Programme: M. Sc. Part-I (Chemistry)

Course Code: ACC-401 **Title of the Course: Concepts in Analytical Spectroscopy**

Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Students should have studied the spectroscopic techniques such as UV-Vis, IR at FY B Sc, S Y B Sc or T Y B Sc levels so as to have basic knowledge of spectroscopy and basic principles.	
Course Objectives:	1. Introduction of various concepts in molecular and atomic spectroscopy. 2. Learning data analysis, handling and interpretation of spectra	
Course Outcomes:	1. Students should be in a position to use spectroscopic methods for qualitative and quantitative analysis. 2. Evaluate the utility of UV/Vis spectroscopy as a qualitative and quantitative method. 3. Identification of functional group based on IR spectra 4. Students should be in a position to predict the structure based on IR, NMR, MS data.	
Content:	**1.Introduction to spectrochemical methods** 1.1. Interaction of Electromagnetic Radiation with Matter: electromagnetic spectra, Regions of Spectrum; Numericals. 1.2 Electronic spectra and Molecular structure: kinds of transition, Chromophores and auxochrome; absorption by isolated chromophores, conjugated chromophores, aromatic compounds, inorganic chelates. 1.3. Infrared absorption and molecular structures: IR spectra, overtones and bands-basis of NIR absorption 1.4. Spectral Databases: Identification of unknown; Application of UV-Vis and IR spectroscopy for identification of unknown compounds 1.5. Solvents for spectrometry: Choices and effect of solvents on UV-Vis and IR spectra. 1.6. Quantitative Calculations: The Lambert-Beer's Law; Mixtures of absorbing species-laws of additivity of absorbance; calibration curve for calculation of unknown; Spectrometric errors in measurement; Deviation from Lambert-Beer's law-chemical deviation, instrumental deviation; Quantitative measurement from IR spectra; Numericals for quantitative analysis using UV-VIS spectroscopy. 1.7. Spectrometric Instrumentation of UV-Vis and IR (brief introduction only): Sources, monochromators, sample cells, Types of instruments; detectors; Instrumental wavelength and absorption calibration. (Chapter 16: Analytical Chemistry, G.D. Christian, 6thEd.) **2. Molecular Luminescence: Fluorimetry, Phosphorimetry and Raman Spectroscopy** 2.1. Introduction, 2.2. Fluorimetry : Theory and basic principle; Quenching; Spectrofluorimeters and applications 2.3. Phosphorimetry: Theory and basic principle; phosphorimeters and application 2.4. Raman Spectroscopy: Theory and Structural analysis using Raman Spectra (Chapter 6: Instrumental Methods of Chemical Analysis, G.W. Ewing,5thEd) **3. Atomic Spectroscopy** 3.1. Principles of emission 3.2. Atomic Emission spectroscopy (AES) 3.3. Flame Emission spectroscopy (FES)	12 hr 4 hr 6 hr

	3.4. Atomic absorption Spectroscopy (AAS) 3.5. X-Ray Fluorescence Spectroscopy (XRF) (Introduction, principles and applications of above techniques shall be discussed; Chapter 13: Analytical Chemistry Principles, J.H. Kennedy, 2nd ed) **4.Spectrometric Identification of Organic compounds** **4.1 Ultraviolet and visible Spectroscopy :** Brief Revision of UV/VIS Spectroscopy **;**Instrumentation and Sampling ; Applications of Electronic S pectroscopy:Conjugated Dienes, Trienes, polyenes, a, ßunsaturated carbony l compounds, aromatic hydrocarbons (Assignment based on BSc. Syllabus for calculating λmax) (Kemp – Chap4) **4.2 Infrared Spectroscopy:** Introduction to IR spectroscopy; Basic IR spectra interpretation; Frequencies of functional group. (Kemp – Chap2). **4.3 Proton and Carbon NMR Spectroscopy:** Theory of NMR **;** Chemical shift; factors influencing chemical shift **;** Solvents used in NMR; Theory of spin-spin splitting and simple spin systems;Coupling constant calculation; Factors influencing coupling constant (Assignment based on BSc. Syllabus) (Kemp - Chapter 3) **4.4 Mass Spectrometry :** Basic PrinciplesandInstrumentation: Problem solving in structure elucidation based on MS (Kemp - Chapter 5) **4.5. Conjoint Spectrometry Problems:** Structural elucidation of organic molecules using UV, IR, NMR (^{1}H,^{13}C), MS, (Silverstein) (**Note:**Assignment based on BSc. syllabus for all above spectrometric structure should be given to student. *More weightage of lectures shall be given for solving IR and NMR data for structur elucidation*)	14 hr
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. Sessions shall be interactive in nature to enable peer group learning.	
Text Books References / Readings	1. G. D. Christian; *Analytical Chemistry*, John Wiley; 6th Edition. 2. J.H. Kennedy, *Analytical Chemistry: Principles*, Saunders College Publishing, 2nd Edition. 3. G. W. Ewing, *Instrumental Methods of Chemical Analysis*, McGraw-Hill Int 5th Ed. 4. W. Kemp; *Organic Spectroscopy*; Palgrave; 3 Ed. 5. D.A. Skoog, D.M. West, F.J. Hollar, S.R. Crouch; *Fundamentals of Analytical Chemistry*, Cengage learning; 9 Ed. 6. J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas; *Vogel's Textbook of Quantitative Inorganic Analysis;* 6th Edition, Pearson Education Asia 2005 7. H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, *Instrumental methods of Analysis*; HCBS Publishing New Delhi; 2004, 7th Ed. 8. C.N. Banwell and E.M. McCash, *Fundamentals of Molecular Spectroscopy*, Tata McGraw- Hill, New Delhi; 4th Ed. 9. R. M. Silverstein, F.X. Webster; *Spectrometric identification of Organic Compounds*; Wiley- India; 6th Ed. 10. H. Gunzler & A. Williams; *Handbook of Analytical Techniques*, WILEY-VCH Verlag GmbH; 2001, 1st Ed. 11. P.S. Kalsi; *Spectroscopy of Organic Compounds*; New Age Internationa l; 2 Ed. 12. R.T. Morrison, R.N. Boyd; *Organic Chemistry*, Prentice Hall India 4th Edition 13. E. Pretsch, P. Buhlmann, C. Affolter; *Structural Determination of Organic Compounds*, Springer; 2005; 2nd Ed.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: ACC-402
Title of the Course: Laboratory Course in Analytical Chemistry
Number of Credits: 02 **Effective from AY: 2018-19**

Prerequisites for the course:	Should have studied practical chemistry courses at F.Y B.Sc, S.Y. B .Sc & T Y B Sc levels so as to have basic knowledge of quantitative analysis.	
Course Objectives:	Introduction of various experimental techniques for analysis. Learning data analysis, handling and interpretation of spectra	
Course Outcomes:	Students should be in a position to use standardized material to determine an unknown concentration. To gain experience with some statistics to analyse data in laboratory Students should be in position to use different techniques for qualitative and quantitative estimation	
Content:	*This course consists of 6 units of experiments in various areas of Analytical chemistry. Minimum 12 experiments shall be carried out and at least 02 experiment from each unit shall be conducted.* **UNIT 1: STATISTICS** 1.Calibration of apparatus (balance, volumetric flasks, pipettes and burettes) and preparation of standard solutions and standardisation **UNIT 2: COLORIMETRY AND UV-VISIBLE SPECTROPHOTOMETRY** 2.Estimation of Iron from Pharmaceutical sample (capsule) by thiocyanate method 3. Estimation of lead/nitrate in water sample 4. Estimation of KNO_3 by UV spectroscopy and $K_2Cr_2O_7$ by Visible spectroscopy 5. Simultaneous determination and Verification of law of additivity of absorbances ($K_2Cr_2O_7$ and KMnO4) 6.Estimation of phosphoric acid in cola drinks by molybdenum blue method **UNIT 3: FLAME SPECTROPHOTOMETRY** 7.Estimation of Na 8.Estimation of K or Ca **UNIT 4: VOLUMETRY** 9.Estimation of Ca in pharmaceutical tablet. 10.Estimation of Al and/or Mg in antacid tablet **UNIT 5:** **ION EXCHANGE CHROMATOGRAPHY &SOLVENT EXTRACTION** 11.Separation and Estimation of Zn and Cd 12.Separation and Estimation of chloride and bromide 13.Extraction of Cu as copper dithiocarbamate (DTC) using solvent extraction and estimation by spectrophotometry	

	UNIT 6: INTERPRETATION EXERCIES 14.Thermal studies: TGDTA and Isothermal weight loss studies of various hydrated solids like $CuSO_4 \cdot 5H_2O$, $Ca_2C_2O_4 \cdot H_2O$, $Fe_2C_2O_4 \cdot 2H_2O$ 15. X-ray powder diffractometry: Calculation of lattice parameters from X-ray powder pattern of cubic system such as $NiMn_2O_4$, $CoFe_2O_4$ etc.	
Pedagogy:	Prelab exercises / assignments / presentations / lab hand-out or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
Text Books/ References / Readings	1. J. H. Kennedy, *Analytical Chemistry Principles*, Saunders College Publishing, Second Edition 1990. 2. G. D. Christian, *Analytical chemistry*, 5th Ed, John Willey and Sons, 1994 3. J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas; *Vogel's Textbook of Quantitative Inorganic Analysis;* 6th Edition, Pearson Education Asia 2005 4. A. J. Elias, *Collection of interesting chemistry experiments*, University press, 2002. 5. R.A. Day & A.L. Underwood, *Quantitative Analysis*, 6th Edition, Prentice Hall, 2001. 6. J. Kenkel, *Analytical Chemistry for Technicians*, 3rd Edition, Lewis publishers, 2002.	

Programme: M. Sc. Part-I (Chemistry)

Course Code: ACO-401 **Title of the Course: Analytical Techniques**
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Should have knowledge of basic analytical techniques such as chromatography, electro-analytical techniques and data handling.	
Course Objectives:	1. Introduction of various statistical approach used in analytical data handling 2. Introduction of different analytical techniques used for qualitative, quantitative estimation	
Course Outcomes:	3. Students should be in a position to understand principle behind different analytical techniques 4. With the knowledge basic techniques used for qualitative and quantitative estimation students should be in a position to choose for appropriate technique for particular analysis 5. Students should be in a position to select the separation techniques for purification of analytes.	
Content:	**Section A** **1 Analytical Objectives, Data Handling and Good Laboratory Practice (GLP)** Scope of analytical science and its literature, qualitative and quantitative analysis, ways to express accuracy and precision, types of errors and their causes; significant figures, control charts, confidence limit, test of significance, rejection of a result- the Q-test. Introduction to significant analytical procedure such as GLP- standard operating procedures, quality assurance, quality control and analytical method validation. **2 Sampling and Calibration Methods** Sampling and sample preparation, general steps in chemical analysis, calibration of glass wares. Finding the best straight line-least square regression, correlation coefficient; Calibration curves, standard addition technique and internal standards. Chemical concentrations. **3 Electroanalytical techniques** Introduction to electroanalytical techniques, electrochemical cells, electrode potentials, voltametry and polarography, cyclic voltametry, coulometry, controlled potential coulomety and coulometric titrations, Stripping voltammetry, ion-selective electrodes and sensors; Evaluation and Calculation; Application to Inorganic and Organic Trace analysis **Section B** **1. Extraction Techniques** ***Liquid-liquid extraction/solvent extraction:*** partition coefficient, distribution ratio and percent extraction; choice of solvents; Solvent extraction of metal ions-ion association complexes and metal chelates; multiple batch extraction, Craig's counter-current distribution; Introduction to green analytical extraction methods:Supercritical Fluid Extraction (SFE); Pressurized Liquid Extraction (PLE); Ultrasound Assisted Extraction (UAE); Microwave Assisted Extraction (MAE);	7 hr 5 hr 6 hr 4 hr

	Enzyme Assisted Extraction (EAE); Solid Phase Microextraction (SPME); Solid Phase Extraction (SPE) **2. Basic Principles in Chromatographic Methods** Principles of chromatography, classification of chromatographic techniques based on mechanism of retention, configuration, mobile and stationary phase. Efficiency of separation- plate theory (theoretical plate concept) and rate theory (Van Deemter equation). Principles and applications of Paper chromatography, thin layer chromatography, HPTLC, Size exclusion and Ion exchange chromatography. Counter-current chromatography for isolation of natural products. **3. Gas and Liquid Chromatography** Introduction; Instrumental Modules; The Separation System; Choice of Conditions of Analysis; Sample Inlet Systems; Detectors; Practical Considerations in Qualitative and Quantitative Analysis; Coupled Systems-introduction to GCMS, LCMS; Applicability-interpretation and numerical problems; Recent and Future Developments **4.Radioanalytical techniques** Theory and principles of radio analytical technique, detection of nuclear radiation, radiation detectors, pulse height analysis, counting error, analytical application of radioisotopes, neutron activation analysis and isotope dilution analysis.	4 hr 6 hr 4 hr
Pedagogy:	Mainly lectures & tutorials. Seminars / term papers /assignments / presentations/ self-study or a combination of some of these can also be used to some extent. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. G.D. Christian, *Analytical Chemistry*, John Wiley New York (2004) 6th Edition 2. D.A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Sounders College publishing (2014), 9th Ed. 3. F. J. Holler, D. A. Skoog, S. R. Crouch, *Priniciples of Instrumental Analysis*, Thomson Books/Cole , 6thEd. 4. J. Mendham, R.C. Denney, J.D. Barnes and M. Thomas,*Vogel's Text Book of Quantitative Inorganic Analysis*, Pearson Education Asia 2000, 6th Ed. 6. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, *Instrumental Methods of Analysis*, CBS Publishing New Delhi, 7th Ed. 7. J.H. Kennedy, *Analytical Chemistry:Principles*, Saunders College Publishing 2ndEd. 8. G.W. Ewing, *Instrumental Methods of Chemical Analysis*, McGraw-Hill (Singapore), 5th Ed. 9. L.G.Hargis, *Analytical Chemistry: Principles and Techniques*, Prentice Hall, New Jersey (1988) 10. R. A. Day, Jr. and A. L. Underwood, *Quantitative Analysis*, Prentice Hall, 2001., 6thEd. 11. T. Rocha-Santos, A.C. Duarte, *Comprehensive Analytical Chemistry*, Elsevier, 2014, 1st Ed.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: ICC-401 **Title of the Course: General Inorganic Chemistry**
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Students should have studied the courses in Chemistry at F.Y. B.Sc., S.Y.B.Sc. and T.Y.BSc. levels so as to have basic knowledge of Inorganic Chemistry and basic principles.	No. of lectures
Course Objectives:	1. To introduce atomic / molecular structure and symmetry. 2. To provide fundamental knowledge of solid state chemistry. 3. To introduce basic aspects of coordination / organometallic / bioinorganic chemistry. 4. To provide the concepts of acids and bases.	
Course Outcomes:	1. Students should be in a position to understand atomic and molecular structure and the importance of symmetry. 2. Students should be able to understand molecular shapes. 3. Students should be in a position to understand concepts in i) solid state chemistry, ii) coordination chemistry, iii) organometallic chemistry, iv) bioinorganic chemistry.	
Content:	**1. Atomic structure, molecular structure and bonding** 1.1 Atomic Structure: Structures of hydrogenic atoms: some principles of quantum mechanics. Many electron atoms: penetration & shielding, building up principle, classification of elements. spectroscopic terms. Atomic/ionic radii, ionization energy, electron affinity, electrononegativity, polarizability. 1.2 Molecular Structure & bonding: Lewis structures, VSPER model, the basic shapes. Valence bond theory: the hydrogen molecule, homonuclear diatomic & polyatomic molecules; hybridisation. molecular orbital theory: approximation, boding & antibonding orbitals. Homonuclear diatomic & Heteronuclear diatomic molecules. **2. Molecular Symmetry**: 2.1 Symmetry elements 2.2 Symmetry operations, equivalent symmetry elements and equivalent atoms, symmetry point groups with examples, point groups of higher symmetry, systematic procedure for symmetry classification of molecules and illustrative examples, 2.3 Dipole moment, optical activity and point groups. **3. Solid state chemistry** 3.1 Structures of solids: crystal structures, lattices & unit cells, close packing of spheres, holes in closed-packed structures. 3.2 Structures of metals & alloys: polytypism, nonclosed-packed structures, polymorphism of metals, atomic radii of metals, alloys, substitutional solid solutions, interstitial solid solutions of non-metals, intermetallic compounds. 3.3 Ionic solids: Basic characteristic structures of ionic solids, the rationalization of structures, ionic radii, radius ratio, structure maps, the energetics of ionic bonding, lattice energy.	9 hr 4 hr 6 hr

	4. **Coordination Chemistry** 4.1 Introduction, representative ligands, nomenclature, 4.2 Constitution & geometry, low coordination numbers, intermediate coordination numbers, higher coordination numbers, polymetallic compounds. 4.3 Isomerism & chirality in square planar & octahedral complexes, ligand chirality. 4.4 Thermodynamics of complex formation: formation constants, chelate & macrocyclic effects, steric effects & electron delocalization. 4.5 Electronic properties of metal complexes: CFT applied to octahedral and tetrahedral complexes, magnetic moments/CFSE. Electronic spectroscopy: basic concepts, interpretation of spectra of d^1 & d^2 ions (Orgel diagram for octahedral and tetrahedral complexes).	5 hr
	5. **Organometallic Chemistry** 5.1 Introduction to organometallic chemistry, nomenclature, stability and inert gas rules (neutral atom and donor pair electron count methods). 5.2 Ligands CO & phosphines, homoleptic carbonyls/synthesis/ properties/ oxidation-reduction of carbonyls/ basicity/reactions of CO/spectroscopic properties of metal carbonyls. 5.3 Oxidative addition and reductive elimination.	4 hr
	6. **Basic Bioinorganic Chemistry** 6.1 Macronutrients/micronutrients. Role of elements in biology. Metal ion transport role. 6.2 Definition of metallobiomolecules / metalloporphyrins, structure of porphine and heme group, examples of metalloenzymes of copper and zinc.	3 hr
	7. **Acids and Bases** 7.1 Brönsted Acidity, proton transfer equillibria in water, solvent levelling, solvent system definition if acids & bases, characteristics of Brönsted acids, 7.2 Periodic trends in aqua acid strengths, non-aqeuous solvents, Lewis acidity, hard & soft acids and bases, solvents as acids & bases, superacids & superbases.	5 hr
Pedagogy:	Mainly lectures / tutorials. Seminars / assignments / presentations / self-study or a combination of some of these could also be used to some extent.	

Text Books / Reference Books	1. P. W. Atkins, T. Overton, J. Rourke, M. Weller & F. Armstrong, *Shriver & Atkins Inorganic Chemistry*, Oxford Publications, 2009, 5th Ed. 2. J. E. Huheey, E. A. Kieter, R. L. Kieter & O. K. Medhi, *Inorganic Chemistry: Principles of Structure & Reactivity*, Pearson, 2011, 4th Ed. 3. F. A. Cotton, G. Wilkinson & P. L. Gauss, *Basic Inorganic Chemistry*, Wiley, 2008 (reprint), 3rd Ed. 4. J. D. Lee, *Concise Inorganic Chemistry*, Wiley, 2008, 5th Ed. 5. F. A. Cotton, *Chemical applications of group theory*, Wiley Eastern, New Delhi, 1976, 3rd Ed. 6. L. Pauling, *The Nature of The Chemical Bond*, Cornell University Press, 1960, 3rd Ed. 7. M.C. Day & J. Selbin, *Theoretical Inorganic Chemistry*, Van Nostrand-Reinhold, New York, 1969,2nd Ed. 8. H.V. Keer, *Principles of Solid state Chemistry*, New age Intl. Ltd, New Delhi, 1995. 9. A.R. West, *Solid State Chemistry and Its Applications*, John Wiley & Sons, Singapore, 1987. 10. D.K. Chakrabarty, *Solid State Chemistry*, New Age Publishers, 1996, 2nd Ed. 11. F. A. Cotton & G. Wilkinson, *Advanced Inorganic Chemistry*, Wiley Eastern, New Delhi, 1984, 3rd Ed.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: ICC-402 Title of the Course: Lab Course in Inorganic Chemistry
Number of Credits: 02 Effective from AY: 2018-19

Prerequisites for the course:	Students should have studied the courses in chemistry at F.Y. B.Sc., S.Y.B.Sc. and T.Y.BSc. levels so as to have basic knowledge of experimental chemistry.	No. of lectures
Course Objectives:	Students shall be trained in the preparation of coordination compounds / double salts, understanding of redox chemistry, determination of metal content and degree of hydration, and determination of the formula of synthesized compounds. Students will be given hands-on experience in using colorimeter / UV-Vis spectrophotometer while performing instrumental analysis.	
Course Outcomes:	1. Students should be in a position to: i) set up and perform inorganic synthesis ii) isolate and purify crystalline product. iii) develop skills for compound characterization iv) determine the metal content by titrimetry / gravimetry /colorimetry.	
Content:	**Synthesis of inorganic compounds (any six)** 1. $[Ni(NH_3)_6]Cl_2$ 2. $[Co(en)_3]Cl_3 \cdot xH_2O$ 3. $[Co(NH_3)_3(NO_2)_3]Cl_3$ 4. $K_3[Al(C_2O_4)_3] \cdot 3H_2O$ 5. $K_3[Cr(SCN)_6] \cdot 4H_2O$ 6. $K_3[Cr(C_2O_4)_3] \cdot 3H_2O$ 7. $[Cr(OAc)_2]_2 \cdot 2H_2O$ 8. Potash alum from scrap aluminium 9. Zinc iodide (Redox synthesis) **Quantitative estimations/determinations (any six)** 1. Estimation of Ni in $[Ni(NH_3)_6]Cl_2$ titrimetry/gravimetry 2. Estimation of Co in $[Co(en)_3]Cl_3 \cdot xH_2O$ volumetrically 3. Estimation of oxalate in $K_3[Al(C_2O_4)_3] \cdot xH_2O$ or $K_3[Cr(C_2O_4)_3] \cdot xH_2O$ 4. Estimation of nitrite by redox titration 5. Estimation of calcium in calcite ore 6. Estimation of copper in gun metal alloy or Devarda's alloy iodometrically 7. Estimation of Cr in chrome alum and $K_3[Cr(C_2O_4)_3] \cdot xH_2O$ to determine degree of hydration. 8. Colorimetric determination of Cr or Ni	24 hr 24 hr
Pedagogy:	Students should be given suitable pre-lab and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Each experiment should preferably be done individually by the students.	
Text Books / Reference Books	1. J. Mendham, R.C. Denney, J.D. Barnes, M.J. K. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 2002, 6th Ed. 2. G. Brauer, *Handbook of Preparative Inorganic Chemistry*, 1963, Vol . 1 & 2. 3. G. Pass & H. Sutcliffe, *Practical Inorganic Chemistry, Preparations, Reactions and Instrumental Methods*, Chapman & Hall, 1974, 2nd Ed. 4. A. J. Elias, *General Chemistry Experiments*, University Press, 2008, Revised Ed. 5. S. DeMeo, J. Chem. Ed., Vol 80, 2003, Pg. No. 796-798. 6. W. L. Jolly, *The Synthesis & Characterization of InorganicCompounds*, Prentice-Hall, INC, 1970.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: ICO-401
Title of the Course: Topics in Inorganic Chemistry & Environmental Chemistry
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Student should have studied the courses in chemistry at F.Y. B.Sc., S.Y.B.Sc. and T.Y.BSc. levels and / or CHIC-401 course so as to have basic knowledge of Inorganic / environmental chemistry.	No. of lectures
Course Objectives:	1. To provide fundamental aspects of transition & inner transition metals & their compounds. 2. To provide knowledge of main group elements of the periodic table & their compounds 3. To introduce various global phenomenon's of atmosphere & environment, follow directive of the Supreme Court in 1993 to introduced environmental education at all levels, have a fair knowledge on the various global activities to justify permissible or adverse, so that future generation are not adversely affected.	
Course Outcomes:	1. Students should be in position to understand fundamentals / usefulness of transition & inner transition metals. 2. Students should be in position to understand chemistry main group elements. 3. Students shall be aware of the maintenance of healthy living atmosphere on the globe.	
Content:	SECTION-I 1. **Chemistry of transition & inner transition elements** 1.1 Transition elements**:** IUPAC definition of transition elements, occurrence, physical & chemical properties, noble character, metal oxides & oxido complexes, examples of metal-metal bonded clusters. 1.2 Inner transition elements: Lanthanides, occurrence, properties, oxidation states, electronic structure, colour and spectra, magnetic properties, lanthanide contraction, compounds of lanthanides. Actinoid chemistry, general trends. 2. **Main group elements and their compounds** 2.1 Boron group: Compounds of boron:- borazine and boron nitride, synthesis, properties, structure & bonding. Borates: classification, structures & examples. 2.2 Carbon group: Allotropes of carbon including C_{60}, intercalation compounds of graphite, carbides. Compounds of silicon: silicates, zeolites & silicones. 2.3 Nitrogen group:- Introduction: oxides & oxyacids of nitrogen. 2.4 Oxygen group: oxyacids & oxohalides of S, S_4N_4 ring compounds: synthesis, properties, structure & bonding.	9 hr 9 hr

	SECTION-II 1. **Atmosphere** Structure and properties of the atmosphere, composition of atmosphere and vertical temperature behaviour, lapse rate and temperature inversion. 2. **Air Pollution** Classification of air pollutants and photochemical reactions in the atmosphere Common air pollutants (e.g. CO, NOx, SO_2, hydrocarbons and particulates) (a) sources (b) physiological and environmental effect (c) monitoring , d) various remedial & technological measures to curb pollution. Air quality standards. 3. **Water pollution** Importance of buffer & buffer index in waste water treatments. C hemical, physical & biological characteristics of water pollution, specific & non-specific characterization of water. DO, BOD, COD, and chlorine demand, typical water treatment & waste water treatment (Municipal). 4. **Treatment of Industrial wastes** Electroplating industry, fertilizer industry and pharmaceuticals industries. 5. **Biogeochemical cycles**: Carbon and Nitrogen cycles nature	2 hr 7 hr 5 hr 2 hr 2 hr
Pedagogy:	Mainly lectures / tutorials. Seminars / assignments / presentations / self-study or a combination of some of these could also be used to some extent.	
Text books / reference books	1. P.W. Atkins, T. Overton, J. Rourke, M. Weller, & F. Armstrong, *Shriver & Atkins Inorganic Chemistry*, Oxford publications, 2009, 5th Ed. 2. J. E. Huheey, E. A. Kieter, R. L. Kieter & O. K. Medhi, *Inorganic Chemistry: Principles of Structure & Reactivity*, Pearson, 2011, 4th Ed. 3. F. A. Cotton, G. Wilkinson & P. L. Gauss, *Basic Inorganic Chemistry*, Wiley, 2008 (reprint), 3rd Ed. 4. N.N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, Pergamon Press, Exetr, Great Britain. 1984. 5. J.D. Lee, *Concise Inorganic Chemistry*, Wiley, 2008, 5th Ed. 6. A.V. Salker, *Environmental Chemistry: Pollution and Remedial Perspective*, Narosa Publication, 2017. 7. A.K. De, *Environmental Chemistry*, New Age, 2006. 8. A.C. Stern, R.W. Boubel, *Fundamentals of Air Pollution*, D. Bruce turner & D.L.Fox, Academic Press, 1984. 9. R.A. Horne, *Chemistry of Our Environment*", John Wiley, N.Y. (1978). 10. C.N. Sawyer & P.J. Macarty, *Chemistry for Environmental Engineering*, Mc Graw Hill, 1978. 12. L.L. Ciaccio, *Water and Water Pollution Hand Book*", Marcel Dekker, 1973. 13. J.C. Lamb, *Water Quality and its Control*, John Wiley & Sons, N.Y., 1985.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: OCC-401
Title of the Course: Structure, reactivity, stereochemistry and reaction mechanism
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Should have studied the courses / topics in Organic Chemistry at F Y B Sc, S Y B Sc and T Y B Sc levels so as to have basic knowledge of organic nomenclature and basic principles.	
Course Objectives:	3. Introduction of various concepts based on molecular orbital theory. 4. Introduction of topicity, prostereoisomerism and chemo-, regio- and stereoselectivity in organic reactions. 5. Learning mechanistic aspects of various type of reactions in organic synthesis.	
Course Outcomes:	5. Students should be in a position to evaluate effect of delocalization of electrons & presence or absence of aromaticity in organic compounds. 6. Students should be in a position to apply various concepts in stereochemistry to understand stereochemical output in a reaction. 7. Students shall be in a position to understand/propose plausible mechanism of organic reactions.	
Content:	1. **Molecular orbitals and delocalized chemical bonding**: Qualitative description of Molecular orbitals of simple acyclic and monocyclic Systems, Frontier molecular orbitals, Conjugation, cross conjugation, resonance, hyperconjugation and tautomerism (types and examples), Aromaticity: Origin of Huckel's rule, examples of aromatic, non-aromatic and antiaromatic compounds; concept of Mobius aromaticity. 2. **Structure & Reactivity:** Acidity, basicity and pKa of organic compounds; Acid and base strengths; HSAB concept & Factors affecting it, Effect of structure & medium on acid and base strength, Concept of superacids and superbases, Electrophilicity & Nucleophilicity, Examples of ambident nucleophiles & electrophiles. (Including revision of aromatic electrophilic and nucleophilic substitution) 3. **Stereochemistry**: Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and *syn* & *anti* nomenclature. Chirality in molecules with two and more chiral centres. Conformational analysis of open chain compounds (Butane, 2, 3-butane diol, 2,3-dibromobutane etc.). *Erythro* and *threo* nomenclature. Topicity and Prostereoisomerism: Topicity of ligands and faces-homotopic, enantiotopic and Cram's rule / diastereotopic ligands and faces. Introduction to chemoselective, regioselective and stereoselective reactions. Stereochemistry of *cis*- and *trans*-decalins, conformation and reactivity of cyclohexane and substituted cyclohexanes, cyclohexene / cyclohexanone. 4. **Reaction Mechanism:** Brief revision of carbocations, carbanions, free radicals, carbenes and nitrenes with reference to generation, structure, stability and reactivity; Types of mechanisms, types of reactions, thermodynamic and kinetic control. The Hammond postulate and principle of microscopic reversibility, Methods of determining reaction mechanisms like- 1) Identification of products,	06 hr 06 hr 08 hr 06 hr

	2) Determination of the presence of intermediates (isolation, detection, trapping and addition of suspected intermediate, 3) Isotopic labelling, 4) Stereochemical evidence, 5) Kinetic evidence and 6) Isotope effect (at least two reactions to exemplify each method be studied) 5. **Aliphatic Nucleophilic substitution:** Brief revision of nucleophilic substitutions with respect to Mechanism, Various factors affecting such reactions; The Neighbouring Group Participation (NGP)/ Anchimeric assistance: General approach to various NGP processes; NGP by unshared/lone pair of electrons; NGP by π-electrons; NGP by aromatic rings (formation of phenonium ion intermediate); NGP by sigma bonds with special reference to bornyl and nor-bornyl system (formation of non-classical carbocation) 6. **Elimination reactions:** The E2, E1 and E1cB mechanisms. Orientation of the double bond, Saytzeff and Hofmann rule. Effects of changes in the substrate, base, leaving group and medium on 1) overall reactivity, 2) E1 vs. E2 vs. E1cB and 3) elimination vs substitution, Mechanism and orientation in pyrolytic *syn* elimination (various examples involving cyclic and acyclic substrates to be studied).	06 hr 04 hr
Pedagogy:	Mainly Lectures & tutorials. Seminars / assignments / presentations / self-study or a combination of some of these could also be used to some extent.	
References/ **Readings**	1. D. Nassipuri, *Stereochemistry of Organic compounds - Principles and Application*, Wiley Eastern Limited, 2013, 4th Ed. Kent, [England]: New Academic Science Limited, 2013. 2. E.L. Eliel, *Stereochemistry of carbon compounds*, Tata MacGraw Hill Publishing Company Ltd. (1990) 3. J. March, *Advanced Organic Chemistry: Reaction, Mechanism and Structure*, Wiley, 2010, 4th Ed. 4. J. Clayden, N. Greeves, S. Warren & Wothers, *Organic Chemistry*, Oxford University Press, 2012, 2nd Ed. 5. I.L. Finar *Stereochemistry and Chemistry of Natural products*, ELBS, Longmans, 1963, Vol. 2, 3rd Ed. 6. V.M. Potapov, *Stereochemistry*, MIR Publishers, Moscow, 1979 7. E.S. Gould *et al*., Mechanism and structure in Organic Chemistry, 1965 8. F. A. Carey, *Organic Chemistry*, 2000, 4th Ed. 9. S.H. Pine, *Organic Chemistry*, McGraw-Hill International Edn. 2010, 5thEd. 10. F.A. Carey and R.J. Sundberg, *Advanced Organic Chemistry*, Vol. I & II. Plenum Press, 1977 11. J. M. Harris & C.C. Wamser, *Fundamentals of Organic Reaction Mechanisms*, John Wiley & Sons. Inc. 1976 12. F.M. Menger, D.J. Goldsmith & L. Mendell, *Organic Chemistry, A concise approach*, 1975, 2nd Ed.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: OCC-402
Title of the Course: Laboratory course in Organic Chemistry
Number of Credits: 02 **Effective from AY: 2018-19**

Prerequisites for the course:	Students should have exposure to common laboratory practices and techniques studied at F Y B Sc, S Y B Sc and T Y B Sc chemistry theory / practical courses.	
Course Objectives:	To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required for organic syntheses.	
Course Outcomes:	Students shall gain the understanding of: 1. Stoichiometric requirements during organic syntheses. 2. Safe and good laboratory practices, handling laboratory glassware, equipment and chemical reagents. 3. Common laboratory techniques including reflux, distillation, steam distillation, vacuum distillation, aqueous extraction, thin layer chromatography (TLC)	
Content:	**1. Introduction to laboratory equipments, apparatus and safety:** a) Use of common laboratory equipments like fume hoods, vacuum pumps, weighing balance etc. to be explained to the students. b) Introduction to various types of quick fit joints and apparatus to the students. c) Discussion of Safety Techniques: i) Disposal of chemicals, ii) Usage of protective equipments, iii) First aid, iv) Fire extinguishers, types of fire, d) Hazards of chemicals. **2. Laboratory Techniques:** a. Simple distillation (any one): Toluene-dichloromethane mixture using water condenser, nitrobenzene and aniline using air condenser. b) Steam distillation (anyone):Separation of *o*-and *p*- nitrophenols, naphthalene from its suspension in water, clove oil from cloves. c) Crystallisation: Concept of induction of crystallization(any one) : i) Crystallisation of phthalic acid from hot water using fluted filter paper and stemless funnel. ii) Acetanilide from boiling water iii) Naphthalene from ethanol . iv) Decolorisation and crystallization of brown sugar (sucrose) with animal charcoal using gravity filtration. d) Sublimation: Simple or vacuum sublimation of camphor, naphthalene, anthracene or succinic acid (any one). e) Vacuum distillation (any one): o-dichlorobenzene, diphenyl ether. Also use of nomograph should be explained. f) Thin layer Chromatography (any one): Separation of *o* and *p*-nitroanilines, Separation of analgesic drugs, Separation of *o* and *p*-nitrophenols,	04 hr 24 hr

	3. Organic synthesis (any four experiments): a) Aliphatic electrophilic substitution: Preparation of iodoform from ethanol & acetone. b) Aromatic electrophilic substitution (anyone): Preparation of p-bromoacet-anilide, bromination of acetophenone to phenacyl bromide, nitration of napthathalene to 1-nitronaphthalene, nitration of benzaldehyde to 3-nitrobenzaldehdye. c) Oxidation of: i) Benzoic acid from toluene ii) Cyclohexanone from cyclohexanol, iii) isoborneol to camphor using Jones reagent (any one). d) Reduction (any one): Reduction of *o*-nitroaniline to *o*-phenylenediamine using Sn/HCl; Reduction of *p*-nitro benzaldehyde to *p*-nitrobenzyl alcohol using $NaBH_4$ e) Bromination of an alcohol using CBr_4/ triphenylphosphine. f) Grignard reaction: Triphenylmethanol from benzoic acid ester or benzophenone. g) Aldol condensation: Dibenzal acetone from benzaldehyde h) Acetoacetic ester condensation : Preparation of ethyl *n*-butylacetoacetate or ethyl acetoacetate. i) Cannizzaro reaction using 4-chlorobenzaldehyde as substrate. j) Friedel Craft's reaction (any one): using toluene and succinic anhydride, resorcinol to resacetophenone, benzene and maleic anhydride to *β*-benzoylacrylic acid k) Solvent free preparation of coumarin by the Knoevenagel condensation under MW irradiation. l) Preparation of oxidizing agent (any one): Pyridinium chlorochromate-silica, pyridinium chlorochromate-alumina, MnO_2. m) Preparation of cuprous chloride. **3**. **Isolation from natural sources :** (any one) Caffeine from tea powder, piperine from pepper, cinnamaldehyde from cinnamon	16 hr 4hr
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Each of the experiments should be done individually by the students.	
References / Readings	1. A.I. Vogel, A.R. Tatchell , B. S. Furniss, A.J. Hannaford, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Prentice Hall; 2011. 2. D. Pasto, C. Johnson and M. Miller, *Experiments and Techniques in OrganicChemistry*, 1st Ed., Prentice Hall, 1991. 3. L.F. Fieser, K.L. Williamson "*Organic Experiments*" 7th edition D. C. Heath, 1992. 4. K.L. Williamson, K.M. Masters, *Macroscale and Microscale Organic*	

	Experiments, 6th Edition, Cengage Learning, 2010 5. R.K. Bansal, *Laboratory Manual in Organic Chemistry*, New Age International, 5th Edition, 2016. 6. S. Delvin, *Green Chemistry*, Sarup & Sons, 2005. 7. O.R. Rodig, C.E. Bell Jr. and A.K. Clark, *Organic Chemistry Laboratory Standard and Microscale Experiments*, Saunders College Publishing, 3rd edition, 2009. 8. J. Mohan, *Organic Analytical Chemistry*, Narosa Publishing House, 2014.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: OCO-401
Title of the Course: Synthetic Organic Chemistry I
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Should have studied the courses / topics in Organic Chemistry at F Y B Sc, S Y B Sc and T Y B Sc levels as well as the course CHOC-401 so as to have basic knowledge of organic nomenclature and basic principles.	
Course Objectives:	1. Introduction to concepts of functional groups and their interconversion 2. Learning mechanistic concepts of carbon-carbon bond making by nucleophilic addition to carbonyl group 3. Learning mechanistic aspects of various oxidation & reductionprocesses used in organic syntheses.	
Course Outcomes:	1. Students should be in a position to choose appropriate oxidizing agent for oxidation of a particular functional group. 2. Students should be in a position to choose appropriate reducing agent for reduction of a particular functional group. 3. Students shall be in a position to understand/propose plausible mechanism of organic reactions. 4. Student should be able to choose appropriate nucleophilic addition reaction for making carbon-carbon bond.	
Content:	**1. Oxidation reactions:** Oxidation of organic compounds using chromium (PCC, PDC) and manganese compounds, Oppenauer oxidation, Swern oxidation, ozonolysis. Other methods of oxidation such as selenium dioxide, $Pb(OAc)_4$, HIO_4, peracids, peroxides, OsO_4,RuO_4, DMSO (Swern) sodium bromated / CAN & NaOCl, DDQ, Prevost's reagent and Woodward Conditions; Catalytic oxidation over Pt, Photosensitised oxidation of alkenes, oxidation with molecular oxygen, aromatization, silver based reagents. 2.**Reduction reactions:** Reduction of organic compounds using hydride-transfer reagents and related reactions : MPV reduction, $NaBH_4$, Trialkylborohydrides, LAH & lithium hydridoalkoxyaluminates, mixed LAH-$AlCl_3$ reagents, DIBAL and reduction with borane and dialkylboranes, Enzymatic reduction involving liver alcohol dehydrogenase/NADH & Bakers' yeast, catalytic hydrogenation, Dissolving metal reductions including acyloin condensation, Clemmensen reduction and Birch reduction,Other methods of reduction: Wolff-Kishner, Raney Ni desulphurisation, di-imide. 3.**Halogenation:** Formation of Carbon Halogen bonds: Substitution in saturated compounds, alcohols, carbonyl compounds, substitution at allylic and benzylic compounds, bromodecarboxylation (Hunsdiecker reaction), Finkelstein reaction, iodolactonisation.	11 hrs 9 hrs 5 hrs

	4. **Esterifiction, amide preparation and hydrolysis:** (study of different mechanisms and reagents) 5. **Name reactions**: Knoevenegel Reaction, Claisen, Darzen, Stobbe, Perkin, Aldol, Benzoin, Pechmann condensation.	6 hrs 5 hrs
Pedagogy:	Mainly Lectures & tutorials. Seminars / assignments / presentations / self-study or a combination of some of these could also be used to some extent.	
References/ Readings	1. H. O. House, *Modern Synthetic Reactions*, 2nd Ed., W. A. Benjamin, Benjamin-Cummings Publishing Co., 1972. 2. W. Caruthers, *Modern Methods of Organic Synthesis*, 4thEd.,Cambridge University Press, 2004. 3. M. B. Smith, Jerry March, *Advanced Organic Chemistry- Reaction, Mechanism and Structure*, 6 Ed, Wiley, 2006. 4. F.A. Carey & R.J. Sundberg, *Advanced Organic Chemistry* (Part A & B) 5th Ed., Springer India Private Limited, 2007. 5. P Sykes, *A guidebook to mechanisms in organic chemistry*, 6th Ed., Pearson Edu., 1996. 6. Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, 2ndEd., Oxford University Press, 2002. 7. E.S. Gould, *Mechanism and structure in Organic Chemistry*, Holt, Reinhart and Winston 1965. 8. F. A. Carey, R. M. Giuliano, *Organic Chemistry*, 8thEd., McGraw-Hill, 2010. 9. S.H. Pine, *Organic Chemistry*, 5th Ed, McGraw-Hill International Edn. McGraw-Hill, 1980.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: PCC-401 **Title of the Course: General Physical Chemistry**
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Should have studied the courses in chemistry at F.Y B.Sc, S.Y B.Sc & T.Y B.Sc levels so as to have basic knowledge of Physical Chemistry and basic principles.	
Course Objectives:	6. Introduction of various concepts on thermodynamics. 7. Introduction of electro chemistry and kinetics. 8. Learning quantum chemistry.	
Course Outcomes:	8. Students should be in a position to understand various concepts in physical chemistry. 9. Students should be in a position to apply these concepts during the lab course in physical chemistry. 10. Students shall be in a position to answer the NET/SET examination questions based on these topics.	
Content:	1.**Thermodynamics** 1.1 Thermodynamic properties: Gas laws, Real gasses, Boyle temperature, Critical temperature, State and path properties. Intensive and extensive properties. Exact and inexact differentials. Internal energy, enthalpy, entropy, free energy and their relations and significances. Maxwell relations. Thermodynamic equations of state. 1.2 Joule-Thomson effect. Joule-Thomson coefficient for van der Waals' gas. Joule-Thomson effect and production of low temperature, adiabatic demagnetization, Joule-Thompson coefficient, inversion temperature. 1.3 The third law of thermodynamics. Need for the third law. Apparent exceptions to third law. Application of third law. Use of thermodynamic functions in predicting direction of chemical change. Entropy and third law of thermodynamics. 1.4 Phase equilibria: Phase rule, Discussion of two component systems forming solid solutions with and without maximum or minimum in freezing point curve. Systems with partially miscible solid phases. 1.5 Three component systems: Graphical representation. Three component liquid systems with one pair of partially miscible liquids. Influence of temperature. Systems with two pairs and three pairs of partially miscible liquids. The role of added salts. 2.**Electrochemistry** 2.1 EMF series, decomposition potential and overvoltage, electronegativity, basic principles, completeness of deposition, Separation with controlled potentials, constant current electrolysis, composition of electrolyte, potential buffers, physical characteristics of metal deposits. 2.2 Electroplating and electroless plating, electrosynthesis. 2.3 Concepts of acid-base aqueous and non-aqueous solvents, hard and soft acid-base concept and applications.	10 hrs 06 hrs

	3.**Chemical Kinetics** 3.1 General introduction to various types of order of reaction including fractional order, Molecularity of the reaction. 3.2 Introduction to reversible and irreversible reactions and reactions leading to equilibrium. Van'tHoffs equation and analysis of Gibbs free energy of equilibrium reactions. 3.3 Collision Theory and Maxwell Boltzmann distribution of energies of colliding molecules(derivationnotrequired). The concept of collisional cross section and reactive cross section and its significance. 3.4 Comparative study of transition state and collision state theory (derivation not required). 3.5 Free radical reactions, Complex reactions such as acetaldehyde decomposition and reaction between H_2 and Br_2, Homogeneous reactions and acid-base catalysis. 3.6 Elementary enzyme reactions. 4. **Quantum Chemistry** 4.1 Operators, Functions, Eigen value equations, Postulates. 4.2 Schrodinger equation, application to simple system viz. free particle, particle in one dimensional, two dimensional and three dimensional box (quantization, separation of variables, degenerate wave functions). 4.3 Hydrogen like atoms, Schrodinger equation and its solutions, atomic orbital wave functions and interpretation. 4.4 Hückel MO theory, Secular equations, Secular determinant, delocalization energy, charge density, π-bond order, free valence, applications to C_2H_4, C_3H_5(radical), C_4H_6, C_4H_4, C_6H_6, C_6H_8	07 hrs 13 hrs
Pedagogy:	Mainly lectures & tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these may be used. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. P. W. Atkins and J. D. Paula, *Physical Chemistry*, Eighth Edition, Oxford University Press, (2007) New Delhi. 2. G. M. Barrow, *Physical Chemistry*, Fifth Edition, Tata McGraw Hill, (2016) New Delhi. 3. J. E House, *Principles of Chemical Kinetics* (Second edition) Academic Press,2007 Elsevier Burlington, USA 4. I. N. Levine, *Quantum Chemistry*, Seventh Edition, Prentice-Hall, (1999) New Delhi.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: PCC-402 Title of the Course: Laboratory Course in Physical Chemistry
Number of Credits: 02 Effective from AY: 2018-19

Prerequisites for the course:	Should have studied the courses in Chemistry at F Y B Sc, S Y B Sc & T Y B Sc levels so as to have basic knowledge of Physical Chemistry and basic principles.	
Course Objectives:	1. Introduction of various concepts on thermodynamics. 2. Introduction of electro chemistry and kinetics.	
Course Outcomes:	1. Students should be in a position to understand various concepts in physical chemistry by conducting experiments. 2. Students should be in a position to apply these concepts during the lab course in physical chemistry.	
Content:	1. To study the kinetics of hydrolysis of ethyl acetate and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. 2. To study the kinetics of the reaction between Potassium per sulphate (K), and Potassium iodide (KI), and to determine a) Energy of activation b) Entropy of activation and c) Free energy change. 3. To determine the order of reaction between potassium persulphate and potassium iodide by graphical, fractional change and differential methods. 4. To determine the degree of hydrolysis of salt of weak base and strong acid using conductometer. 5. To determine the composition of a mixture of acetic acid, dichloroacetic acid and hydrochloric acid by condoctometric titration. 6. To determine the dissociation constants of a dibasic acid and obtain derivative plot to get equivalence point. 7. To determine the dissociation constants of a tribasic acid (Phosphoric acid obtain derivative plot to get equivalence point. 8. To determine formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{3+}/Ce^{4+} system obtain derivative plot to get equivalence point. 9. To study the three component system such as toluene, ethanol and water. 10. To study the three component system such as acetic acid,chloroform; and water and obtain tie line. 11. To determine the molecular weight of polyvinyl alcohol by viscosity measurement. 12. To determine the molecular weight of polystyrene by viscosity measurement.	48 hrs
Pedagogy:	Lectures / tutorials / seminars / term papers /assignments / presentations / self-study or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. A. Finlay & J.A. Kitchener,"*Practical Physical Chemistry*", Longman 2. F. Daniels & J.H. Mathews,"*Experimental Physical Chemistry*", Longman. 3. A.M.James,"*Practical Physical Chemistry*", 4. D.P. Shoemaker & C.W. Garland, "*Experimental Physical Chemistry*", McGraw-Hill.	

Programme: M. Sc. Part-I (Chemistry)
Course Code: PCO-401 **Title of the Course: Topics in Physical Chemistry**
Number of Credits: 03 **Effective from AY: 2018-19**

Prerequisites for the course:	Should have studied the courses in Physical Chemistry at F Y B Sc, S Y B Sc and T Y B Sc levels so as to have basic knowledge of Physical Chemistry and basic principles.	
Course Objectives:	1. Introduction of various mathematical concepts forChemistry. 2. Introduction of topics viz. magnetic materials and properties, photochemistry, Nano materials.	
Course Outcomes:	1. Students should be in a position to understand various concepts in physical chemistry. 2. Students should be in a position to apply these concepts during the lab course in physical chemistry. 3. Students shall be in a position to answer the NET / SET examination questions based on these topics.	
Content:	1.**Mathematical Preparations:** 1.1 Introduction to various functions and function plotting (exponential, logarithmic, trigonometric etc.), functions of many variables. Complex numbers and complex functions. 1.2 .Linear equations, vectors, matrices and determinants. 1.3 Basic rules of differentiation and integration, Partial differentiation, location and characterization of critical points of a function, Regression methods, curve fitting. 1.4 Introduction to series, convergence and divergence, power series, Fourier series, Fourier transformations and Numerical methods 2.**Magnetic Properties** 2.1 Types of magnetism (dia, para, ferro, antiferro and ferrimagnetism) Magnetic susceptibility and its determination. 2.2 Magnetization curves and hysteresis, magnetic anisotropy, magnetic exchange interactions, Neel temperature and magnetic transition. 2.3 Ceramic magnetic materials, Applications of magnetic Materials 3.**Photochemistry**: 3.1 Absorption and emission of radiation of photochemical interest. Einstein's equation. 3.2 Jablonskii's diagram illustrating fluorescence and phosphorescence. 3.3 Prompt and Delayed Fluorescence. Factors affecting Fluorescence life time and quantum yield. 3.4 Flash photolysis and lasers. Photosensitised reactions and photosynthesis. 4. **Nanomaterials:** 4.1 Introduction, Chemical synthesis and methods of structural characterization.	18 hrs 08 hrs 06 hrs 04 hrs

	4.2 Areas of application, Societal health and environmental impact.	
Pedagogy:	Mainly lectures & tutorials. Seminars / term papers / assignments / self-study / or a combination of some of these can be used to some extent. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. P.L. Alger, *Mathematics for Science and Engineering*, McGraw-Hill, New York (1963). 2. E. Kreyszic, *Advance Engineering Mathematics*, Wiley-Eastern, New Delhi (1987). 3. L.N. Muley, *Magnetic susceptibility*, Interscience Publishers, New York (1963). 4. K.K. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, Wiley Eastern Ltd. New Delhi (1988). 5. G.A. Ozinand A.C. Arsenault, *Nanochemistry: A chemical approach to Nanomaterials*, RSC Publishing, Cambridge, (2005).	