Education, USA.
2. *Shriver D.F., Atkins P.W.* and *Langford, C.H*. 1994. **Inorganic Chemistry,** [Second edition], ELBS, New Delhi.

15PCHM103	CORE III: PHYSICALCHEMISTRY I	SEMESTER - I

Total hours: 50

OBJECTIVES:

1. To understand the principles of thermodynamics, quantum chemistry and group theory.
2. To study about the rate and various theory of rates.

CONTENTS

UNIT I **(10 Hours)**

Thermodynamics I: Partial molar properties-Partial molar free energy (Chemical potential)-Partial molar volume and Partial molar heat content-their significance and determination of these quantities. Gibbs-Duhem equation - Variation of chemical potential with temperature and pressure. Thermodynamics of real gases-gas mixture-definition of fugacity-variation of fugacity with temperature and pressure-thermodynamics of ideal and non-ideal binary solutions-dilute solutions. Determination of fugacity of real gases and vander waals gas-fugacity components in ideal solutions-Duhem-Margules equation.

UNIT II **(10 Hours)**

Quantum Chemistry – I: Black body Radiation – Experimental results–Photoelectric effect – de-Broglie equation – Heisenberg uncertainty principle –Compton effect–operators and commutation relations–quantum mechanical postulates –Schrodinger equation and its solution to the problem of a particle in one and three dimensional boxes –the harmonic oscillator.

UNIT III **(10 Hours)**

Quantum Chemistry–II: Schrödinger equation for the rigid rotator and Hydrogen atom–arriving solution for energy and wave function – the origin of quantum numbers and their physical significance–Probability distribution of electrons. Approximation methods–Perturbation and Variation methods–application to Hydrogen and Helium atom.

UNIT IV **(10 Hours)**

Group Theory – I: Symmetry elements and symmetry operations–Point groups–identification and Representation of groups–comparison of Molecular symmetry with Crystallographic symmetry– Reducible and irreducible representation–Direct product representation–Great orthogonality theorem and its consequences–Character Table and their uses.

UNIT V **(10 Hours)**

Group Theory–II: Symmetry selection rules for vibrational, Electronic and Raman Spectra –determination of representation of vibrational modes in non-linear molecules such as H_2O, CH_4, XeF_4, SF_6 and NH_3 –symmetry of Hybrid orbitals in non-linear molecule (BF_3, CH_4, XeF_4, PCl_5 and SF_6) – Electronic spectra of formaldehyde.

TEXT BOOKS:

1. *Prasad R.K.* 1992. **Quantum Chemistry**, Wiley Eastern, New Delhi.
2. *Ramakrishnan V.* and *Gopinathan M.S.* 1988. **Group theory in chemistry**, Vishal Publications, Jalandar.
3. *Raman K.V*. 1990. **Group theory and its application to Chemistry,** Tata Mc-Graw Hill Publishing Co, New Delhi.
5. *Puri P.R., Sharma L.R.* and *Pathania M.S.* 2010. **Principles of Physical Chemistry**, Vishal Publishing Co, Jalandhar.

REFERENCE BOOKS:

1. *McQuarrie D.A*. 1983. **Quantum Chemistry**, University Science Books, Mill Valley, California.
2. *Atkins P.W*. 1983. **Molecular Quantum Mechanics**, Oxford University Press, Oxford.
3. *Cotton F.A.* 1971. **Chemical Application of Group Theory**, John Wiley and Sons Inc., New York.

15PCHEM104	CORE IV: SPECTROSCOPY	SEMESTER - I

Total hours: 40

OBJECTIVES:

1. To understand the basic principles of UV-ViS, IR, NMR and MASS spectroscopy techniques and its applications

CONTENTS

UNIT I **(8 Hours)**

UV-VIS -Ultraviolet – Visible spectroscopy – types of electronic transitions – chromophores and auxochromes - factors influencing positions and intensity of absorption bands – absorption spectra of dienes, polyenes and alpha, beta- unsaturated carbonyl compounds – Woodward – Fieser rules.

IR Spectroscopy–vibrational frequencies and factors affecting them–identification of functional groups – intra and inter molecular hydrogen bonding –finger print region – Far IR region – metal ligand stretching vibrations.

UNIT II **(8 Hours)**

NMR Spectroscopy-Basic idea**-**Nuclear spin – magnetic moment of a nucleus – nuclear energy levels in the presence of magnetic field , relative populations of energy levels – macroscopic magnetization – basic principles of NMR experiments – CW and FT NMR –^{1}H NMR – chemical shift and coupling constants – factors influencing proton chemical shifts and vicinal proton – proton coupling constants –^{1}H NMR spectra of simple organic molecules such as: CH_3CH_2Cl, CH_3CHO, etc., AX and AB spin system – spin decoupling – nuclear Overhauser effect – chemical exchange.

UNIT III **(8 Hours)**

^{13}C NMR and Two - Dimensional nmr spectroscopy-^{13}C NMR – proton decoupled and off-resonance ^{13}C NMR spectra – factors affecting ^{13}C chemical shifts –^{13}C NMR spectra of simple organic molecules – Basic principles of two–dimensional NMR spectroscopy – COSY, NOESY, HMBC and HSQC spectra and their applications.

UNIT IV **(8 Hours)**

Mass spectrometry: Principles – measurement techniques – (EI & FAB) –presentation of spectral data – molecular ions – isotope ions – Fragmentation process - symbolism (scission only) - even and odd electron ions - scission with rearrangement - Retro Diels-Alder rearrangement - McLafferty rearrangement ions –Mass spectra of hydrocarbons, alcohols, phenols, aldehydes, ketones, carboxylic acids, thiols and amines.

UNIT V **(8 Hours)**

Spectroscopic identification of organic compounds-Identification of organic compounds using UV, IR and NMR spectroscopy and mass spectrometry - problems.

TEXT BOOKS:

1. *Kemp W.* 1989. **Organic spectroscopy**, [Third edition], ELBS, New Delhi.
2. *Donald L. Pavia , Gary M. Lampman, George S. Kriz and James A. Vyvyan.* 2009. Introduction to Spectroscopy, [Fifth Edition], Cengage Learning, New York.

REFERENCE BOOKS:

2. *Silverstein R.M.* and *Webster F.X.* 1998. **Spectrometric identification of organic compounds**, John Wiley and Sons, New York.

15PCHMP101	CORE PRACTICAL I: ORGANIC CHEMISTRY PRACTICAL I	SEMESTER - I

OBJECTIVES:

1. To learn about the qualitative analyses by separation.
2. To learn the preparation of organic compounds by named reaction

List of Experiments

1. Separation of components in a two component mixture and identified the followings.

a) Test for aromatic and aliphatic substance.
b) Test for saturated and unsaturated substance.
c) Special elements N / S / X.
d) Test for functional groups.
e) Preparation of derivative for the functional groups.

II. Preparation:

1. Beta naphthyl methyl ether from betanaphthol
2. Resacetophenone from resorcinol
3. para-Nitrobenzoicacid from paranitrotoluene
4. meta-Nitroaniline from metadinitrobenzene
5. Methyl orange from sulphanilicacid
6. Anthraquinone from anthracene
7. Benzhydrol from benzophenone

REFERENCE BOOKS:

1. *Furniss B.S., Hannaford A.J., Smith P.W.G.* and *Tatchell, A.R.* 1989. **Vogel's Practical Organic Chemistry**, [Fifth edition], ELBS & Longman, New Delhi.
2. *Raj K.Bansal.* 1996. **Laboratory manual of Organic Chemistry**, [Third edition], New Age International (P) Ltd., New Delhi.

15PCHMP102	CORE PRACTICAL II: INORGANIC CHEMISTRY PRACTICAL I	SEMESTER - I

OBJECTIVES:

1. To learn the qualitative analysis of inorganic mixture, colorimetry estimation of metals and preparation of inorganic complexes.

List of Experiments

Part I

Semimicro qualitative analysis of mixtures containing two common and two rare cations. The following are the rare to be included :W,Tl,Mo,Te,Se,Ce,Th,Be,Zr,V,U and Li.

Part II

a) **Colorimetric analysis**: photo colorimetric - determination of nickel and copper.

b) **Preparation of the following**:

1. Potassiumtrioxalatoaluminate(III) trihydrate
2. Tristhioureacopper(I)chloride
3. Potassiumtrioxalatochromate(III) trihydrate
4. Sodiumbis(thiosulphato)cuprate(I)
5. Tetramminecopper(II)sulphate
6. PotassiumTetrachlorocuprate(II)

REFERENCE BOOKS:

1. *Svehla G*. 1987. **Vogel's qualitative Inorganic analysis,** [Sixth edition], Orient Longman, New Delhi.
2. *Ramanujam V.V*. 1971. **Inorganic Semimicro Qualitative analysis,** National Publishing Co., Chennai.

15PLS101	CAREER COMPETENCY SKILLS I	SEMESTER - I

Total hours: 15

OBJECTIVES:

1. To enhance employability skills and to develop career competency

CONTENTS

UNIT I **(3 Hours)**

Solving Simultaneous Equations Faster - Number System: HCF, LCM - Decimals – Percentages – Averages.

UNIT II **(3 Hours)**

Powers and Roots - Problems on Trains - Problem on ages - Boats and Streams.

UNIT III **(3 Hours)**

Calendar - Clocks - Pipes and cisterns - Permutations and Combinations - Seating Arrangements.

UNIT IV **(3 Hours)**

Syllogism – Assertion and Reasons – Statements and Assumptions – Identifying Valid Inferences – Identifying strong arguments and weak arguments – Statements and Conclusions.

UNIT V **(3 Hours)**

Reading comprehension – Self Introduction – News Paper Review – Book Review

15PCHM201	CORE V: ORGANIC CHEMISTRY II	SEMESTER - II

Total hours: 50

OBJECTIVES:

On successful completion of the course the students should have

1. Knowledge about the isolation synthesis, and elucidation of various natural products
2. To know different chemical reactions in details

CONTENTS

UNIT I **(10 Hours)**

Aliphatic Nucleophilic Substitution Reaction: The SN_2, SN_1 and SN_i mechanisms, Effects of substrates, attacking nucleophile, leaving group. Neighbouring group participation by π and σ bonds, anchimeric assistance. Nucleophilic substitution at an allylic, aliphatic trigonal and vinylic carbon. Williamson reaction, Vonbraun reaction.

Aromatic nucleophilic substitution reactions, SNAr mechanism, aryl cation mechanism, benzyne mechanism, aromatic nucleophilic substitution of activated halides – Ziegler alkylation, Chichibabin reaction.

UNIT II **(10 Hours)**

Heterocyclic Compounds: Synthesis and properties of imidazole, oxazole and thiazole. Synthesis, properties and structural elucidation of flavones, isoflavones and anthocyanins. Synthesis of pyrimidines, synthesis and structural elucidation of purines (uric acid and caffeine).

UNIT III **(10 Hours)**

Elimination Reactions and Addition Reactions: E_1, E_2, E_1cB and E_2C mechanisms; Stereochemistry of elimination – Hofmann and Zaitsev rules; Competition between elimination and substitution; pyrolytic *cis* elimination – Chugaev reaction; Bredt's rule; Hofmann degradation and Cope elimination. Electrophilic, Nucleophilic and Free radical additions – Additions of halogen and halogen acids to C–C multiple bonds; Markovnikov and Anti Markovnikov addition; Stereochemistry of additions; Hydroboration and Diels – Alder reactions. Reactions of carbonyl group – Mechanisms of Aldol, Perkin, Stobbe and Dieckmann condensations.

UNIT IV **(10 Hours)**

Peptides, Proteins and Nucleic Acids: Sequence analysis of peptides by chemical, enzymatic and mass spectrometric methods; Peptidisation methods like activated ester

method, mixed anhydride method using reagents like DCC and Woodward reagent. Classification of proteins; Primary, secondary and tertiary structures of proteins and their functions. Nucleic acids – nucleosides and nucleotides, their chemistry including synthesis; RNA and DNA; Functions of nucleic acids

UNIT V **(10 Hours)**

Alkaloids and Terpenoids: General methods of structure elucidation of alkaloids; Structure, synthesis and stereochemistry of the following alkaloids – Quinine, papaverin, lysergic acid, atropine and reserpine; Biosynthesis of alkaloids. Structure, Stereochemistry and synthesis of zingiberene, cadinene and abietic acid; Biosynthesis of terpenoids

TEXT BOOKS:

1. *Morrison R.T.* and *Boyd R.N*. 1992. **Organic Chemistry**, Prentice Hall, New Delhi.
2. *Mukherji S.M.* and *Singh S.P.* 1984. **Reaction Mechanism in Organic Chemistry**, [Third edition], Macmillan Publishers, London.
3. *Kalsi P.S.* 2002. **Organic Reactions and Mechanisms**, [Second edition], New Age International Publishers, New Delhi.

REFERENCE BOOKS:

1. *Jerry March*. 1992. **Advanced Organic Chemistry-Reactions, Mechanisms and Structure,** [Fourth edition], John Wiley & Sons, New York.
2. *Carey F.A.* 1996. **Organic Chemistry,** [Third edition], McGraw-Hill Companies. Inc., New York.
3. *Kalsi P.S.* 2005. **Stereochemistry – Conformation and Mechanism**, [Sixth edition], Wiley Eastern Limited, New Delhi.
4. *Finar I.L.* 2000. **Organic Chemistry**, Volume II, [Fifth edition], First Indian reprint, Pearson Education Asia Pvt. Ltd., USA.

15PCHM202	CORE VI: INORGANIC CHEMISTRY II	SEMESTER - II

Total hours: 50

OBJECTIVES:

On successful completion of the course the students should have an exposure to

1. Basic idea on stability and reaction mechanism of coordination complexes
2. To learn about organometallic compound and catalysis.

CONTENTS

UNIT I **(10 Hours)**

Metal - Ligand Bonding: Crystal field theory - splitting of d-orbitals under various geometries, factors affecting splitting, CFSE, evidences for CFSE (Structural and thermodynamic effects), Spectrochemical series; Jahn-Teller distortion - Splitting pattern in octahedral complexes, Dynamic and Static J. T. effect, Jahn-Teller effect and Chelation; Limitations of CFT; Evidences for metal-ligand overlap; M.O. theory and energy level diagrams, concept of weak and strong fields, sigma and pi bonding in complexes, nephelauxetic effect, magnetic properties of complexes.

UNIT II **(10 Hours)**

Stability and stereochemical aspects of complexes: Stability of complexes - Factors affecting stability of complexes, thermodynamic aspects of complex formation, Stepwise and overall formation constants, stability correlations, statistical and chelate effects; Determination of stability constant-Polarographic, photometric and potentiometric methods. Stereochemical aspects- Stereoisomerism in inorganic complexes, isomerism arising out of ligand distribution and ligand conformation, chirality and nomenclature of chiral complexes; application of ORD and CD in the identification of chirality of complexes.

UNIT III **(10 Hours)**

Reaction mechanisms in Complexes: Electron transfer reactions - Outer and inner sphere processes; the bridging ligand, successor complexes; Cross reactions and Marcus-Hush theory. Reaction mechanism of coordination compounds - Substitution reactions, Labile and inert complexes. General mechanism of Substitution in square planar and octahedral complexes - Trans effect - Replacement of coordinated water - mechanism of acid hydrolysis and base hydrolysis - Conjugate base mechanism - Application of substitution reaction in the synthesis of Platinum and Cobalt complexes.

UNIT IV **(10 Hours)**

Organometallic Chemistry: Carbon donors - Alkyl and Aryls - preparation and properties.Carbonyls - 18 electron rule, isolobal concept - application to structure of carbonyls (simple and polynuclear); Nitrosyls-bridging and terminal nitrosyls, bent and linear nitrosyls; Chain Carbon donors - Olefins, acetylene and allyl complexes - synthesis, structure and bonding; Cyclic carbon donors - Metallocene-synthesis, structure and bonding (Ferrocene only) Substitution-electrophilic and nucleophilic attack on ligands. Carbonylation and decarbonylation; oxidative addition and reductive elimination to organometallics - fluxional isomerism.

UNIT V **(10 Hours)**

Catalysis: Hydrogenation of olefins (Wilkinson'scatalyst); Monsanto Acetic acid process; hydro formylation of olefins using Cobalt or Rhodium catalysts (oxoprocess); Oxidation of olefins to aldehydes and ketones (Wacker process); Zeigler-Natta catalyst; Cyclo oligomerization of acetylene using Nickel catalyst (Reppe'scatalyst); polymer bound catalysts.

TEXT BOOKS:

1. *Gopalan. R. and Ramalingam. V*. 2001. **Concise Coordination Chemistry**, Vikas Publisher, New Delhi.
2. *Huheey J.E. Keiter E.A.* and *Keiter R.L.* 2002. **Inorganic chemistry-principles of structure and reactivity**, [Fourth edition], Pearson Education, London.
3. *Purcell.* K.F. and Kotz. J.C. 1985. **Inorganic Chemistry**, WB Saunders Co., USA.

REFERENCE BOOKS:

1. *Shriver D.F., Atkins P.W.* and *Langford, C.H*. 1994. **Inorganic Chemistry,** [Second edition], ELBS, New Delhi.
2. *Cotton F.A*. and *Wilkinson G*. 1988. **Advanced Inorganic Chemistry**, [Fifth edition] Wiley Eastern, New Delhi.

15PCHM203	CORE VII: PHYSICAL CHEMISTRY II	SEMESTER – II

Total hours: 50

OBJECTIVES:

1. To gain the knowledge about statistical thermodynamics, chemical kinetics and electrochemistry.
2. To understand the basic principles of molecular spectroscopy.

CONTENTS

UNIT I **(10 Hours)**

Thermodynamics-II: Derivation of Boltzman distribution equation – physical significance of partition function- translational, rotational, vibrational and electronic partition functions – Quantum statistics – Bose – Einstein and Fermi – Dirac distribution equations – comparison of B.E and F.D statistics with Boltzman statistics – Concept of Negative Kelvin Temperature.

Partition function-Relationships between partition function and thermodynamic properties such as E, H, Cp, Cv, P. Derivation of PV=RT. Calculation of S, A, G etc., from partition functions– calculation of equilibrium constants for very simple reactions.

UNIT II **(10 Hours)**

Chemical Kinetics – I: Theories of Reaction rates – Arrhenius theory –effect of temperature on reaction rate–Hard–Sphere collision theory of reaction rates –molecular beams–Reaction cross section– effectiveness of collisions–Probability factor. Transition state theory of reaction rates–Potential energy surfaces – Partition functions and activated complex–Eyring equation–Comparison of collision theory and activated complex theory–Estimation of free energy, enthalpy and entropy of activation and their significance.

UNIT III **(10 Hours)**

Chemical Kinetics–II: Reactions in solutions– comparison between gas phase and solution reactions –Diffusion controlled reaction-the influence of solvent, ionic strength, dielectric constant and pressure on rate of reactions in solution–Kinetic isotope effects–primary and secondary effects-Linear free energy relationship– Hammett and Taft equations.

UNIT IV **(10 Hours)**

Electrochemistry- I: Ions in solutions – Debye – Huckel theory of strong electrolytes – Debye –Huckel – Onsager equation – verification and limitation – Debye – Huckel limiting law and its extension. Electrode – Electrolyte interface - adsorption at electrified

interface – electrical double layers – Electro capillary phenomena – Lippmann capillary equation – structure of double layers – Helmholtz-Perrin, Gouy-Chapman and Stern models of electrical double layers – electro kinetic Phenomena – Tiselius method of separation of proteins –Membrane potential.

UNIT V **(10 Hours)**

Molecular Spectroscopy – I: Interaction of matter with radiation–Einstein's theory of transition probability–Rotation spectroscopy–Rigid Rotor– Intensity of spectral lines–Molecular parameters from rotation spectra-Effect of isotopic substitution on the rotation spectra Vibrational spectroscopy– harmonic oscillator–anharmonic oscillator–Hot bands–selection rules–Vibrational spectra of polyatomic molecules–Overtones and combination frequencies–Fermi Resonance. Raman spectroscopy–Raman effect–Rotational and vibrational- Raman Spectra –Mutual Exclusion Rule.

TEXT BOOKS:

1. *Rajaram J.* and *Kuriacose J.C.* 1993. **Kinetics and mechanism of chemical transformation,** Macmillan India Ltd, New Delhi.
2. *Glasstone S*. 1960. **Thermodynamics for chemists**. Affiliated East West press, New Delhi.
3. *Prasad R.K.* 1992. **Quantum Chemistry,** Wiley Eastern, New Delhi.
4. *Gurudeepraj*. **Advanced Physical Chemistry**, Goel Publishing House, *Meerut
5. *Puri P.R., Sharma L.R.* and *Pathania M.S.* 2010. **Principles of Physical Chemistry**, Vishal Publishing Co., Jalandhar.

REFERENCE BOOKS:

1. *Banwell C.* 1994. **Fundamentals of Molecular Spectroscopy**, Tata McGraw Hill, New York.
2. *Laidlar K.J. 1987.* **Chemical Kinetics**, Harper and Row, New York.

15PCHEL201	ELECTIVE I: POLYMER CHEMISTRY	SEMESTER - II

Total hours: 40

OBJECTIVES:

1. To know the basic concepts of polymer, coordination in polymer, properties of commercial polymers and polymer processing**.**

CONTENTS

UNIT I **(8 Hours)**

Basic Concepts: Monomers, repeat units, degree of polymerization, Linear, branched and network Polymers. Condensation Polymerization: Mechanism of stepwise polymerization. Kinetics and statistics of linear stepwise polymerization. Addition polymerization: Free radical, cationic and anionic polymerization. Polymerization conditions. Polymerization in homogeneous and heterogeneous systems.

UNIT II **(8 Hours)**

Co-ordination Polymerization: Kinetics, mono and bi metallic mechanism of co-ordination polymers. Co-polymerization: Block and graft co-polymers, kinetics of co polymerization. Types of co-polymerization. Evaluation of monomer. Reactivity ratio. Rate of co-polymerization.

UNIT III **(8 Hours)**

Molecular Weight and Properties: Poly dispersion–average molecular weight concept, number, weight and viscosity average molecular weights. Measurement of molecular weights. Gel permeation chromatography and light scattering. Polymer structure and physical properties – crystalline melting point T_m.The glass transition temperature. Factors affecting T_m and T_g.

UNIT IV **(8 Hours)**

Polymer Processing: Plastics, elastomers and fibres. Compounding processing techniques: calendering, diecasting, rotational casting, film casting, injection moulding, blow moulding extrusion, moulding, thermo forming, foaming, reinforcing and fibre spinning.

UNIT V **(8 Hours)**

Properties of Commercial Polymers: Polyethylene, polyvinylchloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Biomedical polymers - contactlens, dentalpolymers, artificialheart, kidney, skin and blood cells.

TEXT BOOKS:

1. *Billmeye F.W.* 2003. **Text Book of Polymer Science**, [Third edition], John Wiley & Sons, New York.
2. *Gowariker V.R. Viswanathan N.V* and *Sreedha J.* 1986. **Polymer Science**, New Age International Ltd., New Delhi.

REFERENCE BOOKS:

1. *Alcock H.R* and *Lamber F.W.* 1981. **Contemporary Polymer Chemistry,** Prentice Hall, New Delhi.

15PCHMP201	CORE PRACTICAL III :ORGANIC CHEMISTRY PRACTICAL II	SEMESTER - II

OBJECTIVES:

1. Students have practical skill on estimation and preparation of organic compounds and extraction of natural products
2. Know the techniques of chromatography

List of Experiments

I. Organic Estimation

1. Phenol
2. Aniline
3. Glucose
4. Iodine value of an oil
5. Saponification value of oil.

II. Organic Preparation (Involving Two stages)

1. Sym-tribromobenzene from aniline.
2. m-Nitrobenzoicacidfrom methyl benzoate.
3. para–Nitroaniline from acetanilide.
4. Benzanilide from benzophenone.
5. para-Aminobenzene sulphonamide from acetanilide

III. Extraction of Natural Products (Demo only):

1. Caffeine from tea leaves.
2. Citric acid from lemon.

IV Chromatographic Separations (Demo only)

1. Column chromatography: separation of a mixture of ortho and para-Nitroanilines.
2. Thin layer Chromatography: separation of a mixture of ortho and para–Nitroanilines.

REFERENCE BOOKS:

1. *Furniss B.S., Hannaford A.J., Smith P.W.G.* and *Tatchell A.R*. 1989. **Vogel's Practical Organic Chemistry,** [Fifth edition], ELBS, London.
2. *Bansal R.K.* 1996. **Laboratory manual of Organic Chemistry**, [Third edition], New Age International Pvt. Ltd., New Delhi.

15PCHMP202	CORE PRACTICAL IV: PHYSICAL CHEMISTRY PRACTICAL I	SEMESTER - II

OBJECTIVES:

1. Students have a practical skill on Experiments in chemical kinetics, phase rule, Chemical equilibrium and Conductivity measurements:

List of experiments

Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guide line. A minimum of 10 experiments have to be performed in a semester.

1. Study the kinetics of acid hydrolysis of an ester, determination of the temperature Coefficient of the reaction and determination of the activation energy of the hydrolysis of ethyl acetate.
2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half life method and determine the order with respect to iodine and acetone.
3. Determination of association factor of benzoic acid in benzene by distribution method.
4. Study the phase diagram form- toluidine and glycerine system.
5. Construction of phase diagram for a simple binary system(naphthalene – Phenanthrene and benzophenone – diphenylamine)
6. Construction of the phase diagram of the three components of partially immiscible liquid systems (DMSO – Water – Benzene; Water-Benzene – Acetic acid; Ethyl alcohol–Benzene–Water; Acetone-Chloroform–Water; Chloroform – Acetic acid-Water).
7. Determination of the equilibrium constant of the reaction between Iodine and KI by partition method.
8. Determination of equivalent conductance of a weak acid at different concentrations and verify Ostwald's dilution law and calculation of the dissociation constant of the acid.
9. Determination of equivalent conductivity of a strong electrolyte at different concentrations and examine the validity of the Onsager's theory as limiting law at high dilutions.
10. Conductometric titrations of a mixture of HCl and CH_3COOH against Sodium hydroxide.

REFERENCE BOOKS:

1. *Gurtu J.N* and *Kapoor R*. 1980. **Advanced Experimental Chemistry**, S. Chand & Co. Ltd., New Delhi.

15PVE201	VALUE EDUCATION: HUMAN RIGHTS	SEMESTER- II

Total Hours: 25

OBJECTIVE:

1. To make the students to understand the concepts of human rights.

CONTENTS

UNIT I **(5 Hours)**

Human Rights: Definition - Historical Evolution - Classification of Rights - Universal Declaration of Human Rights - International Covenants on Economic and Social Rights - Constitutional Provision for Human Rights - Fundamental Rights - Directive Principles of the State Policy - Indian Constitution.

UNIT II **(5 Hours)**

Civil and Political Rights: Right to Work - Right to Personal Freedom - Right to Freedom of Expression - Right to Property - Right to Education - Right to Equality - Right to Religion - Right to Form Associations and Unions - Right to Movement - Right to Family - Right to Contract - Right to Constitutional Remedies - Right to Vote and Contest in Elections - Right to Hold Public Offices - Right to Petition - Right to Information - Right to Criticise the Government - Right to Democratic Governance.

UNIT III **(5 Hours)**

Economic Rights: Right to Work - Right to Adequate Wages - Right to Reasonable Hours of Work - Right to Fair Working Conditions - Right to Self Government in Industry - Customer Rights - Social and Cultural Rights - Right to Life - Right to Clean Environment.

UNIT IV **(5 Hours)**

Women's Rights: Right to Inheritance - Right to Marriage - Divorce and Remarry - Right to Adoption - Right to Education - Right to Employment and Career Advancement - Rights Relating to Dowry - Right for Equality - Right for Safe Working Conditions - Children's Rights - Right to Protection and Care - Right to Education - Issues Related with Infanticide - Street Children - Child Labour - Bonded Labour - Refugees Rights - Minority Rights - Dalit Rights - Tribal Rights - Nomads Rights.

UNIT V **(5 Hours)**

Human Rights Violation: International, National, Regional Level Organizations to Protect Human Rights - UNO - National Commission for Human Rights - State Commissions - Non Governmental Organizations and Human Rights - Amnesty

Terrorism and Human Rights - Emergency and Human Rights - Judiciary and Human Rights - Media and Human Rights - Police and Human Rights.

REFERENCE BOOK:

1. Paul Singh. **Human Rights and Legal System.** Himalaya Publishing House, New Delhi.

15PLS201	CAREER COMPETENCY SKILLS II	SEMESTER - II

Total hours: 15

OBJECTIVES:

1. To enhance employability skills and to develop career competency

CONTENTS

UNIT I **(3 Hours)**

Assertiveness and Self Confidence-Career Opportunities-Industry expectations (Skill set).

UNIT II **(3 Hours)**

Campus to Corporate-Effective Communication.

UNIT III **(3 Hours)**

Situational Dialogues / Role Play (Telephonic Skills) - Oral Presentations - Prepared -'Just A Minute' Sessions (JAM).

UNIT IV **(3 Hours)**

Body Language- Dress code - Telephone etiquettes - Email etiquettes - Group Discussion - Creativity - Presentation skills

UNIT V **(3 Hours)**

Interviewing Techniques - Do's and Don'ts of Interview - Mock Interview.

15PCHM301	CORE VIII: ORGANIC CHEMISTRY III	SEMESTER - III

Total hours: 50

OBJECTIVES:

1. To know about reactions like Oxidation, reduction and Percyclic reactions
2. To study about reagents used in organic synthesis, and conformational analysis of simple and substituted compounds, structure and stereochemistry of steroids.

CONTENTS

UNIT I **(10 Hours)**

Reagents in Organic Synthesis: Synthesis of simple organic molecules using standard reactions like acylation and alkylation of enamines and active methylene compounds. Sulphurylides. Robinson annulation, protection and deprotection of functional groups (R-OH, R-CHO, RCOR,R- NH_2 and R-COOH) Reagents and their uses: DCC, trimethyl silyl iodide, trimethyl silyl chloride, 1,3– dithiane (umpolung), di isobutyl aluminium hydride (DIBAL), 9BBN,Osmium tetroxide, DDQ, Selenium dioxide, Phase transfer Catalysts

UNIT II **(10 Hours)**

Conformational Analysis: Conformational analysis of simple cyclic (chair and boat cyclohexanes) and acyclic (n-butane) systems, conformation of simple 1,2 disubstituted derivatives–ethylene chlorohydrin and ethylene glycol, Conformational analysis and stereochemical features of disubstituted cyclohexanes (1,2 ; 1,3 ; 1,4 dialkyl cyclo hexanes),conformation and stereochemistry of cis and trans decalins, effects of conformation on reactivity in acyclic and cyclohexanes, Oxidation and acylation of cyclohexanols, reduction of cyclohexanones, esterification and hydrolysis of cyclohexane carboxylic acid derivatives.

UNIT -III **(10 Hours)**

Steroids Structure and Stereochemistry of Cholesterol. Conformation of OH, double in Cholesterol. Reactions of Oestrone, Conversion of cholesterol into progesterone, testosterone and oestrone. Artificial hormones–Stilboestrol and Hexoestrol

UNIT IV **(10 Hours)**

Oxidation and Reduction Reactions Study of the following oxidation reactions with mechanism: Oxidation of alcohols by CrO_3, DMSO alone, DMSO in combination with DCC; acetic anhydride and oxalyl chloride, oxidation of arylmethane, oxidation of methylene alpha to carbonyl, allylic oxidation of olefins, oxidative cleavage of glycols,

oxidative cleavage of double bonds by ozonolysis. Reduction of carbonyl compounds by hydrides, selectivity in reduction of 4– ter – butyl cyclohexanone using selectrides, clemmensen and Wolff Kishner reductions, Birch reduction, MPV reduction.

UNIT V **(10 Hours)**

Pericyclic Reactions: Pericyclic reactions, classification, orbital symmetry, Woodward Hofmann rules, selection rules and stereochemistry of electrocyclic reactions, cycloaddition and sigmatropic shifts, analysis by correlaton diagram method and Frontier molecular orbital method, Sommelet, Hauser, Cope and Claisen rearrangements

TEXT BOOKS:

1. *Carey F.A.* 1996. **Organic Chemistry**, [Third edition], The McGraw Hill Companies, Inc., New York.
2. *Kalsi P.S.* 2002. **Organic Reactions and Mechanisms**, [Second edition], New Age International Publishers, New Delhi.
3. *Finar I.L.* 2000. **Organic Chemistry,** Volume II, [Fifth edition], First Indian reprint. Pearson Education Ltd., London.
4. *Chatwal G.* 1988. **Organic Chemistry of Natural Products,** Volume I & II, Himalaya Publishing House, Mumbai.

REFERENCE BOOKS:

1. *Jerry March.* 1992. **Advanced Organic Chemistry - Reactions, Mechanisms and Structure**, [Fourth edition], John Wiley & Sons, New York.
2. *Mukherji S.M.* and *Singh S.P. 1984***. Reaction Mechanism in Organic Chemistry,** [Third edition], Macmillan Publishers, London.
3. *Morrison R.T.* and *Boyd R.N. 1992***. Organic Chemistry**, [Sixth edition], Prenticemn Hall, New Delhi.
4. *Agarwal O.P. 1988*. **Chemistry of Organic Natural Products**, Volume I & II, Goel Publishing House, Meerut.

15PCHM302	CORE IX: INORGANIC CHEMISTRY III	SEMESTER - III

Total hours: 50

OBJECTIVES:

1. Students have knowledge about spectra like electronic and photoelectron and some analytical techniques and application of spectra in inorganic chemistry.
2. Have some idea of boron compounds and metal clusters.

CONTENTS

UNIT I **(10 Hours)**

Boron compounds and Clusters Boron hydrides - polyhedral boranes, hydroborate ions - preparation, properties and structure, Wade's rules.Carboranes - types - preparation, properties and structure. Metallo carboranes - a general study. Metal clusters – Structure of Re_2Cl_8; multiple metal-metal bonds.

UNIT II **(10 hours)**

Electronic Spectra of Complexes Spectroscopic Term symbols for d^n ions - derivation of term symbols and ground state term symbol, Hund's rule; Selection rules - break down of selection rules, spin-orbit coupling, band intensities, weak and strong field limits - correlation diagram; Energy level diagrams; Orgel and Tanabe-Sugano diagrams - effect of distortion and spin orbit coupling on spectra - Evaluation of Dq and B values for octahedral complexes of Nickel - Charge transfer spectra - Spectral and magnetic properties of Lanthanides and Actinides.

UNIT III **(10 Hours)**

Photoelectron Spectroscopy: Photoelectron Spectroscopy- Principle, Photoelectric effect - PES of diatomic molecules and polyatomic molecules (HCl, HBr, HI, CO, NH_3 and H_2O); Core electron PES; X-ray photoelectron spectroscopy (ESCA) applications.

UNIT IV **(10 Hours)**

Bioinorganic chemistry Metal ions in biological systems - essential and trace metals, Na^+/K^+ Pump; Biologically important complexes of Iron (transport proteins) - haemoglobin, myoglobin, iron-sulphur proteins, cytochrome C, Magnesium (chlorophyll), Cobalt (vitamin B_{12}), Zinc (Carbonic anhydrase, carboxy peptidase) - macrocyclic effect - fixation of Nitrogen.

UNIT V **(10 Hours)**

Inorganic Applications Combined uses of IR and Raman spectra in the structural

elucidation of simple molecules like N_2O, CIF_3, NO_3, ClO_3, NSF_3. Effect of coordination on ligand vibrations, use of group vibrations in the structural elucidation of metal complexes of Urea, Thiourea, Cyanide, Thiocyanate, Nitrate and Sulphate. Effect of isotopic substitution on the vibrational spectra of molecules, vibrational spectra of metal carbony, limitations of IR.

TEXT BOOKS:

1. *Huheey J.E., Keiter E.A.* and *Keiter R.L.* 2002. **Inorganic Chemistry Principles of structure and reactivity**, [Fourth edition], Pearson Education, London.
2. *Cotton F.A* and *Wilkinson G.* 1988. **Advanced Inorganic Chemistry**, [Fifth edition], Wiley Eastern Ltd, New York.

REFERENCE BOOKS:

1. *Bannerjea D.* 1993. **Coordination Chemistry**, Tata McGraw Hill, New York.
2. *Muller U.* 1993. **Inorganic Structural Chemistry**. Wiley, NewYork.
3. *Shriver D.F., Atkins P.W.* and *Langford, C.H*. 1994. **Inorganic Chemistry,** [Second edition], ELBS, New Delhi.

15PCHEL301	ELECTIVE II: PHOTOCHEMISTRY	SEMESTER - III

Total hours: 50

OBJECTIVES:

1. To learn about the principles of photochemistry in various field like organic, inorganic and physical chemistry**.**

CONTENTS

UNIT I **(10 Hours)**

Basics of photochemistry – Energy of a molecules – Defining terms – Singlet, triplet, spin multiplicity and Quantum yield, Laws of photochemistry – Grotthus-Draper law – Beer-Lambert's law – Stark-Einstein Law, Photoprocess – Photophysical process by Jablonski diagram – Fluorescence and its life time- Phosphoresence and its life time, Photochemical process – Primary and Secondary process – Energy transfer – Quenching and defining its terms, Excimer, Exciplex – Intramolecular energy transfer and Intermolecular energy transfer – Photosensitisation.

UNIT II **(10 Hours)**

Quantum Yield – Experimental Determination – Light soruces – Physical actinometers – Chemical actinometers – Sterm volmer equation and its derivation – Quantum yield in photochemical reaction – Hydrogen bromide, Hydrogen iodide, Hydrogen chloride, acetaldehyde, Production of light – Chemiluminescence – Photolysis – Gas phase photolysis.

UNIT III **(10 Hours)**

Photochemistry of carbonyl compounds – Electronic transition – Franck condon principle – Types of excitation – Molecular orbital view of excitation – Types of reactions - Norrish Type I and Norrish Type II and their mechanism – Cycloaddition by Paterno-Buchi reaction, [2+2] cycloaddition, Rearrangement of carbonyl compound – Lumiketone rearrangement, di-pi-methane rearrangement, dienone-phenol rearrangement, oxa-di-pi-methane rearrangement -1,2 –acyl shift and 1,3-acyl shift.

UNIT IV **(10 Hours)**

Photochemistry of alkenes compound Olefin photochemistry – conjugated olefins – Isomerisation and rearrangements – Cis trans isomerisation – valence isomerisation – rearrangement of 1,4 and 1,5 dienes – di -methane rearrangement - Cope and Claisen rearrangement – cycloaddition reactions

UNIT -V **(10 Hours)**

Photochemistry of Aromatic compounds – Arene photoisomerisation – Photodimerisation –Cycloaddition reactions – 1, 2 cycloadditions – Photooxygenation – ene reaction. Inorganic photochemistry – Photo substitution, Photo redox and isomerisation processes; application of metal complexes in solar energy conversion –

TEXT BOOKS:

1. *Mukherjee* R.K.K. 2002. **Fundamentals of Photochemistry**, [Revised edition], New Age International Publication, New Delhi.
2. Jagadamba Singh and Jaya Singh.2012. **Photochemistry and Pericyclic Reactions,** New Age International, New Delhi.

REFERENCE BOOKS:

1. *Alberty R.A.* 1987. **Physical Chemistry**. [Sixth edition]. Wiley Eastern Limited Reprint, New Delhi.
2. *Depuy C.H.* and *Chapman O.S.* 1988. **Molecular Reactions and Photochemistry**, Prentice Hall of India Pvt. Ltd, New Delhi.

15PPHCHI301	IDC I: SOLID STATE PHYSICS	SEMESTER - III

Total hours: 45

OBJECTIVES:

1. To impart knowledge on the structure of crystals, X-ray diffraction and theories of Magnetism.
2. To provide basic concepts regarding dielectrics and modern engineering materials.

CONTENTS

UNIT I **(9 Hours)**

Introduction to crystal systems: Crystal Lattice - Primitive and Unit cell - Seven Classes of Crystals - Bravais Lattice - Miller Indices - Structure of Crystals - Simple Cubic Structure - Hexagonal close packed structure - Face Centered Cubic Structure - Body Centered Cubic Structure - Sodium Chloride Structure - Zinc Blende Structure and Diamond Structure.

UNIT II **(9 Hours)**

X-ray diffraction and crystal defects : Diffraction of X-Rays by Crystals - Bragg's Law in one Dimension - Experimental Method of X-Ray Diffraction - Laue Method - Rotating Crystal Method - Powder Photograph Method - Point Defects - Line Defects - Surface Defects - Volume Defects - Effects of Crystal Imperfections.

UNIT III **(9 Hours)**

Theory of magnetism: Different Types of Magnetic materials - Classical Theory of Diamagnetism (Langevin's theory) - Langevin's Theory of Para magnetism - Weiss Theory of Paramagnetism - Qualitative Explanation of Heisenberg's internal field and Quantum Theory of Ferromagnetism.

UNIT IV **(9 Hours)**

Dielectrics : Fundamental Definitions in Dielectrics - Different types of dielectric polarization - frequency and Temperature Effects on Polarization - Dielectric Loss - Qualitative study of Local Field or Internal Field - Clausius - Mossotti Relation - Determination of Dielectric Constant - Dielectric Breakdown - Properties of different types of Insulating Materials.

UNIT V **(9 Hours)**

Modern Engineering materials: Polymers – Plastics – Ceramics – Super strong materials – Cermets - High temperature materials –Thermo electric materials–Electrets -

Nuclear engineering materials - Metallic glasses - Optical materials–Fiber optic materials & uses - Super conductors - Properties - Types and applications.

Text book:

1. *Arumugam M.* 2008. **Materials Science,** [Third Edition]. Anuradha Publications, Kumbakonam.

REFERENCE BOOKS:

1. *Kittel C.* 1996. **Introduction to Solid State Physics,** [Seventh Edition], John Wiley & Sons (Asia) Pvt. Ltd., New Delhi.
2. *Pillai S.O*. 2005. **Solid State Physics,** New Age International, New Delhi.
3. *Rita John.* 2014. **Solid State Physics,** McGraw Hill Education (India) Private Limited, New Delhi.

15PCHMP301	CORE PRACTICAL V: INORGANIC CHEMISTRY PRACTICAL II	SEMESTER - III

OBJECTIVES:

- Students have skills in quantitative analysis of complex materials and inorganic preparations.

List of Experiments

Part - I: Quantitative analysis of complex materials

Quantitative analysis of the following mixture

1. Copper and nickel
2. Copper and Zinc
3. Iron and nickel
4. Calcium and magnesium

Part - II: Preparations of the following:

1. Sodium hexa nitro cobaltate(III)
2. Sodium Tris oxalate ferrate(III)
3. Prussianblue $Fe_4[Fe(CN)_6]_3$
4. Bis(acetylacetanato)Copper(II)
5. Hexamminecobalt(III) chloride
6. Hexamminenickel(II)chloride

REFERENCE BOOKS:

1. *Svehla G.* 1987. **Vogel's qualitative Inorganic analysis**, [Fourth edition], Orient Longman, London.
2. *Ramanuja V.V.* 1971. **Inorganic Semi micro Qualitative analysis**, National Publishing Co., Chennai.
3. *Basset J., Denney R.C., Jeffery, G.H* and *Mendham J.* 1985. **Vogel's Text book of quantitative inorganic analysis**, [Fourth edition], ELBS, London.

15PCHMP302	CORE PRACTICAL VI: PHYSICAL CHEMISTRY PRACTICAL II	SEMESTER - III

OBJECTIVES:

1. Students have a practical skill on experiments in chemical kinetics, electrochemistry and polarography

List of experiments

Typical list of possible experiments are given. A minimum of 10 experiments have to be performed

1. Determination of the activity coefficient of an electrolyte at different molalities by emf measurements.
2. Determination of the dissociation constant of acetic acid by titrating it with sodium hydroxide using quinhydrone as an indicator electrode and calomel as a reference electrode.
3. Determination of the strength of a given solution of KCl using differential potentiometric titration technique.
4. Determination of the pH of the given solutions with the help of the indicators using buffer solutions and by colorimetric method.
5. Determination of the pH of a given solution by emf method using hydrogen electrode and quinhydrone electrode.
6. Determination of the composition and instability constant of a complex by mole ratio method.
7. Calculation of the thermodynamic parameters for the reaction
   $Zn + H_2SO_4$ -------> $ZnSO_4 + H_2$ by emf method.
8. Determination of the formation constant of silver ammonia complex and stoichiometry of the complex potentiometrically.
9. Solubility and solubility products by emf method.
8. Determination of the activity coefficient of Zinc ions in the solution of 0.002M Zinc sulphate using Debye - Huckel Limiting law.
9. Determination of solubility product of Silver bromide and calculate its solubility in water and 0.1 M and 0.01 M $KBrO_3$ using Debye- Huckel limiting law.
10. Determination of the electrode potentials of Zn and Ag electrodes in 0.1 M and 0.001M solutions at 298 K and find the standard potentials for these electrodes and test the validity of Nernst equations.
11. Determination of the rate constant and order of reaction between potassium

persulphate and potassium iodide and determine the temperature coefficient and energy of activation of the reaction.

12. Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion.)

REFERENCE BOOKS:

1. *Gurtu J.N* and *Kapoor R.* 1980. **Advanced Experimental Chemistry**, Volume - I, S. Chand & Co. Ltd., New Delhi.

15PCHM401	CORE X: ANALYTICAL CHEMISTRY	SEMESTER - IV

Total hours - 50

OBJECTIVES:

1. To impart knowledge about various techniques which are used in chemistry like colorimetry, voltametry and Mass spectra etc.

CONTENTS

UNIT I **(10 Hours)**

Data Analysis: Errors in chemical analysis – Defining terms: mean, median, accuracy and precision – classification of errors: Systematic errors and random errors. Improving accuracy of analysis – mean, standard deviation and Q-test. Comparison of results – Least square (regression and correlation) students' t-test, f-test and Chi square test.

UNIT II **(10 Hours)**

Techniques in Inorganic Chemistry: Colorimetry: Theoretical and practical aspects of colorimetric analysis. Atomic spectroscopy – Principle - Types of atomic spectroscopy – emission methods – absorption methods – fluorescence methods, Plasma sources - Atomizers for atomic spectroscopy –- flame atomizers – Eletrothermal atomizers, Instrumentation of atomic absorption and atomic emission spectroscopy- Application of atomic spectroscopy.

UNIT III **(10 Hours)**

Electrochemical Methods of Analysis: Cyclic Voltammetry and coulometry including constant current and controlled potential coulometry – principle, Experimental set-up and applications. Thermal Characterization techniques- Principle, instrumentation and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration.

UNIT IV **(10 Hours)**

Chromatographic methods: Classification – techniques and applications - column, ion exchange, paper and thin layer chromatography. Gas chromatography and high performance liquid chromatography (HPLC) – principle, equipment design, sample injection system, columns, detectors and applications.

UNIT V **(10 Hours)**

Surface Characterization techniques – Principle, instrumentation and applications of X-ray diffraction analysis (XRD), scanning electron microscopy (SEM), Transmission

electron microscopy (TEM), atomic fluorescence spectroscopy (AFM) and Particle size analyzer (PSA).

TEXT BOOKS:

1. *Skoog D.A* and *West* D.M. 1982. **Fundamentals of Analytical Chemistry,** [Fourth edition], Holt Rinehart and Winston Publications, London.
2. *Gopalan R*, *Rengarajan K* and *Subramanian P.S.* 2004. **Elements of Analytical Chemistry,** [Third Edition] Sultan Chand & Sons, New Delhi.
3. *Dhruba Charan Dash* 2011. **Analytical Chemistry,** PHI Learning Pvt. Ltd, Kolkata.

REFERENCE BOOKS:

1. *Skoog D.A.* 1985. **Principles of Instrumental Analysis,** [Third edition], Saunders College Pub. Co., New Delhi.

15PCHM402	CORE XI: PHYSICAL CHEMISTRY III	SEMESTER -IV

Total hours: 50

OBJECTIVES:

1. Have extended knowledge of quantum chemistry, group theory and spectroscopy
2. And detailed knowledge about surface chemistry and electrochemistry

CONTENTS

UNIT I **(10 Hours)**

Chemical Kinetics-III: Kinetics of complex reactions – reversible reactions, consecutive reactions – Parallel reactions and Chain reactions – General treatment of chain reaction – Chain length – Rice Herzfeld mechanism – explosion limits.

Study of Fast reactions: Luminescence and energy transfer process – Study of kinetics by relaxation methods, temperature and pressure jump methods, stopped flow technique, flash photolysis and magnetic resonance method.

UNIT II **(10 Hours)**

Quantum Chemistry-III: Theory of chemical bonding – Born – Oppenheimer approximation – LCAO – MO approximation for hydrogen molecule ion and Hydrogen – Valence Bond theory of Hydrogen molecule – Comparison of MO and VB theories – Concept of Hybridisation – sp, sp^2 and sp^3 hybridisation – Huckel Molecular orbital (HMO) theory for conjugated π- system – applications to simple systems – (Ethylene, butadiene and benzene) – Physical Significance of HMO coefficients – Self consistant field approximation – Hartree's and Hartree – Fock Self Consistant field theory – Slater type orbitals – Slater rules.

UNIT III **(10 Hours)**

ESR Spectroscopy – ESR spectrum of an unpaired electron-hyperfine structure in ESR spectra- selection rule-hyperfine coupling constant-Spin densities – Mcconnel equation – g factor and coupling constants-application of ESR. **Electronic spectroscopy** – Electronic spectra of diatomic molecules – vibrational coarse structure – Franck – Condon Principle. **Mossbaur Spectroscopy**- Basic principles of NRS spectroscopy-Mossbauer experiment-theorey-chemical shift-Nuclear electric quadrupole splitting-Nuclear Zeeman splitting

UNIT IV **(10 Hours)**

Surface Chemistry and Catalysis: Kinetics of surface reactions: Physical and chemical adsorption – adsorption isotherms – types of adsorption isotherms –

Langmuir adsorption isotherm – B.E.T theory for multilayer adsorption – measurement of surface area – Mechanism of heterogeneous catalytic reactions – the adsorption coefficient and its significance. **Acid – Base catalysis** – mechanism – Bronsted catalysis Law – catalysis by enzymes – rate of enzyme catalysed reactions – effect of substrate concentration, pH and temperature on enzyme catalysed reactions – inhibition of enzyme catalyzed reactions.

UNIT V **(10 Hours)**

Electrochemistry II: Electrochemical inorganic and organic reactions of technological interest (example in each) – Corrosion-basic principles- construction of Pourbaix diagrams – Prevention of Corrosion- Passivation of metals-corrosion inhibitors. Electrochemical energy systems – Primary and Secondary batteries – (dry cells, lead acid - storage batteries, silver-zinc cell, nickel-cadmium battery, mercury cell) –Fuel cells – Electrodeposition – Principles and applications.

TEXT BOOKS:

1. *Gurudeep raj*. 1990. **Advanced Physical Chemistry**. Goel Publishing House, Meerut.
2. *Prasad R.K.* 1992. **Quantum Chemistry**, Wiley Eastern, New Delhi..
3. *Puri P.R., Sharma L.R.* and *Pathania M.S.* 2010. **Principles of Physical Chemistry**, Vishal Publishing Co, Jalandhar.

REFERENCE BOOKS:

1. *Chandra A.K.* 2003. **Introductory Quantum Chemistry**, Tata McGraw Hill, New Delhi.
2. *McQuarri D.A.* 1983. **Quantum Chemistry**, University Science Books, Mill Valley, California.
3. *Laidlar K.J.* 1987.**Chemical Kinetics**, Harper and row, New York.
4. *Glasstone S.* 1969. **An Introduction to Electrochemistry**, Affiliated East West Press, New Delhi.

GUIDELINES

1. SUBMISSION OF RECORD NOTE BOOKS AND PROJECT DISSERTATION:

Candidates appearing for Practical Examinations and Project Viva-Voce shall submit Bonafide Record Note Books/ Record or Thesis prescribed for Practical/ Project Viva-Voce Examinations, otherwise the candidates will not be permitted to appear for the Practical/ Project Viva-voce Examinations.

2. PASSING MINIMUM AND INTERNAL MARK DISTRIBUTION (Theory, Practical and Project)

(i) A. THEORY

The candidate shall be declared to have passed the Examination, if the candidate secures not less than 50 marks put together out of 100 in the Comprehensive Examination in each Theory paper with a passing minimum of 38 marks in External out of 75.

Internal Marks Distribution [CA- Total Marks: 25]

Attendance	: 5 Marks
Assignment	: 5 Marks
Seminar	: 5 Marks
Internal Examinations	: 10 Marks
Total	**: 25 Marks**

B. (i) THEORY (If Internal Evaluation is for 100 Marks)

The candidate shall be declared to have passed the Examination, if the candidate secures not less than 50 marks out of 100 in the Comprehensive Examination (Internal Evaluation only).

Internal Marks Distribution [CA- Total Marks: 100]

Attendance	: 10 Marks
Assignment	: 20 Marks (2 Assignments Compulsory)
Seminar	: 10 Marks
Internal Examinations	: 60 Marks
Total	**: 100 Marks**

(ii) PRACTICAL

The candidate shall be declared to have passed the Examination, if the candidate secures not less than 50 marks put together out of 100 in the Comprehensive Examination in each Practical paper with a passing minimum of 30 marks in External out of 60.

Internal Marks Distribution [CA- Total Marks: 40]

Experiment	: 10 Marks
Attendance	: 5 Marks
Record	: 5 Marks
Internal Examinations	: 20 Marks
Total	**: 40 Marks**

(iii) PROJECT WORK/DISSERTATION

- The project work shall be carried out by each student in the IV semester and has to complete the work at the end Semester.
- Upon completion of the project work/dissertation the candidate will be required to appear for a viva-voce conducted by an external examiner.
- The Student has to attend 3 reviews before completing his/her Project.
- Among three reviews, two will be reviewed by internal resource person and one by External Resource Person.
- A candidate failing to secure the prescribed passing minimum in the dissertation shall be required to re-submit the dissertation with the necessary modifications.

Mark Distribution Pattern

Comprehensive Examination (CE)	:150 Marks
Continuous Assessment (CA)	: 50 Marks
Total	**: 200 Marks**

Mark Distribution Pattern for CE

Project work	: 100 Marks
Presentation	: 25 Marks
Viva-voce examination	: 25 Marks
Total	**: 150 Marks**

The candidate shall be declared to have passed the Examination, if the candidate secure not less than 100 marks put together out of 200 in the Comprehensive Examination in each Project with a passing minimum of 75 marks in External out of 150.

Internal Mark Distribution **[CA - Total Marks: 50 Marks]**

1. Research work done	: 20 Marks
2. Attendance	: 5 Marks
3. Observation Note	: 10 Marks
4. Reviews (3 reviews)	: 15 Marks
Total	**: 50 Marks**

MARK DISTRIBUTION

CORE PRACTICAL I: ORGANIC CHEMISTRY PRACTICAL I (15PCHMP101)

External marks distribution: 60 Marks

Organic analysis

Separation : 5 marks
Aromatic/Aliphatic : 4 Marks
Saturated/Unsaturated : 4 Marks
Special elements (N/S/X) : 6 Marks
Function groups : 10 Marks
Derivative : 6 Marks

Organic Preparation

Crude preparation : 5 Marks
Recrystallization : 10 Marks
Viva - voce examination : 10 Marks
Total marks : 60 Marks

CORE PRACTICAL II: INORGANIC CHEMISTRY PRACTICAL I (15PCHMP102)

External marks distribution: 60 Marks

Inorganic analysis

Group separation : 10 Marks
Cations confirmation (4x5) : 20 Marks

Inorganic Preparation

Crude preparation : 10 Marks
Recrystallization : 10 Marks
Viva - voce examination : 10 Marks
Total marks : 60 Marks

CORE PRACTICAL III: ORGANIC CHEMISTRY PRACTICAL II (15PCHMP201)

Marks Distribution: 60 Marks

Organic estimation : 30 Marks
Organic Preparation:
Crude preparation : 10 Marks
Recrystallization : 10 Marks
Viva - voce examination : 10 Marks
Total marks : 60 Marks

KEY FOR EVALUATION

0-2% -30 marks
2-3% -25 marks
3-4% -20 marks
4-5% -15 marks
>5% -10 marks

CORE PRACTICAL IV: PHYSICAL CHEMISTRY PRACTICAL I (15PCHMP202)

Marks Distribution: 60 Marks

Experiment : 50 Marks
Viva-voce examination : 10 Marks

KEY FOR EVALUATION

Experiment which is done using instrument, the instrumental error also included and then error calculated based on the precise of the instrument by examiners during the examination.

CORE PRACTICAL V: INORGANIC CHEMISTRY PRACTICAL II (15PCHMP301)

Mark Distribution: 60 Marks

Qualitative analysis	: 20 Marks
Preparation	: 15 Marks
Crystallization	: 10 Marks
Viva-voce examination	: 10 Marks
Results	: 5 Marks
Total marks	**: 60 Marks**

CORE PRACTICAL VI: PHYSICAL CHEMISTRY PRACTICAL II (15PCHMP302)

Marks Distribution: 60 Marks

Experiment : 50 Marks
Viva-voce examination : 10 Marks

KEY FOR EVALUATION

Experiment which is done using instrument, the instrumental error also included and then error calculated based on the precise of the instrument by examiners during the examination.

2. QUESTION PAPER PATTERN AND MARK DISTRIBUTION THEORY

<u>Question Paper Pattern and Mark Distribution</u> (For 75 marks)

1. **PART – A (5 x 5 = 25 Marks)**
   Answer ALL questions
   One question from each UNIT with Internal Choice
2. **PART – B (5 x 10 = 50 Marks)**

Answer ALL questions

One question from each UNIT with Internal Choice

Question Paper Pattern and Mark Distribution **(For 100 marks)**

1. **PART – A (5 x 5 = 25 Marks)**
   Answer ALL questions
   One question from each UNIT with Internal Choice
2. **PART – B (5 x 15 = 75 Marks)**
   Answer ALL questions
   One question from each UNIT with Internal Choice

CAREER COMPETENCY SKILLS
METHODOLOGY OF ASSESSMENT

1. On Line Objective Examination (Multiple Choice questions) - Semester I

- 100 questions-100 minutes
- Twenty questions from each UNIT.

On line examination will be conducted at the end of the III Semester **CAREER**

COMPETENCY SKILLS
METHODOLOGY OF ASSESSMENT

1. On Line Objective Examination (Multiple Choice questions) - Semester I

- 100 questions-100 minutes
- Twenty questions from each UNIT.
- On line examination will be conducted at the end of the III Semester.

2. Viva -Voce Semester II

- A Student has to come in proper dress code and he/she should bring 2 copies of Resume for the Viva Voce.
- A student may be asked to
  - Give Self Introduction
  - Submit the resume to the examiner(s) and answer the questions based on it.
  - Speak on any given topic for at least two minutes.
  - Give a presentation for 10 minutes on a topic of their choice.
  - Sit with other students in a Group for a Discussion.