RANI CHANNAMMA UNIVERSITY
(**RCU**)

SCHOOL OF BASIC SCIENCES

Department of Chemistry

for

M.Sc. degree in CHEMISTRY

REGULATIONS
&
SCHEME OF EXAMINATION

As per
CHOICE BASED CREDIT SYSTEM (CBCS)

With effect from Academic Year 2020-21
[Approved in the BOS meeting held on 15-11-2019]

Submitted by
Prof. J. Manjanna
Chairman, Dept of Chemistry &
Chairman, BOS in Chemistry, RCU, Belagavi.

RANI CHANNAMMA UNIVERSITY
DEPARTMENT OF CHEMISTRY
[SCHOOL OF BASIC SCIENCES]

Regulations & Scheme of Examination
for
M.Sc. Degree in Chemistry
as per under CBCS
(Effective from the Academic Year 2020-21)

1.0 Title of the Course
The course shall be called **M.Sc. in CHEMISTRY**.

1.1 Duration of the course: The M.Sc. degree course is of two years duration, spread over four semesters each of four months duration.
1.2 Eligibility for Admission: The Bachelor's degree in Science or equivalent degree with Chemistry as one of the subject. The candidate should have obtained at least 40% of marks in optional subjects as well as in aggregate. Relaxation in respect of SC/ST/Cat -I etc. will be followed as per prevailing rules of the university.
1.3. Admission & Seat Matrix: The rules for admission & Seat matrix are as per university notification from time to time.
1.4. Admission to other semesters: students are allowed to take admissions to successive semesters under carry over benefit (COB) facility.

2.0 Attendance: Every student must have at least 75% attendance in each paper (Theory & Practical) in each semester. Shortage of attendance will be dealt with as per the university rules from time to time.

3.0 Medium of instruction: The medium of instruction shall be English.

4.0 Course Structure:
There shall be *Three* category of Papers namely, Hard Core (Theory), Soft core (Practicals) and Open Elective (Theory) Papers for M.Sc. in Chemistry.
In the 1st semester, there shall be 4 hardcore theory papers of 4 credits in each paper and 1 hardcore paper of 2 credits and 3 practicals each of 2 credits.
In 2nd semester, there shall be 3 hardcore theory papers of 4 credits in each paper and 1 hardcore paper of 2 credits and 3 practicals each of 2 credits & one Open Elective paper with 4 credits.
In 3rd semester, there shall be 3 hardcore theory papers of 4 credits in each paper and 1 hardcore paper of 2 credits and 3 practicals each of 2 credits & one Open Elective paper with 4 credits.

In the 4th semester, there shall be 3 hardcore theory papers of 4 credits in each paper and 1 hardcore paper of 2 credits and 3 practicals each of 2 credits & one **Project** with 4 credits.

Syllabus for Each paper of 4 Credits shall have four Units of 16 h each & Each paper of 2 Credits shall have two Units of 16 h each.

Project work of 4th semester shall be allocated during the 3rd semester itself so that it can be planned well in advance for effective execution under the supervision of Internal and/or External Guide. The Project team shall not exceed *Three* students for a given Topic of study.

5.0 Scheme of Evaluation:

5.1 There shall be an examination at the end of each Semester.

5.2 The duration of Examination of Theory paper carrying 80 marks is 3 h & duration of Examination of Theory paper carrying 40 marks is 2 h.
Duration of Exam for Practicals (Lab) is 4 h and number of students per batch should not exceed 15.
The IA marks of Theory papers are based on average of two IA Tests per Paper per semester as well as Attendance, Seminar and Assignments (if any). The weightage of marks for these components may be distributed accordingly.
The IA marks of Practical paper are based on one IA Tests per Paper per semester.
At least one seminar per Year should be assigned for each student as per the convenience.

5.3 The Theory and Practical Examinations of all the semesters shall be evaluated through single / double valuation by an Internal / External examiner as per the guidelines of RCU.

5.4 Project: The project report shall be evaluated for 80 marks by one Internal and one External examiner based on the *Dissertation* & Oral presentation.
IA marks of 20 allocated for Project work must be earned from ***Industrial visit/ Technical / Study tour*** of minimum 2 days to be undertaken during the 2nd Yr M.Sc. course. Such a visit/ tour (within India) must be endorsed by the Chairman, Dept. of Chemistry (Principal of Affiliated College). The financial support (partial/full) to the enrolled students and Faculty members accompanying the team may be reimbursed by the University/ Affiliated College, as per the norms.
In case the student cannot undertake ***Industrial visit/ Technical / Study tour*** due to health issues or unavoidable circumstances, IA marks shall be based on the presentation of the work in a seminar.

6.0 Pattern of question paper: 80 (Exam) + 20 (IA)
Question paper contains five questions. Question 1 is compulsory. It shall contain 10 objective type questions carrying 2 marks each, drawn from all the four units. Questions 2, 3, 4 and 5 should be drawn from each Unit for 16 marks each (sub questions a, b and c or d carry 5, 5 and 6 marks).

7.0 Maximum period for the completion of M.Sc. Degree Progrmme: There shall be fully carry over system from First to Fourth semesters. Maximum number of years for a student to complete the degree is as specified by the University from time to time.

8.0 The General Regulations Governing Post Graduate Programmes under CBCS and Regulation Governing Post Graduate Programmes in the School of Basic Sciences under CBCS of Rani Channamma University, Belagavi are applicable to this course for all the matters not covered under this.

Course structure of M.Sc. degree in CHEMISTRY @ RCU

Subjects	Paper	Teaching h/ week	Duration of Exam, h	Marks			Credits
				IA	Exam	Total	
1st Semester							
Hard Core	4 T	4 × 4 = 16	4 × 3 h	4 × 20	4 × 80	4 × 100	4 × 4 = 16
	1 T	1 × 2 = 2	1 × 2 h	1 × 10	1 × 40	1 × 50	1 × 2 = 2
Soft Core	3 P	3 × 4 = 12	3 × 4 h	3 × 10	3 × 40	3 × 50	3 × 2 = 6
Total		30	28 h	120	480	600	**24**
2nd & 3rd Semester							
Hard Core	3 T	3 × 4 = 12	3 × 3 h	3 × 20	3 × 80	3 × 100	3 × 4 = 12
	1 T	1 × 2 = 2	1 × 2 h	1 × 10	1 × 40	1 × 50	1 × 2 = 2
Soft Core	3 P	3 × 4 = 12	3 × 4 h	3 × 10	3 × 40	3 × 50	3 × 2 = 6
OEC	1 T	1 × 4 = 4	1 × 3 h	1 × 20	1 × 80	1 ×100	1 × 4 = 4
Total		30	28 h	120	480	600	**24**
4th Semester							
Hard Core	3 T	3 × 4 = 12	3 × 3 h	3 × 20	3 × 80	3 × 100	3 × 4 = 12
	1 T	1 × 2 = 2	1 × 2 h	1 × 10	1 × 40	1 × 50	1 × 2 = 2
Soft Core	3 P	3 × 4 = 12	3 × 4 h	3 × 10	3 × 40	3 × 50	3 × 2 = 6
Project	1 Pr	1 × 4 = 4	1 × 3 h	**1×20***	1 × 80	1 ×100	1 × 4 = 4
Total		30	28 h	120	480	600	**24**
Grand Total		120	112	480	1920	2400	**96**

T - Theory, P- Practical/ **Pr**oject, OEC-Open Elective

* For earning IA marks of Project work, please refer to Section 5.4 in the regulation.

Details of Course structure of M.Sc. degree in CHEMISTRY @ RCU

Papers details		Teaching h/ week	Duration of Exam, h	Marks			Credits
				Exam	IA	Total	
1st semester							
Hard Core	CHIT 1.1: Inorganic Chemistry-I	4	3	80	20	100	4
	CHOT-1.2: Organic Chemistry-I	4	3	80	20	100	4
	CHPT-1.3: Physical Chemistry-I	4	3	80	20	100	4
	CHGT-1.4: Spectroscopy-I	2	2	40	10	50	2
	CHES-1.5: Analytical Chemistry	4	3	80	20	100	4
Soft core	CHIPr -1.6: Inorganic Chemistry Practicals-I	4	4	40	10	50	2
	CHOPr-1.7: Organic Chemistry Practicals-I	4	4	40	10	50	2
	CHPPr -1.8: Physical Chemistry Practicals-I	4	4	40	10	50	2
Total		30	28	480	120	**600**	**24**
2nd semester							
Hard Core	CHIT-2.1 : Inorganic Chemistry –II	4	3	80	20	100	4
	CHOT-2.2 : Organic Chemistry- II	4	3	80	20	100	4
	CHPT- 2.3: Physical Chemistry-II	4	3	80	20	100	4
	CHGT- 2.4: Spectroscopy-II	2	2	40	10	50	2
OEC	CHEG- 2.5: Open elective	4	3	80	20	100	4
Soft core	CHIPr-2.6 : Inorganic Chemistry Practicals-II	4	4	40	10	50	2
	CHOPr- 2.7 : Organic Chemistry Practicals-II	4	4	40	10	50	2
	CHPPr- 2.8 : Physical Chemistry Practicals-II	4	4	40	10	50	2
Total		30	28	480	120	**600**	**24**

Details of Course structure of M.Sc. degree in CHEMISTRY @ RCU

Papers details		Teaching h/ week	Duration of Exam, h	Marks			Credits
				Exam	IA	Total	
3rd semester							
Hard Core	CHIT- 3.1: Inorganic Chemistry-III	4	3	80	20	100	4
	CHOT- 3.2: Organic Chemistry- III	4	3	80	20	100	4
	CHPT- 3.3: Physical Chemistry-III	4	3	80	20	100	4
	CHGT- 3.4: Spectroscopy-III	2	2	40	10	50	2
OEC	CHEG- 3.5: Open elective	4	3	80	20	100	4
Soft core	CHIPr- 3.6: Inorganic Chemistry Practicals-III	4	4	40	10	50	2
	CHOPr- 3.7 : Organic Chemistry Practicals-III	4	4	40	10	50	2
	CHPPr -3.8: Physical Chemistry Practicals-III	4	4	40	10	50	2
Total		30	28	480	120	**600**	**24**
4th semester							
Hard Core	CHIT- 4.1: Inorganic Chemistry-IV	4	3	80	20	100	4
	CHOT- 4.2: Organic Chemistry-IV	4	3	80	20	100	4
	CHPT- 4.3: Physical Chemistry-IV	4	3	80	20	100	4
	CHGT- 4.4: Spectroscopy-IV	2	2	40	10	50	2
Project	CHGP 4.5: Project /Dissertation	4		80	20	100	4
Soft core	CHIPr -4.6: Inorganic Chemistry Practicals-IV	4	4	40	10	50	2
	CHOPr -4.7: Organic Chemistry Practicals-IV	4	4	40	10	50	2
	CHPPr 4.8: Physical Chemistry Practicals-IV	4	4	40	10	50	2
Total		34	28	480	120	**600**	**24**
Grand Total		120	112	1920	480	**2400**	**96**

T : Theory, Pr : Practical, P: Project, EG : Elective General, ES : Elective Special

RANI CHANNAMMA UNIVERSITY

Syllabus of M.Sc. degree in CHEMISTRY
@
Dept. of CHEMISTRY

FIRST SEMESTER

CHIT-1.1 : INORGANIC CHEMISTRY-I
Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I **16 h**
CHEMICAL BONDING
Ionic Bonding
Formation, conditions for the formation of ionic compounds, lattice energy, Born-Lande's equation, calculation of lattice energy from Born-Lande's equation (problems should be solved), conclusions from Born-Lande equation, Born-Haber cycle and its applications (problems should be solved), Kapustinskii equation, factors affecting the lattice energy, properties of ionic substances, Covalent character in predominantly ionic bonds, polarizing power, factors governing the degree of polarization, Fajan's rules in predicting the melting and boiling points and solubility of some compounds.
Energetics of solubility of ionic salts in polar solvents, solvation energy, relative effects of ionic radii on lattice energy and ion-solvation energy, relative solubility of ionic compounds (alkali metal halides and silver halides, sulphates and hydroxides of alkaline earth metals).

Covalent bonding:
Valence bond theory: hybridization of atomic orbitals, Examples for compound having different hybridization (*sp*, sp^2, sp^3, dsp^2, sp^3d, sp^3d^2).
VSEPR theory: Predicting molecular geometries, Bent's rule of hybridization, illustration of Bent's rule with respect to CH_3F, PCl_3F_2), limitations of VSEPR theory.

Molecular orbital theory: Symmetry and overlap, molecular orbital diagrams of diatomic homo nuclear molecules/ions (up to second period elements), hetero-nuclear molecules/ions (HCl, LiF, CO, NO, NO^+ and triatomic molecules–linear (CO_2) and angular (NO_2). Magnetic properties of the molecules/ions based on the MOT, stability of molecules or ions based on bond order. Walsh diagrams for XH_2 species.
Metallic bonding: Characteristics of metallic states, electron sea model, V. B. approach, band theory (MOT).

Self study: Review of different types of chemical bonds with suitable examples.

Skill component: Determine the bond energy and calculate the lattice energies and discuss their application.

UNIT–II **16 h**

CHEMISTRY OF NON-TRANSITION ELEMENTS-I

Electron deficient compounds: Classification of boranes, nomenclature of boranes.**:** Synthesis, structure and properties **of** B_2H_6, B_3H_9, B_4H_{10}, B_5H_9, B_5H_{11} and B_6H_{10}.

Polyhedral skeletal electron pair counting using Wade's rules (*styx* numbers): classification of boron clusters using electron pair count.

Carboranes: Classification, Nomenclature, Synthesis of closocarboranes (C_2B_{10} H_{12}). Structural aspect of closo-$C_2B_{10}H_{12}$.

Metalloborane: Synthesis and structural aspects of $[B_{11}H_{11}AlCH_3]^{2-}$, $[Fe(CO)_3B_4H_8]$ and [2-$CpCoB_4H_8$].

Metallocarboranes: Synthesis of $[(C_2B_9H_{11})_2Fe]^{2-}$, $[C_2B_9H_{11}FeCp]^-$ and $[Co(C_2B_9H_{11})_2]^-$, Structure and Bonding in $[Co(C_2B_9H_{11})_2]^-$

Borazines: Synthesis, reactivity and, structure and bonding.

Electron Rich Compounds: Compounds of Noble gases, Preparation and structure and bonding in Xenon compounds (XeF_2, XeF_4, XeF_6, $XeOF_4$, XeO_2F_2, XeO_3, XeO_4) based on VBT and VSEPR.

Self study: Electron deficient compound other than Boran and Lewis acids.

Skill component: Demonstration on the handling of redox sensitive and air/moisture sensitive materials.

UNIT–III **16 h**

COORDINATION CHEMISTRY AND METAL CLUSTERS

Coordination chemistry: Coordination numbers (1 to 7) and their geometries, geometrical isomerism in square planar and octahedral complexes, optical isomerism in octahedral complexes.

Bonding theories: Review of VBT, EAN and their limitations, Spectrochemical series (Irwin-William series), Crystal Field Theory, splitting of d-orbitals in octahedral, tetrahedral, square planar, trigonal bipyramidal and square pyramid geometries, Jahn-Teller distortion in co-ordination compounds. Factors affecting the CFSE values.

Limitations of CFT, evidences for metal ligand orbital overlap, Molecular Orbital Theory with sigma (σ) bonding applied to octahedral, tetrahedral and square plannar complexes. MO-Theory with ıı(pi)–bonding applied to octahedral complexes.

Metal Clusters

Dinuclear compounds: Quadrapole bonding, calculation of M-M bond order and structural aspects and magnetic properties of $Re_2Cl_8^{2-}$.

Trinuclear clusters: Bond order, magnetic properties and structural aspects of Re_3Cl_9.

Self study: Basics of Coordination Chemistry (Review of VBT, EAN and their limitations).
Skill component: Methods to Identify cis- & trans- as well as L- & D-isomerism.

UNIT–IV **16 h**

Pi (π) ACID METAL COMPLEXES AND ACID-BASE CHEMISTRY

Metal Carbonyls: Different binding modes of CO, pi (π) acidity of CO, back bonding, synergic effect, mononuclear carbonyls, low nuclearity carbonyl clusters and high nuclearity carbonyl clusters, application of 18 electron rule to metal carbonyls.
Structural features of $[Co_2(CO)_8]$, $[Co_4(CO)_{12}]$ and $[Fe_3(CO)_{12}]$.
Preparation and structural aspects of $Ni(CO)_4$, $Fe(CO)_5$ and $Co_2(CO)_8$ by direct reaction of metals, $V(CO)_6$, and $Mn_2(CO)_{10}$ by reductive carbonylation.
Metal Nitrosyls: Coordinating behavior of NO, NO as a bridging ligand, factors favoring linear and bent M-N-O linkage, synthesis of nirosyl complexes (brown ring complex).
Dinitrogen Complexes: Reason for poor coordinating behavior of N_2 compared to its isoelectronic species, binding modes of N_2, preparation of Ru and Mo dinitrogen complexes.
Acid-Base Chemistry: Bronsted-Lowry concept, Lux-Flood theory, solvent-system definition, Lewis theory, Usanovich concept, Hammett acidity function (superacids), HSAB theory.
Self study: structural features of $Ni(CO)_4$, $Fe(CO)_5$ and $Co_2(CO)_8$
Skill component: Preparation of one metal nitogen compound and its characterization.

REFERENCE BOOKS:

01. Fundamental concepts of Inorganic Chemistry by A. K. Das, CBS ,volume 1 to 7.
02. *Concise* inorganic Chemistry 5th Edition J.D. Lee Oxford University Press(OUP), wiley India 2008.
03. Inorganic Chemistry: Principles, structure and reactivity, 1997, J. E. Huheey, E.A.Keiter , R.L.Keiter, O.K.Medhi 4th Edition, Pearson Education, Dorling kindersley (India) Pvt. Ltd. 20th impression 2014.
04. Inorganic Chemistry, C. E. Housecroft and A. G. Sharpe, , 3rd edition.
05. Inorganic Chemistry by Keith F. Purcell, John C. Kotz, New Delhi India , 2010.
06. Inorganic Chemistry – A unified approach by W. W. Porterfield 2nd edition , academic press- An imprint of Elsevier , reprint 2013.
07. Advanced Inorganic Chemistry by F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, 6th Edition, John Wiley , New Delhi, Reprint 2015.

08. Inorganic Chemistry by Gary L. Miessler, Donald A. Tarr, 3rd Edition, Pearson Education, Dorling kindersley (India) Pvt. Ltd. 21st impression 2015.
09. Chemistry of the Elements by N N Greenwood and A. Earnshaw ,2nd Edition school of chemistry University of Leeds , 1st published by Pergamon press plc 1984, Reprinted 2001, 2002, 2003(twice),2005.

CHIPr -1.6 **INORGANIC CHEMISTRY PRACTICALS-I**

Duration: 4 h/ week & Total: 64 h **Credits : 2**

Part A. Ore Analysis:

01. Haematite: Iron by volumetric (potassium dichromate and Ceric ammonium sulphate) method and by colorimetric method
02. Pyrolusite: Determination of manganese dioxide in pyrolusite using permanganate titration
03. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.

Part B. Alloy Analysis :

04. Quantitative analysis of Copper-Nickel in alloy /mixture:
05. Copper volumetrically using KIO_3.
06. Nickel gravimetrically using DMG
07. Quantitative analysis of Copper-Zinc in alloy/mixture:
    i. Copper gravimetrically as Cu(I) thiocyanate.
    ii. Zinc by volumetrically by EDTA method

Part C. Determination of COD and BOD of polluted water.

REFERENCE Books:

1. Vogel's Textbook of Quantitative chemical analysis, - J Mendham, R.C. Denney, J.D. Barnes M.J.K. Thomas, peason education, india. 3rd, 4th , 5th and 6th edition.2008
2. Vogel's Quantitative Inorganic analysis , 7th edition G. Svehla , B.Sivasankar, pearson education, India.
3. Practical Inorganic Chemistry, - K. Somashekara Rao, Chennupati Venkata Suresh.BPS books,2019.
4. Principles of Inorganic Chemistry,- Puri, Sharma, Khalia.Mlestone publishers & distributors, 2014.

CHOT-1.2 : ORGANIC CHEMISTRY-I

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT-I **16 h**

BASIC CONCEPTS AND REACTION MECHANISM

Concept of hybridization: sp^3, sp^2, sp – with examples.
Electronic effects: Inductive, electronic, resonance and hyperconjugation.
Classification of organic reagents and reactions.
Reactive Intermediates: carbocations, carbanions, free radicals, carbenes, nitrenes, and arynes- their formation, stability, structure and reactions.
Organic acid and bases: Effect of substituents with examples
Reaction Mechanism: Classification, determination of reaction mechanism by kinetic and non-kinetic-methods.
Kinetic Method: Mechanistic implications from rate laws, the transition state theory, ambiguities ininterpreting kinetic data, solvent effect, ionic effect, isotopic effect, solvent isotopic effect, substituent effect, steric effect, linear free energy relationships–Hammett equation and Taft treatment.
Non-kinetic methods: Energy profile diagram, identification of products, testing possible intermediates, trapping of intermediates, cross over experiments, isotopic labeling, stereochemical studies, limitations.

Self study (SS): Basic of atom, molecules, hybridization, ionization energy, electron affinity, electronegativity, delocalization, Bohr theory, Aufbau principle, steric effect, rate of reaction, activation energy, isotopes, stereochemistry.

Skill components: Free radical- ESR spectra of some of the molecule analysed. Carbocation- isolated compound list and analysis.

UNIT-II **16 h**

ADDITION AND ELIMINATION REACTIONS

Addition reactions: Types of addition reactions, mechanism and stereochemistry of addition, effect of substrates and solvents during addition. Addition to Carbon-Carbon double bond-addition of hydrogen halide(Markonikov's rule), bromine. Addition to carbon-hetero multiple bonds (C=O)-Introduction, structure and reactivity, HCN, bisulphate, Grignard reagent, hydride, amino compounds, alcohols and thiols.
Elimination reactions: Introduction, types of elimination-E_1, E_2, E_{1CB} mechanisms, orientation during elimination reactions-Saytzeff and Hoffmann rules, pyrolytic eliminations, Chugave, Cope eliminations, Hoffmann degradation and dehalogenation of vicinal di halides, substitution v/s elimination with suitable example.

Self study (SS): Basics of saturated and unsaturated compounds, Markonikov's and anti-Markovnikov's rule, electrophiles and nucleophiles, geminal and vicinal compounds, difference between addition and elimination reactions.

Skill components: Analyse some addition and elimination product by FT-IR , UV-vis and NMR spectra available from open access/recorded.

UNIT-III **16 h**

SUBSTITUTION REACTIONS

Aromatic electrophilic substitution reactions: General mechanism of electrophilic substitution in aromatic systems using examples of nitration, halogenations, sulphonation and Friedal Craft alkylation and acylation.

Orientation effect of disubstitution in aromatic systems with suitable examples.

Nucleophilic substitution at saturated carbon: Mechanism of S_N1, S_N2, S_Ni reactions–effect of solvent, substrate and leaving group, neighboring group participation, substitution at vinylic and allylic carbon.

Aromatic nucleophilic substitution reactions: Substitution of hydrogen, substitution other than hydrogen, S_NA_r reactions, S_N1, S_N2 and benzyne mechanism, Bucherer reaction.

Self study(SC): Basics of Aromaticity, electrophiles and nucleophiles, electron withdrawing and electron releasing groups and their examples, difference between solute and solvents, vinylic and allylic groups, acids and bases, saturated and unsaturated carbons, stereochemistry (retension & inversion), rate of reaction and activation energy.

Skill components(SC): SN^1, & SN^2 products may be analyzed by polarimeter method and record and analyzed nitration and halogenation products using UV-Vis and FT-IR.

UNIT-IV **16 h**

STEREOCHEMISTRY

Optical isomerism: Concepts of chirality-symmetry elements and cause for optical activity, chiral structures, relative configuration- Fischer's DL notation, threo and erythro nomenclature , absolute configurations- R, S nomenclature.

Molecular presentation: Sawhorse, Newman, Fischer and fly wedge formulae, enantiomers, epimers, anomers, recemic mixtures, resolution of racemic mixtures- Mechanical, biochemical and chemical method.

New methods of asymmetric synthesis: using optically active reagents, optically active substrates and optically active catalysts with suitable examples.

Enantio selective synthesis and diastereo selective synthesis.

Conformational analysis: Simple acyclic systems (butane, 1,2-dichloroethane) and cyclic systems(chair and boat forms of cyclohexane), effect of conformation on reactivity in acyclic and cyclic systems with suitable examples, stereoisomerism in biphenyls, allenes, and spirans.

Geometrical isomerism: Cis-trans, E-Z and syn-anti notations for geometrical isomers, geometrical isomerism in substituted alkenes, oximes, monocyclic and fused and bridge ring system, determination of configuration of geometrical isomers-physical and chemical methods.

Self study(SS):Basics of stereochemistry, classification, Isomerism, optical activity, chiral compounds, priority order, cis-trans, dextro-levo, oxidizing and reducing agents, plane of polarization.
Skill components(SC): Students need to create suitable model for R & S configuration by stick & ball method. Dextro & leavo rotation of some samples record/analyzed by suitable data.

REFERENCE BOOKS:

01. Organic reaction mechanisms- V.K. Ahluwalia, R.K. Parashar, 4rt Edition, Narosa Publishing House, New Delhi, Chennai, Mumbai, Kolkata 2011.
02. Organic chemistry , Jonathan clyden, Nick Greeves and Stuart warren. 2nd edition , Oxford university press , UK 2014.
03. Organic reaction and their mechanisms- P.S. Kalsi, 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2007.
04. Organic chemistry- R.T. Morrison, R.N. Boyd, 6th Edition, Pearson India 2017.
05. Solomons *Organic chemistry- T.W.Graham solomons, Craig B.* Fryhle, Scott A.Snyder, golden edition, Wiley . Reprint 2017.
06. Solomons and Fryhles Organic chemistry 10th Stereochemistry of Organic compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley & Sons, 1994.
07. Stereochemistry of Organic compounds- Principles and applications, Nasipuri, D, Revised 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2009.
08. Advanced organic chemistry, Jerry March, 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2008.
09. P. J. Garratt in Comprehensive organic chemistry, D. Barton and W. D. Ollis, 1st Edn. Pergamon Press, Oxford, 1979.
10. Organic photochemistry, J. M. Coxon and B. Halton, 1st Edn, Cambridge Univ. Press, London, 1974.
11. Molecular reactions and photochemistry, C. H. Deputy and D. S. Chapman, 1st Edn. Prentice-hall India, New Delhi, 1972.
12. Organic Chemistry,volume 1, New age, S.M. Mukherji, S.P.Singh, R.P.Kapoor, R.Dass.

CHOPr-1.7: ORGANIC CHEMISTRY PRACTICAL-I

Duration: 4 h/ week & Total: 64 h **Credits : 2**

TWO STEP PREPARATIONS

01. Preparation of acetanilide from aniline
02. Preparation of p-bromoacetanilide from acetanilide
03. Preparation of hydrolysis of p-bromoacetanilide to p-bromoaniline
04. Preparation of p-nitroacetanilide from acetanilide
05. Preparation of hydrolysis of p-nitroacetanilide to p-nitroaniline
06. Preparation of bezoic acid from benzaldehyde
07. Preparation of 2-hydroxynaphthaldehye from 2-naphthol
08. Preparation of 2,4,6 tribromo benzene from aniline
09. Preparation of phenylazo-β-naphthol
10. Preparation of 1-phenyl-3-methyl-pyrazolone

NOTE : Two preparations are to be given for Practical Examinations.

REFERENCE BOOKS:

01. Vogel's Text Book of Practical Organic Chemistry, Brian S , Furniss, Anthony j. Hannaford, 5th Edition, Pearson India, 2005.
02. Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India,2011.
03. Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
04. Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
05. Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
06. Laboratory techniques in Organic chemistry-V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt.Ltd.
07. Laboratory Manual of Organic Chemistry Raj K. Bansal. 5th edition, New Age international publishers, 2008.

CHPT-1.3 : PHYSICAL CHEMISTRY-I

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I **16 h**

QUANTUM CHEMISTRY-I

A brief resume and comparative studies of classical and quantum mechanical phenomenon, Summarization of the results of some experiments (black body radiation, Plank quantum theory, term symbols), Photoelectric and Compton effects. Davison and Germer experiment, Franck-Hertz experiment, Young's double slit experiment. Derivation of Bohr's principle of quantization of angular momentum of electron from de-Broglie's relationship, consequences of de-Broglie equation, de-Broglie concept (To be derived). Uncertainty principle, mathematical expression for uncertainty principle. Postulates of quantum mechanics, operators, algebra of operators, ψ properties. Hamiltonian operators and their properties, Schrödinger's equation (with respect to space and time time). Physical significance of and characteristics of wave function, eigen function and eigen values, probability distribution function, normalization of ψ, orthogonality of ψ boundary valued condition. Application of equation to one dimension box.

Self Study: Basic study about quantum and classical chemistry, study postulates of quantum chemistry, learning linear algebra.

Skill Component: Installation and operating DFT Software.

UNIT-II **16 h**

THERMODYNAMICS-I

Review of basic principles of thermodynamics (I and II laws of thermodynamics, concept of free energy and entropy, combined form of first and second laws of thermodynamics. Entropy change during spontaneous process. Helmholtz and Gibbs free energies. Thermodynamic criteria of equilibrium and spontaneity. Variation of free energy with temperature and pressure. Third law of thermodynamics-calculation of absolute entropies. Real gases and fugacity, Variation of fugacity with temperature and pressure. Thermodynamics of dilute solutions: Raoult's law, Henry's law. Ideal and non-ideal solutions: Liquid-liquid solutions, liquid-solid solutions, multicomponent systems and excess thermodynamic properties. Maxwell's relation (to be derived). Thermodynamic equations of equipartition of energy, Classius-Clapeyron equation (to be derived) and its application. Entropy of vaporization. Vant-Hoff's equation, integrated form of van't Hoff's equation. (problems to be solved).

Self Study: Study terms used in chemical thermodynamics, standard units of measurement of length, weight, time and capacity, zeroth law thermodynamics.

Skill Component: Temperature dependent chemical reactions, explaining state and path functions.

UNIT–III **16 h**

ELECTROCHEMISTRY –I

Arrhenius theory of strong and weak electrolytes and its limitations, theory of ionic conductance in solutions, ionic atmosphere, relaxation and electrophoretic effects, Debye-Huckel theory of strong electrolytes, Debey-Huckel-Onsagar equation(derivation) and Debey-Huckel limiting law(derivation), quantitative and qualitative treatment of Debye-Huckel limiting law, Onsagar activity co-efficient, mean ionic strength (Debey-Huckel limiting law). A brief survey of Helmholtz-Perrin, Gouy-Chapman and Stern electrical double layer (No Derivation). Liquid junction potential and its determination. Fundamentals of batteries, classification of batteries, battery characteristics, primary batteries, dry cell, alkaline MnO_2 batteries and other batteries, secondary batteries-lead acid, alkaline storage batteries and fuel cells types and applications.

Self Study: Redox reactions, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's law, electrolysis and law of electrolysis (Elementary idea)

Skill Component: Cyclic Voltammetric Study of ferrocyanide/ferricyanide Redox couple.

UNIT–IV **16 h**

POLYMER AND DENDRIMER CHEMISTRY: Basic concepts: Monomers, polymers and degree of polymerization, general classification of polymers, homopolymers, copolymers, terpolymers. Polymer molecular weight: Number average and weight average molecular weights, polydispersity and molecular weight distribution in polymers. Viscoelastic behavior of polymers (Stress Strain curve). Addition polymers and condensation polymers, comparison between thermoplastics and thermosetting polymers. Transition in Polymers: Definition of glass transition temperature (Tg) and flow temperature (Tf) and melting temperature (Tm). Thermal behavior of amorphous and crystalline polymers, factors affecting Tg. Plasticizers, properties and their effect on Tg of PVC. Comparison of Tg and Tm, Tg of copolymers and polymer blends, relation between Tg and Tm. Preparation, properties and commercial importance: polyethylene, polystyrene, polyvinyl chloride, poly sulphone, polyurethances, polyisoprenes. Metallocene catalysis polymerization (Ziegler-Natta polymerization). Methods of polymer fabrications, Fabrication of shaped polymer objects, Spinning industrial polymers. **Dendrimers and hyper-branched polymers:** Introduction to dendrimers, methods of preparation, common properties and applications. Synthesis of polyamidoamines using devergent route and dendratic polyether macromolecules using convergent route.

Self Study: Study of polymers in everyday life. Physical and Chemical properties of Polymers.

Skill Component: Visiting polymer industries around Belgaum

REFERENCE BOOKS:

01. Physical chemistry –Moore,Orient Longman, 5th edition, Longman publishing group(January 1, 1998).

02. Principle of polymer science, by Bhahadur and N.V Sastry, 2nd addition Alpha science international, 2005.
03. An introduction to Chemical Thermodynamics –R. P.Rastogi and R.R.Misra, Vikas, Delhi, 1978.
04. Thermodynamics, Statistical Thermodynamics and Kinetics- Thomas Engel and Phillip Reid, 3rd edition, Pearson publication.
05. An introduction to Electrochemistry – Samuel Glastone, Read books Ltd, 2011.
06. Electrochemistry principles and applications – D. R Crow, 4th edition, CRC Press (30 September 1994).
07. Modern electrochemistry Vol. I and II, by J.O.M. Bockris and A.K.N. Reddy, Pentium Press, New York (1970).
08. Industrial Electrochemistry–D. Pletcher and F.C. Walsh, Chapman, II Edition, 1984
09. Molecular Quantum Mechanics – Peter Atkins and Ronald Friedman, 5th edition, Oxford university press (11 May 2012).
10. Quantum Chemistry- Anintroduction- W Kauzmann, Academic Press Inc,(1st December 1957).
11. Quantum Chemistry-R.K. Prasad, 2nd Edition, New Age Int-2001

CHPPr-1.8 PHYSICAL CHEMISTRY PRACTICALS-I

Duration: 4 h/ week & Total: 64 h **Credits : 2**

1. **Conductometry**
   - **a.** Acid mixture versus NaOH
   - **b.** Weak acid with salt versus NaOH
   - **c.** Strong acid with salt versus NaOH
   - **d.** To determine the acidic and basic dissociation constant of an amino acid and determination of isoelectric point by pH metry.
   - **e.** Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.
2. **Potentiometry**
   1. $K_2Cr_2O_7$ versus FAS
   2. Acid mixture versus NaOH
   3. $KMnO_4$ versus FAS
   4. Determination of dissociation constant of H_3PO_4 using potentiometric method.
   5. Determination of pKa value of phosphoric acid by pH meter.

REFERENCE BOOKS:

1. Advanced Physico-Chemical Experiments–J.Rose,John Wiley, Newyork(1964).
2. Practical Physical Chemistry –B. Viswanathan, P.S.Raghvan, MV Learning publisher.
3. Advance Practical Physical Chemistry – J.B.Yadav, 30th edition, Krishna prakashan media.
4. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
5. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill

CHGT-1.4 SPECTROSCOPY-I

Teaching: 2 h/ week & Credits : 2 **Total: 32 h**

UNIT–I **16 h**

MICROWAVE and RAMAN SPECTROSCOPY

Electromagnetic radiation: Interaction of radiation with matter-absorption, emission, reflection, refraction, transmission, dispersion, polarization, interference and scattering, natural line width and broadening (Doppler effect), Heisenberg uncertainity and intensity of spectral lines, regions of electromagnetic spectrum and their corresponding energies: rotational, vibrational and electronic transitions and their energy levels.

Microwave spectroscopy: Diatomic molecules**-r**igid and non rigid rotatormodel(No derivation), rotational quantum number and the selection rule, effect of isotopic substitution on rotation spectra, relative intensities of the spectral lines, classification of polyatomic molecules based on moment of inertia-linear, symmetric top, asymmetric top and spherical molecules, rotation spectra of polyatomic molecules(CO_2, CH_3F and BCl_3), moment of inertia expression for linear tri-atomic molecules, experimental techniques-microwave spectrometer, applications-principles of determination of bond length and moment of inertia from rotational spectra and determination of dipole moments.

Raman spectroscopy: Introduction, Raman and Rayleigh scattering, Stokes and anti-Stokeslines, polarization of Raman lines, depolarization factor, polarizability ellipsoid, theories of Raman spectra-classical and quantum theory, comparison of Raman and IR spectra, rule of mutual exclusion principle, advantages of Raman spectra.

Self study(SS): Basic of emission, reflection, refraction, transmission, dispersion, polarization, scattering, Doppler effect, Heisenberg uncertainity,diatomic molecules**,** isotopes, polyatomic molecules, moment of inertia, tri-atomic molecules, bond length anddipole moments. Basic of Raman Theory, polarisability

Skill component (SC): Raman spectral studies of any two compounds.

UNIT–II **16 h**

UV-VISIBLE and INFRARED SPECTROSCOPY

UV-visible spectroscopy: Types of transitions and their theoretical interpretation, Beer's law, Lambert's law, Beer's-Lambert's law, limitations, chromophores, auxochromes, effect of substituents on the position of λmax, prediction of λmax for polyenes, α,β-unsaturated aldehydes and ketones (Woodward- Fisher rules), aromatic systems and their derivatives. basic components of instrumentation-single and double beam designs, applications-analysis of binary mixtures, measurement of dissociation constants of acids and bases.

IR spectroscopy: Vibration of diatomic molecules, vibrational energy curves for simpleharmonic oscillator, effects of anharmonic oscillation, vibration-rotation spectra of carbon monoxide(No derivation), expressions for fundamental and overtone frequencies, vibrations of polyatomic molecules–The number of degrees of

freedom of vibration, , modes of vibration(CO_2 and H_2O), fundamental, overtone, combination, hot bands, Fermi resonance, force constant and its significance, theoretical group frequency, intensity of absorption band and types of absorptions, identification of functional groups- alkanes, alkenes, aromatics, carboxylic acids, carbonyl compounds(aldehydes and ketones, esters), amides and amines, fingerprint region, vibrational coupling, hydrogen bonding, steric effect and ring strain.

Self study(SS): Basic of Self study(SS): Basic of Beer's law, Lambert's law, Beer's-Lambert's law, chromophores, auxochromes, binary mixtures, IR spectroscopy, Quantum theory of IR spectroscopy and Polarity of bond.
Skill component (SC): Selected organic compounds may record UV-vis absorption of benzophenone, benzaldehyde and substituted compounds. And student need to study, how to calculate molar extinction co-efficient (ε), λ_{max} and concentration of some of the molecules/proteins.
Selected six organic compounds may record FT-IR and analysed complete spectrum of stretching and bending.

REFERENCE BOOKS:

1. Introduction to Spectroscopy. Pavia, Lampman , Kriz, Vyvyan 5th edition, cengage learning India private limited ,2015.
2. Spectroscopy of organic compounds – P. S. Kalasi, 6 th edition New age international publishers. Reprint 2005.
3. Modern spectroscopy by J.Michael Hollas , published by John Wiley& sons, Ltd. 2004.
4. Elementory Organic spectroscopy – Principles and applications– by Y.R.Sharma, publishers- S.Chand & company PVT.LTD. New Delhi , revised edition 2013.
5. Organic Spectroscopy, William Kemp, 3rd edition, Palgrave, reprinted 2008.
6. Organic Spectroscopy, 1nd edition– Jag Mohan, Narosa Publishing House
7. Vibration Spectroscopy Theory and Applications, D. N. Satyanarayana, New age International(P) Limited publishers New Delhi, reprint 2005. .
8. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash. 4th edition, Tata McGraw-Hill, India, New Delhi, 2017.
9. Application of absorption spectroscopy of organic compounds, John R. Dyer, prentice- Hall of India Pvt.Ltd. 2007.
10. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw-Hill, New York
11. Physical methods in inorganic chemistry – R. Drago, 2 nd edition , Saunders college pub. 1992.
12. Instrumental methods for chemists – Gurdeep Chatwal, Himalaya publication house , 2012.
13. Applications of IR and Raman spectroscopy to coordination and organometallic compounds, K. Nakamoto, 2008.

CHES-1.5: ANALYTICAL CHEMISTRY

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT-I **16 h**

DATA ANALYSIS

Classification of analytical methods: Types of instrumental analysis, analytical methods on the basis of simple size. Errors, types of errors, determinate and indeterminate errors, accuracy and precision. Distribution of random errors, frequency distributions normal error curves. Statistical treatment of finet samples, measure central tendency -mean, medium, range, average deviation, relative average deviation, standard deviation and variance. Students' confidence interval of the mean. Testing for significance, comparison of two means and two standard deviations. Criteria for rejection of an observation-Q test, control chart, propagation of errors, significant figures. Least square methods of deriving calibration of plots. Principles of sampling the sampling step. Methods for sampling solid, liquid and gaseous samples. Effect of sampling uncertainties. Sampling hazards, need for quality assurance: ISO 9000 series of quality of system.

Self study(SS): Basics of analytical errors, accuracy, precision and sampling method.

Skill components(SC): Students should able to identify the errors occurred during the volumetric (Ore/ Alloy) analysis by laboratory method.

UNIT–II **16 h**

CHROMATOGRAPHY

Introduction, Principles, classifications, fundamentals of chromatography (Partition coefficient, Retardation factor, retention volumes), Dynamics of chromatography (Efficiency, zone spreading, eddy diffusion) chromatograms, retention time and column efficiency, plate theory and rate theory, Van-Deemeters equation, column resolution, factors influencing resolution.

THIN LAYER CHROMATOGRAPHY

Introduction, stationary and mobile phase systems, Rf value calculation, various technique of developments, visualization and applications.

ION EXCHANGE CHROMATOGRAPHY

Introduction, principle, classification of ion exchange resins, mechanism of ion exchange,synthesis of ion exchange resins (cation and anion), characteristics of ion exchange resins (size, capacity, cross linking and swelling and resistance) applicationsin analytical and metal separations.

HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Introduction, principles, instrumentation, mobile phase, stationary phase, types of column, various detectors used, and applications.

Self study(SS): Basic fundamentals of chromatography, TLC, HPLC and ion exchange chromatography.

Skill components(SC): Prepare the TLC plates , analyse the mixtures , identify and check the purity of compound.

UNIT–III **16 h**

SEPERATION TECHNIQUES and THERMAL METHODS OF ANALYSIS

Solvent Extraction: Definition, types, principle and efficiency of extraction, sequence of extraction process, factors affecting extraction-pH, oxidation state, modifiers, synergistic, masking and salting out agents, techniques-batch and continuous extraction, applications, Separation of lanthanides.

Electrophoresis: Introduction, types and techniques of electrophoresis, factor affecting migration of ions, continuous electrophoresis, thin layer electrophoresis, moving boundary electrophoresis, zone electrophoresis, and Curtain electrophoresis, reverse osmosis electro dialysis, capillary electrophoresis and applications.

Thermal Methods of Analysis: Introduction, thermogravimetric analysis (TGA), types of thermogravimetric analysis, principle and method, automatic thermogravimetric analysis, instrumentation, types of recording thermobalances, sample holders, factors influencing thermograms and applications, isothermal analysis, Differential Thermal Analysis (DTA), principle of working, theory and instrumentation, simultaneous DTA-TGA curves, factors affecting results and applications. Differential Scanning Colorimetry(DSC), principle of working, theory, instrumentation and applications. Types of titrations and gravimetric analysis.

Self study(SS): Basics of extraction, electrophoresis, TGA, DTA, DSC.

Skill components(SC): Students should do the binary mixture separation by using separation technique(Solvent extraction).

UNIT–IV **16 h**

ELECTROANALYTICAL TECHNIQUES

Introduction, electrochemical cells, faradic and non-faradic current, mass transfer in cells, galvanic and electrolytic cells, anodes and cathodes, liquid junction potential, schematic representation of cells.

Polarography: Theory, principle and applications classical polarography, dropping mercury electrode, polarogram, polarographic measurements, polarographic current, Ilkovic equation, current and concentration relationship, half wave potential, oxygen interference- advantages and limitations. Qualitative and quantitative analysis. Derivative polarography.

Amperometry and Coulometry at controlled potential and at constant current.

Cyclic voltametry - basic principles, instrumentation and applications, stripping voltammetry and its applications including Electro -organic synthesis.

Electrogravimetry - theory, electrode reactions, over-voltage, characteristics of a good deposit, completeness of deposition, Determination of copper and nickel in Cu-Ni alloy.

Self study(SS): Basics of electrochemical cells, galvanic and electrolytic cells, polarography, Qualitative and quantitative analysis.
Skill components(SC): Students need to do the chemical analysis of the given reducible / oxidizable substances using polarogram.

REFERENCE BOOKS:

01. Principle of Quantitative Chemical Analysis – Robert de levie, International edition (1997) McGraw Hill Co.
02. Quantitative Analysis- Day and Underwood, Prinitce Hall Indian, Pvt Ltd 6thedition (1993).
03. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhm and R.C. Denney ELBS 5thedition (1998).
04. Quantitative Chemical Analysis: D.C Harris W.M. Freeman and Co, NY, USA, Ed, (1995).
05. Physical Methods in Inorganic Chemistry- R. Drago, Affiliated to East west Pvt, (1968).
06. Introduction to chromatography- theory and practice-V.K. Srivastava and K.K.Srivastava, S. chand Company Ltd., IV Ed (1991).
07. Basic Concepts of analytical Chemistry- S.M Khopkar, New Age Intentional Publishers, IIEd.,(1998).
08. Analytical chromatography- G.R Chatwal, Himalaya Publishing House, VII Ed., (1998).
09. Principles of Instrumental Analysis, D.A. Skoog, E.J. Holler, T.A. Nieman, 5th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
10. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, E.J. Holler, S.R. Crouch, 8th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
11. Introduction to Chromatography- Theory and Practice**,** V.K. Srivatsan and K.K. Srivatsan, S. Chand Company Ltd. 4th Edition (1991).
12. Analytical Chemistry – Theory and Practice,, R.M. Verma, 3rd Edition, CBS Publishers ,New Delhi, India, 2012.

M.Sc. in CHEMISTRY @ RCU
SECOND SEMESTER

CHIT-2.1: INORGANIC CHEMISTRY-II

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I **16 h**

SYMMETRY AND GROUP THEORY

Molecular symmetry: Symmetry elements and symmetry operations, rotation axis, rules for orientation of molecules, plane of symmetry, rotation-reflection axis, centre of symmetry and identity element of symmetry, products of symmetry operations, general relations among symmetry elements and symmetry operations.

Group theory: Concept of a group, definition of a point group, procedure for classification of molecules into point groups, subgroups, Schoenflies and Hermann-Maugin symbols for point groups, multiplication tables for the symmetry operations of simple molecules, matrix notation for the symmetry elements and for geometric transformations, class of a group and similarity transformation.

Representation of groups: Reducible and irreducible representations, Great Orthogonality theorem and its consequences, labeling of irreducible representations, group theory and hybrid orbitals to form bonds, character tables (Cs, Ci, C2, C2v and C3v).

Applications of group theory: Applications of group theory to crystal field theory, bonding in octahedral and tetrahedral complexes, symmetry and dipole moments, symmetry and optical activity.

Self study: Finding the symmetry elements in compounds with higher CN (> 6)
Skill component: Construct the ball and stick model of any chairal compound and deduce the representations.

UNIT–II **16 h**

COORDINATION CHEMISTRY-REACTIONS, KINETICS AND MECHANISMS

Types of mechanisms in substitution reactions-dissociation, interchange and association.

Metal-ligand equilibria step-wise and overall stability/formation constant, factors affecting stability of metal complexes. Determination of stability constant by spectrophotometric (Job's) method.

Reactions and kinetics of substitution in square planar complexes: Trans effect, substitution reactions. Rate law and mechanism of nucleophilic substitution in square planar complexes, thermodynamic and kinetic stability.

Reactions and kinetics of substitution in octahedral complexes: Ligand field effects and reaction rates, mechanism of substitution in octahedral complexes, reaction rates influenced by acid and base, mechanism of redox reactions-outer sphere and inner sphere mechanisms. Marcus theory, photochemistry of metal complexes-types of photochemical reactions, photo-substitution and photo-redox reactions and excited

state outer sphere electron transfer reactions (solar energy conversion), complimentary and non-complimentary reactions.

Self study: Fundamental of Solar cell and its reaction mechanism.
Skill component: Find the rate law of substitution reaction using UV-Vis spectrophotometer.

UNIT–III **16 h**

SOLID STATE AND STRUCTURAL CHEMISTRY

Types of solids, close packing of identical solid spheres, tetrahedral and octahedral voids, packing fraction, radius ratio.

Crystallographic systems: Bravias lattices, Miller indices, external features of crystals.

Structures of selected crystals: normal and inverse spinels, hexagonal structures, pervoskites.

Defects in solids: Point defects (stoichiometric and non-stoichiometric), line defects and plane defects, stacking faults and grain boundaries.

Structural transformation of solids

Solid solutions : Hume – Rothery rules, substitutional solid solutions and interstitial solid solutions, solid solution mechanism.

Alloy systems: Phase diagram and their features with respect to alloys - two and three component systems, copper–zinc system, steels with reference to iron-carbon systems.

Self study: X-ray diffraction technique for powder sample and single crystal.
Skill component: Indexing of XRD pattern of a cubic system.

UNIT–IV **16 h**

NUCLEAR CHEMISTRY

Radioactivity, nuclear reactions, nuclear power reactors–radioactivity, determination of half life, radioactive decay kinetics, parent-daughter decay-growth relationships, secular and transient equilibria, nuclear reactions, spallation, nuclear fission and fusion, types of nuclear power reactors, basic features and components of a nuclear power reactor, safety measures, an introduction to breeder reactors, applications of radioisotopes-synthesis of various useful radioisotopes, physico-chemical and analytical applications-isotope dilution method, activation analysis, radiometric titration and ^{14}C dating, medical, agricultural and industrial applications of isotopes.

RADIATION CHEMISTRY

Interaction of matter with radiation, radiation dosimetry-units and measurement of chemical dosimeters (Fricke and ceric sulphate dosimeters), radiation chemistry of water, a brief introduction to radiolysis of liquids and solids, industrial applications of radiation chemistry (radiation polymerization, food irradiation and radiation synthesis).

Health and Safety Aspects: Biological effects of radiation, hazards in radiochemical work, radiation protection, decontamination procedures, permissible exposure doses, nuclear waste management including waste storage and disposal procedures.

Self study: Safety measures from radiation field
Skill component: Measuring the radioactivity present in standard sample using GM counter OR construct the Fricke dosimeter and measure the absorbed radiation.

REFERENCE BOOKS:

01. Symmetry and Spectroscopy of Molecules by K. Veera Reddy, New Age International(P) Ltd.
02. Chemical Applications of Group Theory by F. A. Cotton, 3rd Edition, John Wiley & Sons.
03. Group theory and its Chemical Applications by P. K. Bhattacharya Himalaya publishing house.
04. Inorganic Chemistry: Principles, structure and reactivity, by J. E. Huheey, Ellen Keiter, Richard A Keiter and Okhil K Medhi, 4th edition, Pearson publication.
05. Inorganic Chemistry, by C. E. Housecroft and A. G. Sharpe, 4th edition Pearson publication.
06. Inorganic Chemistry by Keith F. Purcel and John C. Kotz, Saunders, 1977.
07. Concepts and Models of Inorganic chemistry by Bodie Douglass, John Alexander and Darl Mcdaniel, 3rd edition, John Wiley and Sons.
08. Inorganic Chemistry by Gary L Miessler and Donald A Tarr, 3rd Edition, Pearson Publication.
09. Introduction to Solids by Leonid Azaroff, 33rd reprint edition, McGraw Hill Education Pvt Ltd.
10. Solid State Chemistry and its Applications by Anthony R. West, John Wiley and Sons.
11. Solid State Chemistry: An Introduction by Lesley E. Smart and Elaine A. Moore, 3rd edition, CRC Press(24 June 2005).
12. Fundamental concepts of Inorganic Chemistry by A. K. Das, volume 1 to 7.
13. Essentials of Nuclear Chemistry by H.J. Arnikar, Eastern Wiley (1990).
14. Nuclear Chemistry by U.N. Dash, Sultan Chand and Sons (1991).
15. Nuclear Chemistry by Friedlander and Kennedy, John Wiley and Sons (1987)

CHIPr-2.6: INORGANIC CHEMISTRY PRACTICAL-II

Duration: 4 h/ week & Total: 64 h **Credits : 2**

Part A. Qualitative analysis:
Qualitative analysis of at least FIVE ternary mixtures containing one rare cation and one interfering anion.

Part B. Preparation of complexes:

01. $K_3[Al(C_2O_4)_3]$ $3H_2O$ & $[Cu(thiourea)_3]_2$ SO_4. H_2O
02. Estimation of Copper in tristhiourea copper (I) sulphate by Iodometric method

REFERENCES:

1. Practical Inorganic Chemistry by Shikha Gulati, JL Sharma and Shagun Manocha, CBS Publication.
2. Vogel's Qualitative Analysis, Seventh edition, by Svehla G, Pearson India.
3. Inorganic qualitative analysis in the Laboratory, 1st edition, by Clyde Metz, Academic Press.
4. W. L. Jolly, Modern Inorganic Chemistry, McGraw, Hill Co., 1984.
5. M. Day and J. Selbin, Theoretical Inorganic Chemistry, 2nd edition, Von. Nostrand, 1980.
6. H. J. Emeleus and J. J. Anderson, Modern Aspects of Inorganic Chemistry, Von. Nostrand, 1962.

CHOT-2.2: ORGANIC CHEMISTRY-II

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT-I **16 h**

NAMED REACTIONS

C-C bond forming reactions: Aldol condensation, Dickmann condensation, Stobbe condensation, Micheal addition, Perkin reaction, Reimer-Tiemann reaction, Reformtsky reaction, Wittig reaction, Mannich reaction, Shapario reaction.

C-N bond forming reactions: Chichibabin reaction, Barton reaction, Hofmann-Loffler-Freytag reaction, Stork enamine reaction.

C-O bond forming reactions: Sharpless asymmetric epoxidation, Bayer-Villeger reaction.

C-Cl bond forming reaction: Hell-Volhard-Zelinski reaction.

Self study(SS): Basic of reaction mechanisms, addition, substitution and rearrangement reactions. Stereochemistry.

Skill components:Aldol condensation, Michel addition & HVZ reaction products are analyzed by spectroscopic (FT-IR, UV-Vis and NMR spectroscopy) available from online sources.

UNIT-II **16 h**

OXIDATION AND REDUCTION REACTIONS

Oxidation reactions: Introduction,Oxidation reactions examples and applications of chromium series-$K_2Cr_2O_7$, PDC, PCC, Sorret and Jones reagents. Manganese compounds-$KMnO_4$, MnO_2.

Oxidation reactions involving ozone, peracids, lead tetraacetatate, periodic acid, osmanium tetroxide, selenium dioxide, Oppenauer oxidation.

Reduction reactions: Introduction, Catalytic hydrogenation-both heterogeneous (examples Nickel and palladium) and homogeneous, metal hydride reductions (NaBH4 and LiAlH4), reduction with dissolved metal, diimide reduction, Clemmensen, Wolf Kishner, Meerwin-Varley-Ponndorf reduction, Leukart reaction and reductions with diborane.

Self study(SS):Basics of oxidation and reduction, calculation of oxidation number, oxidizing and reducing agents with examples.

Skill components(SC):Oxidizing and reducing agents are identified with model reaction (two examples), and monitor reaction using TLC, UV-Vis and FT-IR.

UNIT –III **16 h**

REARRANGEMENT REACTIONS

Classification and general mechanistic treatment of nucleophilic, electrophilic and free radical rearrangements.

Rearrangement reactions involving migration to electron deficient carbon: Wolf, Wagner-Meerwein, Pinacol-pinacolone and Benzil-benzilic acid rearrangement.

Rearrangement reactions involving migration to electron rich carbon: Favorskii, Sommlet-Houser, Naber and Steven rearrangement.
Rearrangement reactions involving migration to electron deficient nitrogen: Hoffmann, Lossen, Curtius, Schmidt, Beckmann rearrangement.
Rearrangement reactions involving migration to electron deficient oxygen: Dakin, Bayer- Villiger and Hydroperoxide rearrangement.

Self study: Basics of rearrangement, nucleophiles, electrophiles and free radicals with examples, migration and rearrangement of atoms, electron rich and electron deficient atoms.
Skill components(SC):Students need to give one nucleophilic, electrophilic & free radical rearrangement reactions with suitable examples, analyzereactants and products using spectral data (record/online source).

UNIT-IV **16 h**

HETEROCYCLIC COMPOUNDS

Nomenclature of heterocyclic compounds-Hantz-Wiedamann system.
Synthesis and reactions of
3-Membered heterocyclic compounds – aziridines, azirines, oxiranes, oxirenes and thiiranes.
4-Membered heterocyclic compounds with one and two hetero atoms – azitidines, oxetanes and thietanes
6-Membered heterocyclic compounds with one and two hetero atoms – pyridine, pyrimidine, quinoline.
7-Membered heterocyclic compounds – azepines, oxepines, thiepines.

Self study(SS): Basics of heterocyclic compounds, nomenclature and examples, aromatic, non-aromatic and anti-aromatic compounds.
Skill components(SC):List out each heterocyclic ring contain drug molecule (one each) and give its biological applications with mechanism/mode of action.

REFERENCE BOOKS:

01. Understanding organic reaction mechanisms, A. Jacob, Cambridge Univ. Press, 1997.
02. Introduction to organic chemistry A. Streitweiser, Jr and C. H. Heathcock, Macmillan, 1985.
03. Physical and mechanistic organic chemistry, R.A.Y. Jones, 1st Edn. Cambridge Univ. Press, 1979.
04. Mechanisms of molecular migrations, Vols I and II, B. S. Thiagarajan, 1st Edn. Pergamon Press, Oxford, 1979.
05. P. J. Garratt in Comprehensive organic chemistry, D. Barton and W. D. Ollis, 1st Edn. Pergamon Press, Oxford, 1979.
06. Radicals in organic synthesis, B. Giese, Pergamon Press, 1986.

07. Stereoelectronic effects in organic chemistry, P. Deslongchamps, 1st Edn. Pergamon Press, 1983.
08. Organic photochemistry, J. M. Coxon and B. Halton, 1st Edn, Cambridge Univ. Press, London, 1974.
09. Molecular reactions and photochemistry, C. H. Deputy and D. S. Chapman, 1st Edn. Prentice-hall India, New Delhi, 1972.
10. Stereochemistry of carbon compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley & Sons, 1994.
11. Stereochemistry, Potapov, MIR, Moscow, 1984.
12. Stereochemistry, D Nasipuri, New Age Int, 1999.
13. Advanced organic chemistry, J. March, 4th Edn. John Wiley, 2008.
14. Organic Chemistry, R. E. Ireland Prentice-Hall India, New Delhi, 1975.
15. Some modern methods of Organic Synthesis, W. Caruthers, Cambridge Uni. Press London, 2nd Edn. 1998.
16. Stereochemistry of organic compounds- Principle and applications, D. Nasipuri, 2nd Edn., New Age International Publishers, 2001.

CHOPr-2.7: ORGANIC CHEMISTRY PRACTICAL-II

Duration: 4 h/ week & Total: 64 h **Credits : 2**

PART-A
ANALYSIS OF BINARY ORGANIC MIXTURE
Systematic qualitative analysis of binary mixture (solid+solid, solid+ liquid)
Chemical equations to be discussed for all tests.

PART-B
Fractional crystallization: Separation of mixture of naphthalene and biphenyl.
Fractional distillation: Separation of Mixture of benzene and toluene.
Thin layer chromatography: Separation of plant pigments.
Column chromatography: Separation of mixture of O & P-nitroanilines.

NOTE: Only experiments in PART-A are to be given in Practical Examination.

REFERENCES

01. Vogel's Text Book of Practical Organic Chemistry, 5th Edition by Brian S.Furniss, Antony J. Hannaford, Peter W.G. Smith and Austin R. Tatchell, John Wiley & Sons, New York.
02. Advanced Practical Organic Chemistry by N.K. Vishnoi, Vikas, Publishing House, 1979.
03. A Handbook of Organic Analysis Qualitative and Quantitative, 4th Edition by Hans Thacher Clarke, CBS Publishers.
04. Advance Practical Organic Chemistry by O.P. Agrawal, Krishnna Prakashan Media (P) Ltd, 2014.
05. Practical Organic Chemistry 4th Edition, by F G Mann and B C Saunders, Pearson India.

CHPT-2.3: PHYSICAL CHEMISTRY-II

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT-I **16 h**

QUANTUM CHEMISTRY-II

One dimensional simple harmonic oscillator in classical mechanics and quantum mechanics, wave functions of the harmonic oscillators, the applications of Schrödinger's equations to the H atom derivation (separation of R, θ, φ equations and their solutions). Quantum number and their characteristics. Approximate methods in quantum mechanics, variations method, linear and non linear variation functions, application to the He atom, ant symmetric and asymmetric exclusion principle, Slater's determination wave functions, Morse Potential Curve, terms symbols and spectroscopic status. Hydrogen like wave functions, angular and radial wave functions and its application to hydrogen atom, general equation and general determination, application of variation method to hydrogen molecule, ion and normal and degenerate states, Orbital diagram need for variation methods. Perturbation theory, first and second order perturbation theory and its application to linear harmonic oscillator.

Self study (SS): Study history of quantum mechanics, overview of Electronic structure of the molecule, VBT, MOT and Density functional theory.

Skill Component (SC): Brief explanation and experimental results on Density Functional Theory (DFT).

UNIT-II **6 h**

STATISTICAL THERMODYNAMICS-II

Statistical thermodynamics: Introduction to statistical thermodynamics, energy states, quantum mechanical and statistical aspects, unit cells, microscopic state and macroscopic state, phase space, system, assembly and ensemble, use of ensemble, microcononical ensemble, canonical ensemble, probability, thermodynamic probability, molecular basis of residual entropy.

Classical statistics, Sterling's approximation, Maxwell Boltzmann distribution law and its applications. Bose-Einstein statistics, Fermi-direc statistics and their comparisons. Derive the relationship between entropy and thermodynamic probability, partition function, thermodynamic functions in terms of partition function (energy, heat capacity, entropy, Gibb's free energy, enthalpy Helmholtz free energy). Evaluation of different types of partition function. i) Translational partition function. Ii) Rotational partition function for diatomic molecule iii) vibrational partition function for diatomic molecule ,electronic partition function iv) nuclear partition function, separation of partition function, residual entropy (problems to be solved).

Self study(SS): Principles of Mechanics and ensembles, Fundamental postulates of Statistical thermodynamics and Applications.

Skill Component(SC): Plotting of radial wave functions using origin software

UNIT-III **16 h**

CHEMICAL KINETICS: Complex reactions: Kinetics of parallel, consecutive and reversible reactions. Chain reactions: Branched chain reactions, general rate expression, Auto catalytic reactions (Hydrogen-Oxygen reaction), oscillatory reactions and explosion limits. Theories of reaction rates: Collision theory and its limitations, Activated complex theory (postulates -derivation) and its applications to reactions in solution. Energy of activation, other activation parameters - determinations and their significance. Lindemann theory, Hinshelwood's theory of unimolecular reactions. Potential energy surfaces: Features and construction, theoretical calculations of Ea.

Reactions in solution: Ionic reactions - salt effects, effect of dielectric constant (single and double sphere models). Effect of pressure, volume and entropy change on the rates of reactions. Cage effect with an example. Fast reactions- Introduction, study of fast reactions by continuous and stopped flow techniques, relaxation methods (T-jump and P-jump methods), flash photolysis, pulse and shock tube methods.

Self study(SS): Study of rate of reaction(Average and instantaneous), Factors effecting rate of reaction.

Skill Component: Kinetics Studies of the Bleaching of Food Dyes.

UNIT-IV **16 h**

PHOTOCHEMISTRY AND PHOTODEGRADATION

PHOTOCHEMISTRY: Electronic transitions in molecules, The Franck-Condon principle, electronically excited molecules - singlet and triplet states. Life times of excited states of atoms and molecules. Quantum yield and its determination. Actinometry – ferrioxalate, uranyl oxalate, MGL and Reinekke's salt actinometers.

A review of laws of photochemistry –Grottus-Draper law, Beer-Lambert law, Stark-Einstein law. Photo physical processes – kinetics of unimolecular reactions, experiments in photochemistry, photo properties - fluorescence, phosphorescence, chemiluminescence. Delayed fluorescence – E-type and P-type. State diagrams, Stern-Volmer equation (to be derived), lasers in photochemical kinetic studies, photo electrochemistry, solar energy conversion and storage.

Photochemical processes – types of photochemical reactions – electron transfer, photo dissociation, oxidation and isomerization reactions with examples. Photosensitization. Flash photolysis.

PHOTODEGRADATION: Photocatalyst – ZnO, TiO_2, solar cells, principle, application of ZnO/TiO_2 in the photo degradation of dyes (IC), pesticides (DDT) and in industrial effluents. Nature of dyes used in Dye-sensitized solar cells.

Self study (SS): Mechanistic background of photochemistry, Chemistry of Electronically excited states.

Skill Component: Degradation of Methylene blue using ZnO or TiO_2 nano semiconductors.

REFERENCE BOOKS:

01. Statistical themodynamics by B.C. Meclelland, Chapman and Hall, London (1973).

02. Text book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition, (1974).
03. Thermodynamics by Rajaram and Kunakose, East West, Nagin Cx,Dehli,1986.
04. An introduction to Chemical Thermodynamics by R.P.Rastogi and S.S.Misra,Vikash,Delhi,1978.
05. Introductory Quantum Mechanics by Atkins, Claredon, Oxford publication.
06. Quantum chemistry by Kauzman, Academic Press,1957.
07. Quantum chemistry by R.K.Prasad ,2nd Edition, New Age Int-2000.
08. Physical chemistry by Atkins, ELRS 1982.
09. Physical chemistry by Moore, Orient Longman,1972.
10. Quantum Chemistry by Eyring, Walter and Kimball, John Wiley and Sons, Inc., New York.
11. Theoretical Chemistry by S. Glasstone, East West Press, New Delhi, (1973).
12. Modern Molecular Photochemistry by Turro, N.J. (1991), Sausalito, University Science.
13. Photochemistry by Wayne, C.E., Wayne, R.P. (1996), Oxford University Press.

CHPPr-2.8: PHYSICAL CHEMISTRY PRACTICALS-II

Duration: 4 h/ week & Total: 64 h **Credits : 2**

Chemical Kinetics

a. Determine the specific reaction rate of potassium persulphate-iodide reaction by initial rate method.
b. Study the kinetics of the iodination of acetone in the presence of acid by initial rate method.
c. Study the acid catalyzed inversion of cane sugar and find out: (i) the order with respect to sucrose, (ii)the rate constant, (iii)compare kinetically strength of two acids(HCL and H_2SO_4).
d. Study of kinetics of autocatalytic reaction between KMnO4 versus oxalic acid.
e. Evaluation of Arrehenius parameter for the reaction between $K_2S_2O_8$ versus KI (first order)

pH metery:

a. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and calculation of dissociation constant of the base by pH meter.
b. Determination of pH of acetic acid with sodium acetate buffer by pH meter.
c. Determination of pH of formic acid with sodium formate buffer by pH meter.

Colorimetric:

a. Determination of dissociation constant of a given indicator by colorimetric method.
b. Verification of Beers lamberts law by colarimetric method and calculation of molar extinction co-efficient (molar absorption co-efficient)
c. To construct the calibration curve Fe^{2+}-KCNS and Cu^{2+}-NH_3 systems and estimate the amount of respective salt present in a given solution by colarimetrically

REFERENCE BOOKS:

1 Selected Experiments in Physical Chemistry by D. A. Jenkins, G. R. H. Jones, and Joseph Lionel Latham, Butterworths (1964) publisher.
2 Experiments in Physical Chemistry by David P. Shoemaker, Carl W. Garland, Joseph W. Nibler, McGraw-Hill Inc.,US; 5th Revised edition edition (1 October 1988)
3 Advanced Physico-Chemical Experiments by J.Rose, John Wiley, & Sons New York (1964).
4 Experimental Inorganic/Physical Chemistry, 1st Edition by Mounir A. Malati, Woodhead Publishing house 1999.
5 Quantitative Chemical Analysis, 7th edition by Daniel C. Harris, W. H. Freeman; (May 19, 2006).
6 Spectrophotometric determination of elements by Zygmunt Marczenko, E. Horwood, 1976.
7 Spectrophotometric determination of elements by Ellis Horwood Series in Analytical Chemistry, Prentice Hall Europe (a Pearson Education company); First Edition edition (February 1, 1976)

CHGT-2.4: SPECTROSCOPY-II

Teaching: 2 h/ week & Credits : 2 **Total: 32 h**

UNIT–I **16 h**

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Magnetic properties of nuclei (magnetic moment, g factor, nuclear spin), effectof external magnetic field on spinning nuclei, Larmor precessional frequency, resonance conditions, population of nuclear magnetic energy levels, relaxation processes, relaxation time, line width and other factors affecting line width.

Chemical shift, reference standards employed in NMR, factors influencing chemical shift-electronegativity(shielding and deshielding), anisotropic effect, vander Walls deshielding, effect of restricted rotation, H-bonding.

Nature of protons bonded to carbon and other nuclei, Proon integrals, spin-spin coupling-coupling constant, types of coupling, Karplus equations-variation of coupling constants with dihedral angle.

Instrumentation-Frequency sweep instruments, field sweep instruments and pulsed FT-NMR instruments, Chemical equivalence and magnetic equivalence, proton exchange reactions.

First order spectra, non first order spectra, simplification of complex spectra-increasing magneticfield strength, double resonance, deuterium exchange reactions, and lanthanide shift reagents. Nuclear Overhauser Effect (NOE), variable temperature probe.

^{13}C-NMR Spectroscopy: Comparison of ^{1}H-NMR and ^{13}C-NMR, proton decoupling or noise decoupling or broad band decoupling, chemical shift positions of carbon atoms in organic molecules.

Two dimensional NMR Spectroscopy: COSY, NOESY, DEPT Spectra and MRI.

Self study (SS): Basic of spectroscopy, Electromagnetic radiation, nuclear spin, NMR solvent, theory of NMR.

Skill component (SC): Download NMR spectra of simple molecules: C_2H_5OH, CH_3-CO-CH_3, C_6H_6, CH_3OH and $CH_3CH_2CH_2OH$, analyse ^{1}H, ^{13}C and 2D NMR data.

UNIT–II **16 h**

MASS SPECTROMETRY

Introduction, basic theory, instrumentation-single focusing, double focusing, quadrupole mass filter, TOF instruments. Methods of generation of positively charged ions-electron impact ionization, chemical ionization, fast atom bombardment(FAB), matrix assisted laser desorption ionization.

Resolving power, base peak, molecular ion peak, meta stable peak, isotopic peaks-calculation of percentage intensity of (m+1) and (m+2) peaks.Exact molecular mass, molecular formula, hydrogen deficiency index, preliminary analysis of structure.

Modes of fragmentation- fragmentation rules, McLafferty rearrangement, retro Diels-Alder reaction, ortho effect, fragmentation of following class of organic compounds – alkanes, alkenes, alcohols, aldehydes, ketones, carboxylic acids, amino compounds.

Combined applications of spectroscopic techniques

Combined applications of IR, UV-Visible, ^{1}H NMR, ^{13}C NMR and Mass spectrometry in the structural elucidation of organic compounds.
01. Structure analysis when spectral data of the organic compound is given
02. Structure analysis when spectra of organic compound are given

Self study (SS): Origin of mass spectrometry, ionization, principle, types of detector.
Skill component (SC): Download some six simple different functional group contain compounds and analyse fragmentation pattern and justify how this help for structure elucidation of new compounds.

REFERENCE BOOKS:

01. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash. 4th edition, Tata McGraw-Hill, New Delhi.
02. Introduction to Molecular Spectroscopy by G. M. Barrow, McGraw-Hill, New York.
03. Introduction to Spectroscopy by Pavia, Lampman and Kriz, 3rd edition, Thomson.
04. Spectroscopy by B. P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 1 & 2, 1976.
05. Vibration Spectroscopy Theory and Applications by D. N. Satyanarayana, New age International, New Delhi.
06. Organic Spectroscopy by William Kemp, 3rd edition, Palgrava, 1991.
07. Optical Method of Analysis by E. D. Olsen, McGraw Hill Inc, 1975.
08. Spectroscopy of organic compounds by P. S. Kalasi, Wiley Eastern Ltd, India 1993.
09. Introduction to instrumental analysis by R. D. Braun, McGraw Hill Book company 1982.
10. Physical methods in inorganic chemistry byj R. Drago, East West Pvt. Ltd, 1968.
11. Instrumental methods of chemical analysis by Gurdeep Chatwal and Anand.
12. Organic Spectroscopy, 2nd edition by Jag Mohan, Narosa Publishing House New Delhi.
13. Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A: Theory and Applications in Inorganic Chemistry, 6th Edition, by K. Nakamoto, John Wiley and Sons, Jan 2009.

[OPEN ELECTIVE]

CHEG-2.5: CHEMISTRY FOR EVERY DAY LIFE

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT-I **16 h**

POLLUTION

Air pollution: Air pollutants, prevention and control, green house gases and acid rain, ozone hole and CFC's, photochemical smog and PAN, catalytic converters for mobile sources, Bhopal gas tragedy.

Hydrologic cycle, sources, criteria and standards of water quality-safe drinking water, public health significance and measurement of water quality parameters-(colour, turbidity, total solids, acidity, alkalinity, hardness, sulphate, fluoride, phosphate, nitrite, nitrate, BOD and COD), water purification for drinking and industrial purposes.

Toxic chemicals in the environment.

Detergents- pollution aspects, eutrophication. Pesticides and insecticides- pollution aspects, heavy metal pollution, solid pollutants -treatment and disposal, treatment of industrial liquid wastes. Sewage and industrial effluent treatment.

Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil, estimation of rancidity, tests for common edible oils Tests for adulterants like aregemone oil and mineral oils.

UNIT-II **16 h**

INDUSTRIAL CHEMISTRY

Composition of soil - inorganic and organic components in soil- micro and macro nutrients.

Fertilizers: Classification of Fertilizers- straight fertilizers, compound/complex fertilizers, fertilizer mixtures, manufacture and general properties of fertilizer products-Urea and DAP.

Ceramics: general properties, porous and non-porous wares, Manufacturing process, extrusion, turning, drying, decoration, Porcelain and china.

Cement: Types, manufacture, additives, setting, properties & testing of cement.

Glass: Manufacture, properties, shaping of sheets & plate glasses. Annealing, finishing. special glasses.

Paints and Pigments: White pigments (white lead, ZnO, lithopone, titanium dioxide), blue, red, yellow and green pigments. paints and distempers, requirements of a good paint, emulsion, latex, luminescent paints, fire retardant paints, varnishes, enamels, lacquers, solvents and thinners.

UNIT-III **16 h**

BIOORGANIC COMPOUNDS

Carbohydrates: Chemistry of important derivatives of monosaccharides - ethers, esters, acetals, ketals, deoxysugars and aminosugars.

Vitamins: Classification and Nomenclature. Source and deficiency diseases, biological functions of Vitamins- Vitamin A_2, Vitamin B, Vitamin C, Vitamin D & Vitamin K.

Food Analysis: Dairy products- composition of milk and milk products, analysis of fat content, minerals in milk and butter, Estimation of added water in milk.

Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, estimation of methyl alcohol in alcoholic beverages.

Food additives, adulterants and contaminants- Food preservatives like benzoates, propionates, sorbates, bisulphites, artificial sweeteners like saccharin, dulcin and sodium cyclamate.

Flavours: vanillin, esters (fruit flavours) and monosodium glutamate. Artificial food colourants - coal tar dyes and non-permitted colours and metallic salts. Pesticide residues in food.

Drugs: Classification and nomenclature. Analgesics - aspirin, paracetamol; Anthelmentics – mebendazole, Antiallergics - chloropheneramine malleate.

Antibiotics: Pencillin, chloromycetin and streptomycin.

UNIT-IV **16 h**

INDUSTRIAL ORGANIC CHEMISTRY

Chemical energy systems and limitations, principles and applications of primary and secondary batteries and fuel cells, Basics of solar energy, Energy storage devices, Polymers in everyday life: from buckets to rockets: types and classification of polymers, source and general characteristics of natural and synthetic polymers, typical examples of polymers

Corrosion: Types and prevention, corrosion failure and analysis.

REFERENCE BOOKS:

01. Introduction to Industrial Chemistry by B.K. Sharma, Goel Publishing, Meerut(1998).
02. Medicinal Chemistry, Revised Edition by Asthoush Kar, New Age International, 2005.
03. Drugs and Pharmaceutical Sciences Series, Marcel Dekker, Vol.II, INC, New York.
04. Chemical Analysis of Foods by H.E. Cox, Pearson.
05. Foods – Facts and Principles by N. Shakuntala Many and S. Swamy, 4th ed. New Age International (1998).
06. Physical Chemistry by P. Atkins and J. de Paula 7th Ed. 2002, Oxford University Press
07. Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.
08. Organic Chemistry by I. L. Finar, Vol. 1 & 2, Pearson Education India; 6 edition (2002).
09. Polymer Science and Technology by J. R. Fried, Pearson Prentice Hall; 3 edition (24 June 2014).

M.Sc. in CHEMISTRY @ RCU

III SEMESTER

CHIT- 3.1: INORGANIC CHEMISTRY-III

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I 16 h

ELECTRONIC SPECTRA OF TRANSITION METAL COMPLEXES

Microstates, R-S coupling, term symbols for d^n ions, spectroscopic ground states, types of electronic spectra, selection rules for the electronic transitions, relaxation of the selection rules, nature of spectral bands, effect of spin-orbit coupling, effect of distortion and reduction in symmetry, Orgel diagrams, limitations of Orgel diagrams, Tanabe-Sugano diagrams, characteristics of the T-S diagrams, Racah parameters, interpretation of spectra of octahedral, tetrahedral, calculation of nephelauxetic parameter.

Charge transfer bands: origin, types and characteristics, intervalence charge-transfer bands.

Self study: Prepare the chart for term symbols for d^n ions.

Skill component: Record the electronic spectra of transition metal complex (d^4 or d^7) and assign the bands.

UNIT–II 16 h

ORGANOMETALLIC CHEMISTRY-I

Classification of organometallic compounds, the 16 and 18 electron rule, synthesis, structure and bonding in metal alkyl (Li, Mg and Al) and reactions of Grignard's reagents.

Chemistry of organometallic compounds with π - bonding ligands: Synthesis, Structure, Spectroscopy, Reactions and bonding in metal – carbon π - bonded systems involving dihapto to hexahapto ligands viz, Olefins (Zeise's salt), allylic moieties, butadienes, cyclobutadienes and cyclopentadienes.

Fluxional behavior of organometallic compounds.

Homogeneous and heterogeneous catalysis: oxidative additions, reductive elimination, insertion and deinsertion reactions, hydrogenation, hydroformylation, isomerisation, carboxylation and polymerisation, water gas shift reaction.

Self study: Recent advance in fluxional behavior of organometallic compounds

Skill component: Preparation of any organometallic compound using Grignard's reagent.

UNIT–III 16 h

BIO INORGANIC CHEMISTRY: METAL STORAGE AND TRANSPORT

Metal storage and transport of Fe, Zn, Cu, V, Mo, Co, Ni and Mn ions in living organism, iron proteins involved in transport and storage of iron (ferritin, hemosiderin, transferritin), copper proteins involved in transport and storage of copper (Ceruloplasmin serum albumin).

Electron transfer proteins - general features of iron sulfur proteins, Rubredoxin, Ferredoxins (2Fe-ferredoxin, Rieske proteins).
Blue-copper proteins: General features and types of blue copper proteins and their functions.
Cytochromes: structural features, classification and functions of cytochromes. Biological nitrogen fixation, *In vivo* and *in vitro* nitrogen fixation, Interactions of transition metal complexes with DNA.
Self study: Recent advances in electron transfer Fe-S proteins.
Skill component: Synthesis and characterization of metallo protein/ metallo enzyme /amino acid based metal complex.

UNIT–IV **16 h**

BIO INORGANIC CHEMISTRY: METAL IONS IN BIOLOGICAL SYSTEMS

Essential and trace elements, biological functions of biometals, active transport of cations (Na and K pump), ionophores, different types of naturally occurring ionophores.
Metalloenzymes: metalloproteins as enzymes – carboxy peptidase, catalases, peroxidases, cytochrome P450, superoxide dismutase, copper oxidases, vitamin B12 coenzyme, synthetic model compounds.
Metals in medicine- metal deficiency (Fe, Mn, Cu and Zn), chelation therapy and metal complexes as drugs.
Chlorophyll and its role in photosynthesis: Transport and storage of dioxygen- heme proteins, oxygen uptake, functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers.

Self study: Role of Chemistry in Biological systems, Functions of various metallo enzymes.
Skill component: Determination of metals in commercially available vitamin Tablets and /or preparation of salen-cobalt(II) complex and its oxygen scavenging activity.

REFERENCE BOOKS:

01. Inorganic Chemistry: Principles, structure and reactivity, 4th edition (January 17, 1997) by J.E. Huheey, E A.Keiter and R L. Keiter, Prentice Hall Publication.
02. Inorganic Chemistry, 3rd edition by C. E. Housecroft and A. G. Sharpe, Pearson, India.
03. Physical-Inorganic Chemistry; A coordination Approach by S. F. A. Kettle, 1996, Springer-Verlag Berlin Heidelberg publisher.
04. Inorganic Chemistry by Purcel and Kotz.
05. Inorganic Chemistry : A Unified Approach, 2nd Edition, by W. W. Porterfield, Academic Press (12 April 2013).
06. Concepts and Models of Inorganic chemistry, 3rd Edition by B E.Douglass, J J.Alexander and D H.Mcdaniel, John Wiley & Sons (5 May 1994).
07. Advanced Inorganic Chemistry, 5th Edition by F. ALBERT COTTON, SIR GEOFFREY WILKINSON, CARLOS A. MURILLO, MANFRED BOCHMANN, Wiley and Sons Ltd.

08. Inorganic Chemistry, 5th Edition by Donald Arthur Tarr and Gary L. Miessler, University Science Books, (1990).
09. Fundamental concepts of Inorganic Chemistry, 2nd edition by A. K. Das, volume 1 to 7, CBS publication (2019).
10. Electronic spectroscopy by D. N. Sathyanarayana, University Press, (2001).
11. Electronic Spectroscopy by A. B. P. Lever, Elsevier Science Ltd (1 November 1968).
12. Elements of Magnetochemistry by A. Symal and R I. Dutta, East West Pvt Ltd.
13. Bioinorganic Chemistry by A. K. Das, Books & Allied Ltd (1 January 2013).
14. Bioinorganic Chemistry by Bertini, Gary, Lippard and Valentine, ACS publication, (1995).

CHIPr -3.6: INORGANIC CHEMISTRY PRACTICAL-III

Duration: 4 h/ week & Total: 64 h **Credits : 2**

PART-A Preparation of coordination compounds

01. Copper-glycine complex : cis and trans forms
02. Tris thiourea Copper (I) sulphate mono hydrate
03. Mercury tetrathiocyanatoCobaltate (II)
04. Tris ethylenediamine Ni(II) Chloride
05. Cis $[Co(en)_2Cl_2]$ Cl
06. Separation of optical isomers of $[Co(en)_3]^{3+}$

PART-B Characterization (Metal ion determination in above complexes

07. Copper by Iodometric method
08. Copper by Iodometric method
09. Nickel by gravimetric method
10. Cobalt volumetrically by EDTA method

PART-C Anion Estimation

11. SO_4^{2-} as Barium Sulphate (gravimetrically)
12. Cl^- by Silver nitrate (demonstration)
13. Interpretation of IR and NMR Spectra of
14. Tris (thiourea) Copper (I) sulphate
15. Cis $[Co(en)_2Cl_2]Cl$
16. $[Co(en)_3]^{3+}$

REFERENCE BOOKS:

1. INTEGRATED APPROACH TO COORDINATION CHEMISTRY AN INORGANIC LABORATORY GUIDE, Rosemary A. Marusak, Kate Doan, Scott D. Cummings, John Wiley & Sons, Inc., Publication.

2. Practical Inorganic Chemistry by Shikha Gulati, JL Sharma and Shagun Manocha, CBS Publication.
3. Vogel's Qualitative Analysis, Seventh edition, by Svehla G, Pearson India.
4. Inorganic qualitative analysis in the Laboratory, 1st edition, by Clyde Metz, Academic Press.
5. W. L. Jolly, Modern Inorganic Chemistry, McGraw, Hill Co., 1984.
6. M. Day and J. Selbin, Theoretical Inorganic Chemistry, 2nd edition, Von. Nostrand, 1980.
7. H. J. Emeleus and J. J. Anderson, Modern Aspects of Inorganic Chemistry, Von. Nostrand, 1962.
8. Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual, Gregory S. Girolami, Thomas B. Rauchfuss and Robert J. Angelici. University Science Books.
9. Synthetic methods of organometallic and inorganic chemistry ed. by Wolfgang A. Herrmann, Georg Thieme Verlag, New York, 1997, Vol 7 and 8
10. Vogel's qualitative inorganic analysis, by Svehla, G. Publisher: Harlow : Longman, 1996.
11. Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis. By: Arthur Israel Vogel; John Bassett Publisher: London; New York: Longman, 1978.

CHOT-3.2: ORGANIC CHEMISTRY-III

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT –I **16 h**

REAGENTS IN ORGANIC SYNTHESIS

Use of the following reagents in organic synthesis and functional group transformation:

1. Gilmann reagent	2. Lithium diisopropyl amide (LDA)
3. Dicyclohexyl carbodimide (DCC)	4. 1,3-Dithiane (reactivity umpolung)
5. Trimethylsilyl iodide	6. Tri-n-butyl tin hydride (TNBH)
7. DDQ	8. Woodward-Prevost hydroxylation
9. Baker's Yeast	10. Phase transfer catalysts
11. Crown ethers	12. Peterson synthesis

Self study(SS): Basics of reagents, storage, handling, expire date. Basic of Crown ethers and Phase transfer catalyst.

Skill components(SC):Students need to list out hazardous and non-hazardous reagentsin the above 12 synthesis. Give model for storing safe and handling during reaction (gaggle, Fume hood and other safety measures)

UNIT –II **16 h**

PHOTOCHEMISTRY

Interaction of radiation with matter, types of excitation, rate of excited molecules, quenching, quantum efficiency, quantum yield, transfer of excitation energy, actinometry, singlet and triplet states, experimental methods in photochemistry of carbonyl compounds, and transition, Norrish type I and Norrish type II reactions Paterno–Buchi reaction, photoreduction, photochemistry of enones, hydrogen abstraction rearrangement of unsaturated ketones and cyclohexadienones, photochemistry of parabenzoquinones, photochemistry of aromatic compounds with reference to isomerization, addition and substitution, photochemical isomerization of cis and trans alkenes, photo-Fries rearrangement, Barton reaction, Hoffmann-Loefler-Freytag reaction, photochemistry of vision.

Self study(SS):Basics of photochemistry (PC), principle of PC, effect of photon on organic molecules.

Skill components(SC):Students select at least FOUR photoreaction products and analyse using different spectroscopic data (UV-Vis, FT-IR, NMR and mass spectrometry from online source).

UNIT –III **16 h**

PERICYCLIC REACTIONS

Pericyclic Reactions: Classification of pericyclic reactions, molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1, 3, 5-hexatriene, allyl system, Woodward-Hoffman correlation diagram method and Perturbation of molecular

orbital (PMO) approach of pericyclic reaction under thermal and photochemical conditions, FMO and PMO approach to the following reactions.
Electrocyclic reactions- Con rotatory and dis rotatory ring closure 4n and 4n+2 and allylic systems, Woodward and Hoffmann selection rules for pericyclic reactions.
Cycloadditions reactions - Antrafacial and suprafacial additions, more emphasis on [2+2] and [4+2] Cycloadditions, Diels-Alder reaction, 1,3-dipolar cycloaddition reactions.
Sigmatropic rearrangements: Antrafacial and suprafacial shift involving carbon moieties, retention and inversion of configuration, Ene, Claisen and Cope reaction.

Self study(SS): Basics of pericyclic, elecctrocyclic and cycloaddition reactions. orbital shape, con-rotation and dis-rotation, stereochemistry.
Skill components(SC):Students need to prepare some models (ball & Stick) to show some of the selected reactions.

UNIT –IV **16 h**

MEDICINAL CHEMISTRY

Introduction, definition of drug, requirements of drugs, chemotherapy, pharmacokinetics, pharmacodynamics, metabolites and anti metabolites, prodrug and soft drugs, agonists and anti-agonists, concept of drug receptor, elementary treatment of drug receptor interactions, theories of drug activity-occupancy theory, rate theory, induced fit theory, classification of drugs.
Sulphonamides: Introduction, classification, synthesis and SAR studies of sulphathiazole, sulphanilamide, sulphadiazine.
Antimalarials: Introduction, classification, synthesis and drug action-Chloroquin and Pamaquin.
Analgesics: Introduction, classification, synthesis and drug action-Paraacetomol, aspirin, salol, phenyl butazone, antipyrine.
Anti-inflammatory: Introduction, classification, synthesis and drug action-Indomethacin and ibuprofen.

Self study(SS): Basics of drugs, chemotherapy, receptor, drug action and SAR studies.
Skill components(SC):Student need to list each class (four) one drug molecule, analyze using spectral data (UV-Vis, FT-IR and NMR)and list out pharmacological and pharmacodynamics data (online source).

REFERENCE BOOKS:

01. Organic synthesis by Jagadamba singh and L,D.S.Yadav , [ragati prakashan educational publishers .
02. Organic reaction mechanisms- V.K. Ahluwalia, R.K. Parashar, 4rt Edition, Narosa Publishing House, New Delhi, Chennai, Mumbai, Kolkata 2011.
03. Photochemistry and pericyclic reactions by Jagdamba Singh, Jaya singh 3rd edition, new age international publishers, 2009.

04. Photochemistry and pericyclic reactions by Jagdamba Singh, Jaya singh 4th edition, new age international publishers, 2012.
05. Fundamentals of photochemistry, K.K. Rohatgi- Mukherjee, 3rd edition new age international publishers, 2017.
06. Photochemistry and pericyclic reactions by V.Balzani, P.Ceroni and A.Juris, John. Wiley publishers , 1st edition, 2014.
07. Principles of Molecular Photochemistry- An introduction by N.J.Turro, V.Ramamurthy, J.C. Scaiano. published by University of science books, 2009.
08. Principles and applications of Photochemistry by Brian Wardle , published by John Wiley & sons , 2009.
09. Medicinal Chemistry- An introduction , Gareth Thomas , 2nd edition, John Wiley & sons publications , 2011.
10. Medicinal Chemistry by D.Sriram and P.Yogeeswari, Pearson education , India, 2009.
11. Burger's Medicinal Chemistry and Drug Discovery, Vols. 4, Edited by Donald.J. Abraham, 6th edition John Wiley publication, 2003
12. Foye's Principles of Medicinal Chemistry, 6th Edn., T. L. Lemke, Wolters Kluwer, Lippincott Williams and Wilkins, 2007
13. Medicinal Chemistry, Ashutosh Kar, revised and expanded 3 rd edition, New age international(P) limited, publishers, 2005.
14. An Introduction to Medicinal Chemistry, P Graham, 5th edition, OUP Oxford, 2013.
15. Medicinal Chemistry – G R Chatwal, Himalaya publishing house , New Delhi, 2012.
16. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical chemistry, Edited by J .H Block , J .M Beale, Jr. published by Wolters Kluwer-Lippincott, Williams and Wilkins, 12th edition, 2011.
17. Goodman and Gilman's Pharmacological Basis of Therapeutics, by Laurence L.Brunton , John S. Lazo and Keith L.Parker , 11th Edition., Tata McGraw-Hill, 2005.
18. Photochemistry, Carol E Wayne and Richard P Wayne, Oxford University Press, (1996).
19. Organic Photochemistry, J. M. Cozen and B. Halton, Cambridge University Press (I Edition) 1974.
20. Molecular Reactions and Photochemistry, C H Deputy and D S Chapman, Prentice Hall India, New Delhi (1st Edition) , 1972.
21. Introduction to organic chemistry A. Streitweiser, Jr and C. H. Heathcock, Macmillan, 1985.
22. Radicals in organic synthesis, volume 5, by Bernd. Giese, Pergamon Press, 1986.

CHOPr-3.7: ORGANIC CHEMISTRY PRACTICAL-III

Duration: 4 h/ week & Total: 64 h **Credits : 2**

PART-A: **ORGANIC ESTIMATIONS**

01. Estimation of aniline
02. Determination of equivalent weight of acids by silver salt method.
03. Estimation of sugars by Fehling's method.
04. Determination of saponification value of oils.
05. Determination of iodine value of oils.
06. Determination of enol content by Meyer's method.

PART-B: MULTISTEP **ORGANIC PREPARATION**

01. Preparation of 2-bromo-3-phenyl propionic acid from cinnamic acid.
02. Preparation of anthralinic acid from phthalimide.
03. Preparation of p-chlorotoluene from p-toluidine.
04. Preparation of benzophenoneoxime and its rearrangement to benzanilide.

REFERENCES

01. Vogel's Text Book of Practical Organic Chemistry, Brian S , Furniss, Anthony j. Hannaford, 5th Edition, Pearson India, 2005.
02. Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India,2011.
03. Advanced Practical Organic Chemistry, N.K. Vishnoi, 2nd Vikas, Publishing House Pvt. LTD, 1996.
04. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis Renu Aggarwal, V. K. Ahluwalia, Universities press (India), 2001.
05. Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
06. Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
07. Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
08. Laboratory techniques in Organic chemistry-V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt.Ltd.
09. Laboratory Manual of Organic Chemistry Raj K. Bansal. 5th edition, New Age international, 2008.

CHPT-3.3: PHYSICAL CHEMISTRY-III

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I **16 h**

SUPERCONDUCTORS AND MEGNETOCHEMISTRY

Semiconductors: Free carrier concentration in semiconductors, Fermi level and carrier concentration in semiconductors, effect of temperature on mobility, electrical conductivity of semiconductors, Hall effect in semiconductors, p-n junction.

Superconductors: Introduction, conventional super conductors, magnetic properties of superconductors, The Meissner effect, Thermodynamics of superconducting transitions, London equation, London penetration Depth, Normal tunnelling and Josephson effect, BCS theory of superconductors, cooper pair, theory of high temperature superconductors and applications.

Magnetochemistry: Introduction, types of substances, theory of paramagnetism, diamagnetism and ferromagnetism (langevin's and Weiss's theory). Measurements of magnetic susceptibility: Theory of susceptibility, Gouy, Bhatnagar-Mathur and Quincke's method and applications of magnetic susceptibilities.

Self-study(SS): Study about Insulators, Semiconductors & Conductors, Semiconductors types, Examples, Properties and Applications.

Skill Component: Preparation of ferrites and study of magnetic properties.

UNIT–II **16 h**

ATOMIC STRUCTURE AND ATOMIC SPECTRA: A brief history of atomic models drawbacks, Bohr theory of Hydrogen atom, Sommerfeld's relativistic atomic model,A wave mechanical concept of the atom. Characteristics of Quantum numbers, Vector atomic model. Brief explanation of doublet structure of alkali spectra (Li, Na and K) and compound doublets, Helium and alkaline earth spectra (Magnesium and Calcium), spark spectra and arc spectra. Moseley lines. Multiplet structure of line spectra, prohibition of inter combinations. Multiplicities and term symbols. Space quantization: Zeeman effect, normal and anomalous Zeeman effects, Paschen- Backeffect, Stark effect.

Self-study(SS): Study About Line spectra, Bohr Model, Applications of absorption and emission spectra.

Skill Component: Experimental studies of UV-Vis spectrophotometry

UNIT–III **16 h**

CATALYSIS

Difference between heterogeneous, homogeneous and bio-catalysis; Importance of heterogeneous and homogeneous catalysis in chemical reactions, characteristics of catalytic reactions and acid-base catalysis.

Theories of Catalysis: Boundary layer theory, Catalysis by semiconductors, Wolkenstein theory, Balanding's approach, electronic factors is catalysis by metals, molecular orbital approach.

Enzyme catalysis: Mechanism and kinetics of enzyme catalyzed reactions, the Michaelis-Menten equation, Effect of temperature on enzyme catalysis.

Heterogeneous catalysis: surface reactions, Kinetics of surface reactions, Unimolecular surface reactions, Bimolecular surface reactions, pH-dependence of rate constants of catalyzed reactions, Autocatalysis and oscillatory reactions.
Homogeneous Catalysis: Intermediate stages in homogenous Catalysis, energy profile diagram, general scheme for calculating kinetics of the reactions, decomposition of hydrogen peroxide, hydrogenation, hydroformulation, isomerization, wacker reaction, coupling reactions and asymmetric oxidations.
Self-study(SS): Characteristics of Catalytic reactions, Mechanism of Catalytic actions, Intermediate compound formation theory.
Skill Component: Shape selective catalysis by Zeolites, Practical demonstrations and paper presentations.

UNIT–IV **16 h**
SURFACE CHEMISTRY
Surface chemistry: Introduction, adsorption, isotherms(Gibbs, Frendlich,nand Langmuir), surface excess; BET isotherm, surface area, pore size and acid strength measurement.LB film, membrane equilibrium, micellisation, catalytic activity, surface active agent, Classification of surface active agent, Critical Micellar Concentration (CMC), Factor affecting the CMC of surfactants, hydrophobic interaction, thermodynamics of micellization-phase separation and mass action model, micro emulsion, reverse miceles. Thermodynamics of adsorption: interpretation of chemisorptions based on the structure and nature. Kinetic of surface reactions: rate determining step, various types of reactions, Applications of adsorption:-High vacuum, Gas marks, Softening of hard water, Drying gases, Decolorisation, Refining of petroleum and vegetable oils, Prevention of evaporation of water. In curing diseases, concentration of ores, Adsorption indicators.
Self-study(SS): Difference between surface reactions and chemical reactions, adsorption, types of Adsorption, Examples and Applications of adsorption in daily life.
Skill Component: X-ray diffraction studies of oxides.

REFERENCE BOOKS:

1. Introduction to Super Conductivity, Revised 2nd Edition by A C. Rose-Innes and E H. Rhoderick, Pergamon Press; (1978).
2. Superconductivity, 2nd Edition, by Charles P. Poole, H A Farach,R J Creswick & R Prozorov, Academic Press (August 9, 2007).
3. Superconductivity: Basics and Applications to Magnets, by R G Sharma, Springer; 2015 edition (February 26, 2015).
4. Superconductivity: Properties, Applications & New Developments, by Paulette Grant, Nova Science Pub Inc; UK ed. edition (December 15, 2015).
5. Heterogeneous catalysis and applications, by G.C. Bond, Oxford (1987).
6. Heterogeneous catalysis, by D. K. Chakraborty and B. Vishwanathan, New Age Int. (2008).
7. Heterogeneous catalysis, by J. M. Thomas and W.J. Thomas, VCH publication (1997).

8. E. R. Rideal, "Concept in Catalysis" Academic press (1968).
9. M. Beller, A. Renken and R. van Santen, "Catalysis", Wiley VCH (2012).
10. Chemical kinetics and catalysis, by G. Panchenov and V. Lebedev, Mir publication (1976).
11. Chemical Kinetics and Catalysis, by R. Van Santen and J. Niemantsvedict, Plenum Press (1995).
12. Practical surface analysis by AES & XPS, by D. Briggs and M. Seah, John Wiley (1983).
13. Atomic Spectra and Atomic Structure, 2nd edition by Gerhard Herzberg, Dover Publications; (August 19, 2010)
14. Atomic and Molecular Spectroscopy: Basic Aspects and Practical Applications, by Svanberg, Sune, Springer-Verlag Berlin Heidelberg.
15. Atomic Structure, by Colm T. Whelan, Morgan & Claypool Publishers, 2018.
16. Introduction to Surface Chemistry and Catalysis, 2nd Edition by Gabor A Somorjai & Yimin LiWiley-Blackwell (June 8 2010).

CHPPr-3.8: PHYSICAL CHEMISTRY PRACTICAL-III

Duration: 4 h/ week & Total: 64 h **Credits : 2**

01. Analysis of binary mixture of two miscible liquids by viscometry and the relation between viscosity of solution and electrical conductivity
02. To determine the percentage composition of unknown mixture of A and B liquids by Abbe's refractometer by graphical method
03. To determine the percentage composition of unknown mixture of A and B liquids by Abbe's refractometer by formula method.
04. Determination of parachor value for CH_2 groups by surface tension between two liquids 1) ethanol+propanol 2) ethanol+surfactant 3) propanol+surfactant.
05. To determine the step wise heat of neutralization of polybasic acid using thermoflask
06. Determine the concentration of Cu(II) and Fe(II) solution by photometric titration with EDTA
07. Determination of energy gap for semiconductor (Ge) and effect of temperature on semiconductor by four probe method.
08. Study of salt effect on solubility and determination of activity coefficient

Computational Methods:

1. Familiarity with word processing, Electronics spread sheets, Data processing, Mathematical packages, chemical structure drawing and molecular modeling.

Spectrophotometry:

1. Record the UV-spectra of a given compound, e.g. acetone in cyclohexane.
   a. Plot transmittance versus wavelength
   b. Plot absorbance versus wavelength
   c. Calculate the energy involved in the electronic transition in different units, i.e, cm^{-1}, J/mol, cal/mol and eV.

REFERENCE BOOKS:

1. Advanced Physico-Chemical Experiments–J.Rose,John Wiley, Newyork(1964).
2. Instrumental analysis manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Experimental Inorganic/Physical Chemistry- Mounir A. Malati.
6. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
7. Experimental physical chemistry, R. C. Das and B. Behera, Tata McGrawHill Publishing Company Limited, 1983.

8. Experimental Physical Chemistry, V. D. Athawale and Parul Mathur, New Age International (p) Limited, Publishers, New Delhi, 2001.
9. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994)

CHGT- 3.4: SPECTROSCOPY-III

Teaching: 2 h/ week & Credits : 2 **Total: 32 h**

UNIT–I **16 h**

ESR and Applications of IR Spectroscopy

Electron spin resonance (ESR) spectroscopy

Basic principle interaction between spin and magnetic field, origin of spectral line-intensity, width and position of spectral lines, relaxation process, multiplicity in ESR, hyperfine splitting, g-value and factor affecting. Rules for interaction of spectra, zero field splitting and Krammer's degeneracy, John-Teller distortion, isotropic and anisotropic coupling constants, nuclear quadrupole coupling interaction, spin hamitonium, ESR spectra of radical containing a single set of equivalent protons-methyl, parabezoquinone, cyclopentadienyl, benzene. ESR spectra of transition metal complexes, applications.

Applications of infra red spectroscopy to inorganic compounds

Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N-dimethylacetamide, urea, ammine, acetato, cyano and thiocyanato complexes), mono, di and trinuclear carbonyl complexes and nitrosyls complexes, change in spectra accompanying change in symmetry upon coordination (NO_3^-, SO_4^{2-}, NO_2^- and ClO_4^-), hydrogen bonding, instrumentation including FTIR.

Self study(SS): Basics of spins (Hunds rule, Aufbau principle), ESR, spectral line, magnetic field, diamagnetism and paramagnetism, degeneracy, rules for interaction of spectra.

Skill components(SC):Analyze some important inorganic compounds (two samples in each) FT-IR and ESR spectra from open source/record spectra .

UNIT–II **16 h**

NUCLEAR QUADRUPOLE RESONANCE and MOSSBAUER SPECTROSCOPY

Nuclear quadrupole resonance spectroscopy: Consequence of nuclear spin larger than ½, prolate and oblate nucleus, nuclear quadrapolar charge distribution-theory and instrumentation, relationship between electric field gradients and molecular structure, applications and interpretation of eQq data, effect of crystal lattice on the magnitude of eQq, structural information from NQR spectra.

Mossbauer spectroscopy: Theory and principles, experimental methods, isomer shift, quadrapole interactions, electron density, magnetic interactions; time and temperature dependent effect, application-Iodine trihalides, Prussian blue, trisiron dodecacarbonyl, tin halides, hexacyano ferrate and nitroprussides.

Self study(SS): Basic of NqR and Mossbauer, prolate and oblate nucleus, electric field, electric field gradient, crystal lattice, electron density.

Skill components(SC): Students need to prepare the model to show the working of Mossbauer spectroscopy experiment.Two complex sample Mossbauer spectra need to be analyzed from open source data.

REFERENCE BOOKS:

01. Electronic paramagnetic resonace spectroscopy by Pratik Bertand.
02. Principles and applications of ESR spectroscopy by Andrew Lund, Masaru Shoiotani and Shimada.
03. Electron spin resonance spectroscopy of organic radicals by Prof. Dr. Fabian Gerson, P.D. Dr. Walter Huber, by Wiley publishers India, 2003.
04. Electron spin resonance – Elementory theory and practical applications by John.E. Wertz and James R.Bolton. Spinger publishers.
05. Introduction to magnetic resonance spectroscopy ESR, NMR, NQR by D.N Sathyanarayana , I K Inernational publishing house Pvt. Ltd , 2009.
06. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash. 4th edition, Tata McGraw-Hill, New Delhi.
07. Introduction to Spectroscopy. Pavia, Lampman , Kriz, Vyvyan 5th edition, cengage learning India private limited ,2015.
08. Vibration Spectroscopy Theory and Applications, D. N. Satyanarayana, New age International (P) Limited publishers New Delhi, reprint 2005.
09. Instrumental methods for chemists – Gurdeep Chatwal, Himalaya publication house , 2012.
10. Organic Spectroscopy, 1st and 2nd edition– Jag Mohan, Narosa Publishing House New Delhi.
11. Modern spectroscopy by J. Michael Hollas , published by John Wiley& sons, Ltd. 2004.
12. Elementory Organic spectroscopy – Principles and applications– by Y. R. Sharma, publishers- S.
13. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash. 4th edition, Tata McGraw-Hill, India, New Delhi, 2017.

[OPEN ELECTIVE]

CHEG-3.5: ENVIRONMENTAL CHEMISTRY

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT-I **16 h**

POLLUTION

Environmental segments, evolution of earth's atmosphere.

Air pollution: Air pollutants, prevention and control, green house gases and acid rain, carbon monoxide, industrial sources and transportation sources.

SO_x- sources, ambient concentration, test methods, control techniques - scrubbing, , limestone injection process. Ozone hole and CFC's, photochemical smog and PAN.

NO_x- sources, ambient concentration, test methods, thermodynamics and NO_x, control techniques.

Particulates: Size distribution, particulate collection - settling chambers, centrifugal separators, wet scrubbers, electrostatic precipitators & fabric filters, catalytic converters for mobile sources, Bhopal gas tragedy.

UNIT-II **16 h**

WATER POLLUTION

Hydrologic cycle, sources, chemistry of sea water, criteria and standards of water quality- safe drinking water, maximum contamination levels of inorganic and organic chemicals, radiological contaminants, turbidity, microbial contaminants, public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, sulphate, fluoride, phosphate and different forms of nitrogen in natural and polluted water, chemical sources of taste and odour, treatment for their removal, sampling and monitoring techniques.

UNIT-III **16 h**

WATER ANALYSIS

Determination and significance of DO, BOD, COD and TOC, water purification for drinking and industrial purposes, disinfection techniques, demineralization, desalination processes and reverse osmosis.

Radioactive waste management, radionuclides in soil, effects of ionizing radiations-effect on ecosystem, accidents at atomic power plants-Chernobyl disaster, disposal of radioactive liquid wastes, methods of radiation protection.

UNIT-IV **16 h**

DETERGENTS, PESTICIDES and SOIL ANALYSIS

Toxic chemicals in the environment, impact of toxic chemicals on enzymes. **Detergents**- pollution aspects, eutrophication.

Pesticides-pollution of surface water. Sewage and industrial effluent treatment, heavy metal pollution. Chemical speciation- biochemical effects of pesticides, insecticides, particulates, heavy metals (Hg, As, Pb, Se), carbon monoxide, nitrogen

oxides, sulphur oxides, hydrocarbon, particulates, ozone, cyanide and PAN. Solid pollutants and its treatment and disposal.

Composition of soil - Inorganic and organic components in soil, micro and macro nutrients, nitrogen and sulphur pathways, soil pollution: classification of pollutants and their characteristics, sources, prevention and control, sampling and monitoring techniques.

REFERENCES BOOKS:

01. A.K. De : Environmental Chemistry (Wiley Eastern).
02. S.K. Banerji : Environmental Chemistry (Prentice Hall India), 1993.
03. S.D. Faust and O.M. Aly : Chemistry of Water Treatment, (Butterworths), 1983.
04. G.D. Christian : Analytical Chemistry, (4th Ed.), (John Wiley)
05. Sawyer and McCarty, Chemistry for Environmental Engineering (McGraw Hill) 1978
06. I. Williams, Environmental Chemistry, John Wiley, 2001
07. S. M. Khopkar, Environmental Pollution Analysis, (Wiley Eastern).
08. J.W. Moore: Heavy Metals in Water, (Springer-Verlag), 1984.
09. C. Malcolm, K.Killham and Edwards: Soil Chemistry and its Applications, Cambridge (1993)
10. M. Raymond and J.C. Shickluna: Soils, 5th Ed. (Prentice Hall, India), 1987.

M.Sc. in CHEMISTRY @ RCU

IV SEMESTER

CHIT-4.1: INORGANIC CHEMISTRY-IV

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I **16 h**

NON-TRANSITION, F-BLOCK ELEMENTS & CARBENES

Silicates: Types of silicates, Clay minerals and Zeolites

Phosphazenes: Synthesis of Cyclophosphazenes and polyphosphaznes. Reactions of Hexachlorocyclotriphosphazene and polyphospazne. Structural aspects of Hexachlorocyclotriphosphazene.

Sulphur-Nitrogen compounds: Synthesis, structure and reactivity of S_4N_4, $S_4N_4H_4$, S_2N_2 /and $(SN)_x$.

Carbenes: Singlet and triplet state, Fisher and Schrock carbenes, metal carbenes, reactivity of carbenes and metal carbenes.

Chemistry of f-block metals: f-orbitals and oxidation states, atom and ion sizes, spectroscopic and magnetic properties (Electronic spectra and magnetic moments of lanthanides, luminescence of lanthanide complexes, Electronic spectra and magnetic moments of actinides), inorganic compounds and coordination complexes of the lanthanides and uranium.

Self study: Synthesis and structural aspects of Uranium complexes.

Skill component: Collection of Montmorillonite (2:1 smectite) clay mineral from soil.

UNIT–II **16 h**

MATERIAL CHEMISTRY

Fuel Analysis: Definition and classification of fuels, characteristics of fuels, sampling, proximate and ultimate analysis of coal, and determination of calorific value. Liquid fuels: determination flash point, fire point, aniline point, knocking of petrol and diesel octane and cetene numbers, carbon residue.

Gaseous fuels: Analysis of coal gas, water gas, producer gas, gobar gas and blast furnace gas. Calorific value, determination of Junker's gas calorimeter. Relative merits of solid, liquid and gaseous fuels.

Explosives: TNT, RDX etc.

Metal hydrides and Carbides: Salt like, covalent and interstitial carbides, Metal hydrides relevant to hydrogen storage applications (NaH, $NaBH_4$, $LiAlH_4$ etc.)

Silicone polymers: Introduction, nature of chemical bonds containing silicon, general methods of preparation (fluids and resins) and properties of silicones. Applications, industrial uses of silicon, silicon carbide and silicon dioxide.

Self study: Chemical weapons and their impact on mass destruction – safety issues.

Skill component: Determination of calorific value of any suitable fuel or Preparation of silicone polymer.

UNIT–III **16 h**

SOLID STATE CHEMISTRY

Electrical properties of solids: Conductors, insulators, semiconductors. Measurements by DC and AC methods.

Ionic conductivity: Alkali halides- vacancy conduction in NaCl crystal, interstitial conduction in AgCl.

Li-ion battery – Electrode materials and working.

Solid electrolytes: β- Alumina, AgI and Ag+ ion solid electrolytes, anion conductors (Yttria stabilized zirconia), requirements for conductivity, Applications including solid oxide fuel cell.

Self study: Cathode materials used in Li-ion battery.

Skill component: Deduce the ionic conductivity of anion conductor (YSZ) from the Nyquist plot.

UNIT–IV **16 h**

MAGNETIC & OPTICAL PROPERTIES

Magnetic properties: Types of magnetic materials (magnetic ordering in Ferro,antiferro, dia, para and ferri). Magnetically concentrated compounds- ferro, antiferro and ferri magnetic, spin cross-over systems.

Magnetization vs. applied field(hysteresis loops), Effect of temperature, spin-only formula, orbital contribution, spin-orbit coupling.

Selected examples of magnetic materials (Fe_2O_3, Fe_3O_4), metal and alloys, transition metal oxides, spinels, garnets, ilemenites, perovskites, magneto plumbites.

Measurement of magnetic susceptibility – Gouy and Faraday methods, diamagnetic corrections. correlation of magnetic and structural properties, applications.

Optical properties: Luminescence and phosphors, configurational coordinate model, some phosphor material, antistokes, phosphors, lasers.

Self study: Different types of magnetic materials – effect of temperature.

Skill component: Determine the magnetic susceptibity of any transition metal and/or Lanthanide complex by Guy's method.

REFERENCE BOOKS:

01. Inorganic Chemistry: Principles, structure and reactivity, 1997, J.E. Huheey, Keiter and Keiter.
02. Inorganic Chemistry, 3rd edition, C. E. Housecroft and A. G. Sharpe.
03. Inorganic Chemistry by Purcel and Kotz, Saunders, 1977.
04. Inorganic Chemistry, 2nd Edition by W. W. Porterfield, Academic press.

05. Concepts and Models of Inorganic chemistry by Douglass, Alexander and Mcdaniel.
06. Advanced Inorganic Chemistry by Cotton and Wilkinson.
07. Inorganic Chemistry by Miessler and Tarr.
08. Fundamental concepts of Inorganic Chemistry by A. K. Das, volume 1 to 7.
09. Elements of Magnetochemistry by Symal and Dutta.
10. Organometallic Chemistry by Meharotra and Singh.
11. Organometallic Chemistry by G. E. Coates.
12. Introduction to Solids by Azaroff.
13. Solid State Chemistry and its Applications by Anthony R. West.
14. Solid State Chemistry: An Introduction, 3rd edition, Lesley E. Smart and Elaine A. Moore.

CHIPr -4.6: INORGANIC CHEMISTRY PRACTICAL-IV

Duration: 4 h/ week & Total: 64 h **Credits : 2**

01. Use of Cation and Anion resins column set up.
02. Analysis of Cement (SO_3).
03. Use of oxime, salicyladoxime, DMG in the separation and estimation using spectrophotometric/volumetric/gravimetric method.
04. Cu + Ni
05. Al + Mg
06. Ni in the presence of Fe.

REFERENCE BOOKS:

01. Practical Inorganic Chemistry by Gulati and Shikha and Sharma and JL and Manocha and Shagun, CBS PUBLICATION.
02. Inorganic Chemistry 3rd Edition 2008 by Donald A Tarr and Gary Miessler, PEARSON INDIA.
03. Inorganic Chemistry Practical by Dr Deepak Pant, Scince press.
04. Vogel's Qualitative Analysis, Seventh edition, by Svehla G, Pearson India.
05. Inorganic qualitative analysis in the Laboratory, 1st edition, by Clyde Metz, Academic Press.
06. W. L. Jolly, Modern Inorganic Chemistry, McGraw, Hill Co., 1984.
07. M. Day and J. Selbin, Theoretical Inorganic Chemistry, 2nd edition, Von. Nostrand, 1980.
08. H. J. Emeleus and J. J. Anderson, Modern Aspects of Inorganic Chemistry, Von. Nostrand, 1962.

CHOT-4.2: ORGANIC CHEMISTRY-IV

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT –I **16 h**

ORGANIC SYNTHESIS

Designing the synthesis based on retrosynthetic analysis

Disconnection Approach: An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclization reactions, amine synthesis.

One Group C-C Disconnections: Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes in organic synthesis.

Two Group C-C Disconnections: Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, Michael addition and Robinson annulations.

Retrosynthesis: Retrosynthesis of benzocaine, 4-methoxy acetophenone, saccharin and bisavalone.

Protecting Groups: Illustration of protection and deprotection in organic synthesis, Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups.

Self study(SS):Basic of retrosynthetic analysis, synthons, synthetic equivalents, chemoselectivity, reversal of polarity, cyclization reactions, basic of protecting group.

Skill Components (SC): Student need to analyse retosynthetic pathways of saccharin and acetophenone product and intermediate analysis using several spectral data. How carbonyl group is protection monitored by FT-IR spectra need to be explained by taking (acetal and cyclic acetal formation one reaction)

UNIT –II **16 h**

BIOORGANIC POLYMERS

Carbohydrates: Introduction, ring size determination of monosaccharides-glucose and fructose, configuration andconformations of monosaccharides, anomeric effect, Hudson's rules, epimerization and mutarotation, synthesis, industrial and biological importance of glycosides and amino sugars.

Polysaccharides-structural elucidation of starch, structure of cellulose, glycogen, importance starch, cellulose and glycogen as energy and structural materials.

Polypeptides and Proteins: Introduction, Use of blocking agents, Bruce-Merrifield synthesis of polypeptides.

Structure of proteins- End group analysis(Edman's and Sanger's methods), Primary secondary, tertiary and quaternary.

Nucleic acids: Introduction, classification, components of nucleic acids, structures and synthesis of nucleosides and nucleotides, Watson-Crick model of DNA, role of DNA and RNAs in protein synthesis, genetic code-salient features.

Self study(SS):Basics of carbohydrates, origin, types, examples, stereo isomers of D-Glucose, Basic chemistry of amino acids, types of amino acids, history of nucleic acids.
Skill components: Students need to analyse spectral data of D- Glucose and D-Fructose(open source/record). Pentapeptide sequence (H2N-Leu-Ala-Phe-Pro-Gly-OH) analyzed mass spectrometry fragmentation pattern and confirm the sequence. DNA and RNA mass determination techniques may be model/analyzed (open source).

UNIT –III **16 h**

ALKALOIDS AND TERPENOIDS

Alkaloids: Introduction, classification, methods of isolation, general methods of isolation from plants, general methods of structural elucidation, structural elucidation and synthesis of ephedrine and quinine. Structure and biological importance of cocaine, codaine, thiebane and morphine.
Terpenoids: Introduction, classification, isoprene rule, structural elucidation and synthesis of menthol and zinzeberine.
Antibiotics: Introduction, classification, structure and their importance of penicillins, chloramphenicol, streptomycine, chloromycitin and tetracyclins, synthesis of cepahloshorin-C.

Self study (SS):Basics of alkaloids, terpenoids and antibiotics, isolation and nomenclature.
Skill components (SC): Analyzeeach one compound of the above class using various spectra.

UNIT –IV **16 h**

STEROIDS, ANTIBIOTICS AND PROSTAGLANDINS

Steroids: Introduction, classification; Diels hydrocarbon- its importance and synthesis, stereochemistry of cholesterol.
Structural elucidation of cholesterol-Blanc's rule, location of double bond, hydroxy group, angular methyl groups and side chain in cholestrerol, total synthesis.
Prostaglandins: Introduction, classification and biological importance, constitution of PGE_1, synthesis of PGE_1 by Corey's and Upjohn's approach.
Vitamins: Definition, Classification and biological importance, synthesis of vitamin C from D(+)-Glucose, synthesis of vitamin A.

Self study(SS): Basics of steroids , Prostaglandins, Vitamins, occurrence, nomenclature and isolation.
Skill components(SC):Students can make model of cholesterol.Students need to perform a small group project on water soluble & fat soluble vitamins, andanalyze Vit- A UV-vis and FT-IR data (record/open source).

REFERENCE BOOKS:

01. Organic synthesis- Design, reagents, reactions and rearrangements by Jagdamba Singh and Dr. L.D.S. Yadav , Pragati prakashan educational publishers , 2005.
02. Workbook for Organic synthesis- The disconnection approach by Stuart Warren, Volume 2, published by John Wiley & sons. reprinted 2001.
03. Organic synthesis- Strategy and control by Paul Wyatt and Stuart Warren , , published by John Wiley & sons. 2013.
04. F. A. Carey and Sundberg, Advanced Organic Chemistry : Part A – Structure and mechanism, 4th edition Kluwer academic publishers , New York, 2002. & Part B- Reaction and synthesis, 5th edition, spingers publication, 2007.
05. Chemistry of natural products by Sujata V.Bhat, Bhimsen A.Nagasampagi, Meenakshi Sivakumar , edited by Meenakshi Sivakumar , Bhimsen A.Nagasampagi, published by Springer science & business media, 2005.
06. Natural products by O.P. Agarwal, published by Krishna prakashan media, 2006.
07. Organic chemistry of natural products volume 1 by Gurdeep chatwal. Published by Himalaya publishing house , 2015.
08. Organic chemistry of natural products volume 2 by Gurdeep chatwal edited by M. Arora , by Himalaya publishing house , 2015.
09. Natural products – Their chemistry and biological significance by J.Mann and R.S. Davidson , published by Longman scientific & technical, 2009.
10. F. A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
11. Comprehensive Organic Synthesis – B. M. Trost and I. Fleming series, Pergamon Press, New York, 1991.
12. S. K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998
13. Terpenes, J. Verghese, Tata McGraw-Hill, New Delhi, 1982.
14. Chemistry of terpenes and terpenoids, A. Newman, Academic Press, London, 1975.
15. Chemistry of natural products Vol. I & II, O. P. Aggarwal, Goel Publishing House, 6thEdn. 1982.
16. Medicinal natural products: A biosynthetic approach, P. M. Dewick. John Wiley, Chichester, 1997.
17. The colours of life: An introduction to the chemistry of porphyrins and related compounds, L. R. Milgrom, Wiley Chichester, 1995.
18. Chemistry of natural products: A unified approach, N. R. Krishnaswamy, University Press, India, 1999.
19. Terpenes, J. Verghese, Tata McGraw-Hill, New Delhi, 1982.
20. Handbook of naturally occurring compounds Vol. II: Terpenes, T. K. Davon, I. Scott, Academic Press, NY, 1972.

CHOPr-4.7: ORGANIC CHEMISTRY PRACTICAL-IV

Duration: 4 h/ week & Total: 64 h Credits : 2

PART-A : Isolations

01. Isolation of cysteine from human hair
02. Isolation of hesperidine from orange peel
03. Isolation of myristine from nutmug
04. Isolation of lycopene from tomato
05. Isolation of piperine from pepper
06. Isolation of caffeine from tea
07. Isolation of casein from milk
08. Isolation of nicotine from tobacco

PART-B : INSTRUMENTAL METHODS IN ORGANIC ANALYSIS

01. Recording/predicting/downloading from web sites the UV, IR, NMR and GC-MS/mass spectra of the compounds prepared in C-105/205/305 (Organic Practical – I), C-106/206/306 (Organic Practical – II), C-405 (Organic Practical – III) and C- 406 (Organic Practical – IV).
02. Structural elucidation of organic compounds with the help of spectra provided by the instructors/examiners.

REFERENCE BOOKS:

01. Vogel's Text Book of Practical Organic Chemistry, Brian S , Furniss, Anthony j. Hannaford, 5th Edition, Pearson India, 2005.
02. Practical Organic Chemistry F.G. Mann, B.C Saunders, Fourth edition, Pearson India,2011.
03. Systematic Laboratory Experiments in Organic Chemistry Arun Sethi, New Age International, 2003.
04. Comprehensive Practical Organic Chemistry: Qualitative Analysis Ahluwalia V.K. Sunitha Dhingra, First edition, Orient Longman, 2004
05. Practical Organic Chemistry: Qualitative Analysis Bhutani S.P. Chhikara A, First edition, ANE books-new Delhi, 2009
06. Laboratory techniques in Organic chemistry-V.K. Ahluwalia , Pooja Bhagat & Renu Aggarwal, I.K. International Publishing House Pvt.Ltd.
07. Laboratory Manual of Organic Chemistry Raj K. Bansal. 5th edition, New Age international publishers, 2008.
08. Modern experimental Organic Chemistry John H. Miller and E. F. Neugil
09. An introduction to practical Organic Chemistry Robert, Wingrove etc.
10. Semimicro qualitative Organic Analysis Cheronis, Entrikin and Hodnet.
11. Practical Organic Chemistry N. K. Visnoi, New AGE International(P) Ltd. London, 3rd edition, 1996.

CHPT-4.3: PHYSICAL CHEMISTRY-IV

Teaching: 4 h/ week & Credits : 4 **Total: 64 h**

UNIT–I **16 h**

PARTIAL MOLAR PROPERTIES

Partial molar properties, concept of partial molar properties, consequences of partial molar property concept. Physical significance of partial molar quantities. Determination of partial molar properties (direct method, intercept method, apparent molar properties). Chemical potential, physical significance of chemical potential, variation of chemical potential with pressure and temperature. Gibb's Duhem equations, chemical potential of a pure solid or liquid. Chemical properties of pure ideal gas, non ideality, activity, fugacity, activity coefficients for solutes and solvents. Determination of activity coefficient, thermodynamic function of ideal gases i) free energy of ideal mixing (□G mix) ii) enthalpy of ideal mixing iii) entropy of ideal mixing iv) volume of ideal mixing v) Helmholtz's free energy of ideal mixing vi) Duhem-Margules equation and its applications. Thermodynamics of ideal and non ideal solutions. Relationship between chemical potential Kapler-Clausius equation.

Self study(SS): Applications of partial molar properties, relationship to thermodynamic potentials.

Skill Component: Measuring partial molar properties**,** Formal Report on Partial Molar Volume Experiment

UNIT–II **16 h**

NANOMATERIALS & LIQUID CRYSTALS

Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic – nematic transition and clearing temperature- homeotropic, planar and schlieren textures, twisted nematics chiral nematics, molecular arrangements in smectic A & C phases. Optical properties of liquid crystals.

Nanomaterials: Introduction – importance and characterization of nanomaterials – stability of nanoparticles In solutions – synthesis of metal nanomaterials: Physical methods (Laser Ablation, Evaporation, sputtering and solvated metal dispersion) chemical methods (Thermolysis, Sonochemical approach, reduction of metal ions by hydrogen and methanol)

Self study(SS): Physical and Chemical properties of Nanomaterials, Current study and research work on Nanoscience and Liquid Crystals.

Skill Component: Synthesis of nanomaterials by chemical method.

UNIT–III **16 h**

CHEMICAL KINETICS

Kinetics of opposed reactions, 1^{st} order opposed by 1^{st} order, 1^{st} order opposed by 2^{nd} order. 2^{nd} order opposed by 2^{nd} order. Kinetics of parallel and simultaneous reactions,(derivation of rate equations), time for maximum concentration of intermediate, Kinetics of chain reactions, activation energy of chain reactions, chain

length, chain transfer reactions, inhibition decomposition of C_2H_6, Reaction between H_2 with Br_2 and Cl_2, decomposition of O_3, Rice-Herzfeld mechanism with example(CH_3CHO), polymerization reactions. Kinetics of polymerization reactions, free-radical mechanism, kinetics of addition polymerization.

Self study(SS): Factors effecting rate of reaction, Elementary reactions, Molecularity of reactions. Differential and integrated rate laws.

Skill Component: Literature survey of chemical kinetics.

UNIT–IV **16 h**

ELECTROCHEMISTRY AND ELECTROPLATING

Electrical double layer and its structure Helmoltz-Perrin, Guoy-Chapman and Stern models. sedimentation potential, Dorn effect, streaming potential, Zeta potential and its determination, kinetics of electrode process, Butler Volmer equation, Tafel equation, generation of hydrogen. Bio-electrochemistry, biosensors, communication in biological systems.

Industrial Electrochemistry: Electro-organic and inorganic syntheses.

CORROSION AND PLATING: Types, measurement and preventive methods, metallic and non metallic coatings. Corrosion inhibition. Measurement of corrosion rate by weight loss, Tafel plots. Homogeneous theory of corrosion. Evans diagrams. Potential- pH (Pourbaix) diagrams of iron. Metal finishing, electroplating of single metals like Zn, Cd, Cu, Au, Pt- alloy plating, industrial application.

Self study(SS): Electrolysis and Electrolytic Cell, Electrochemical Series, Applications of electrolysis.

Skill Component: Electrodeposition of Zn and Cu from different alkaline bath solutions.

REFERENCE BOOKS:

01. Elements of statistical thermodynamics- E.K.Nash, Wesley, 1974
02. Statistical thermodynamics- M.C.Gupta, Willey Eastern ltd. 1990.
03. Statistical mechanics-Doley.
04. Textbook of polymer science –Billmeyer, Willey Intersection.
05. Elements of statistical thermodynamics- E.K.Nash, Wesley, 1974
06. Statistical thermodynamics- M.C.Gupta, Willey Eastern ltd. 1990.
07. Statistical mechanics-Doley.
08. Introduction to Solid state Physics—C. Kittel, 5th Edition, Wiley Eastern, Ltd.
09. Glasstone S. ;Electrochemistry; Litton Educational pub.
10. Barrow G.M.; Physical Chemistry, Benjaman Publishers, New York.
11. Puri B.H., Sharma L.R. and Pathania M.S.; Principles of Physical Chemistry, Vishal Publishing Co., 42nd Edition.
12. Glasstone S.G.; Physical Chemistry, D.Van Nostrand, New York (1946) 1198.
13. Jeffrey I Steinfeld, Joseph S F and William L. Hase; Chemical Kinetics and Dynamics Printice Hall, 2nd edition, 1998
14. C.N.R. Rao and J. Gopalakrishna "New Directions in solid state chemistry" Cambridge University Press, Cambridge (1999).
15. Electrochemistry –Principles and applications by E.G. Potter.
16. Electrochemistry by Reiger, Prentice Hall (1987).

CHPPr-4.8: PHYSICAL CHEMISTRY PRACTICAL-IV

Duration: 4 h/ week & Total: 64 h **Credits : 2**

Chemical Kinetics

1. Kinetics of acid catalyzed of hydrolysis of methyl acetyl and determination of energy activation.
2. Study of kinetics of autocatalytic reaction between $KMnO_4$ versus oxalic acid.
3. Evaluation of Arrehenius parameter for the reaction between $K_2S_2O_8$ versus KI (first order)

Partial Molar properties:

1. Partial Molar volume of ethanol-water system by intercept method.

Electoplating:

1. Electro deposition of Copper sulphate
2. Corrosion of an electrode

Semi Conductors:

1. To calculate the band gap energy (E_g) in semiconductors

REFERENCE BOOKS:

1. B. Vishwanathan, P.S. Raghavan; Practical Physical Chemistry,Viva Books,2010.
2. J.B.Yadav; Advance Practical Physical Chemistry, Goel Publishing House,10th Edition.
3. Gurdeep Raj; Advance Practical Inorganic Chemistry, Goel Publishing House,19 th Edition.
4. V.D. Athawale, P. Mathur; Experimental Physical Chemistry, New age International Publishers.
5. S. W. Rajbhoj, T.K. Chondherkar; Systematic experimental physical Chemistry, Anjali Publication.
6. Experimental Physical Chemistry –F. Daniels et al.
7. Selected Experiments in Physical Chemistry – Latham.
8. Experiments in Physical Chemistry – James and Prichard.
9. Experiments in Physical Chemistry – Shoemaker.
10. Advanced Physico-Chemical Experiments –J. Rose.
11. Practical Physical Chemistry –S.R. Palit.
12. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
13. Experiments in Physical Chemistry – Palmer.
14. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
15. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill

CHGT-4.4: SPECTROSCOPY-IV

Teaching: 2 h/ week & Credits : 2 **Total: 32 h**

UNIT–I **16 hours**

FLAME EMISSION and CHIROPTICAL SPECTROSCOPY

Flame emission spectroscopy: Introduction, principle, flames and flame spectra variation of emission intensity with flames, flame background, metallic spectra in flame. Total consumption and premix, Butters interference, roll on temperature on absorption, and applications.

Chiroptical spectroscopy: Plane polarized light, instrumentation, optical rotary dispersion (ORD), plane curves, Cotton effect curves, application of optical rotation method in the determination of rate constants, acid catalyzed muta-rotation of glucose, inversion of cane sugar, octant and haloketone rules, applications. ORD in the determination ofconfiguration of cyclic and steroidal ketones.

Self study(SS):Basic of atomic spectra, Bunsen flame, Polarized light, optical activity, specific rotation.

Skill components(SC):Students need to analyze one ORD spectrum of steroid stereochemistry and two halo ketone compounds (open source) and simple structure model may be constructed.

UNIT–II **16 hours**

MOLECULAR LUMINESCENCE and PHOTOELECTRON SPECTROSCOPY

Molecular luminescence spectroscopy: Theoretical basis for fluorescence andphosphorescence. Singlet and triplet excited states. Variables affecting luminescence-quantum efficiency, transition types, structure and structural rigidity, temperature and solvent effects, effect of pH, dissolved oxygen and concentration effect. Excitation spectra *vs* emission spectra. Fluorescence instrumentation-fluorometers and spectrofluorometers. Sensitivity and selectivity. Modification necessary to measure phosphorescence. General scope of applications of luminescence.

Photoelectron spectroscopy: Introduction, principles, chemical shifts, photoelectron spectra ofsimple molecules, X-ray photoelectron and Auger electron spectroscopy, applications.

Self study(SS):Basic of fluorescence and phosphorescence, singlet and triplet states, photo-ionization process, chemical shifts and basic of photoelectron spectra.

Skill components(SC):Students need to list out THREE molecule fluorescence spectra and analyze. Students need to collect N2, NaN3 and HBr molecules photoelectron spectra (open source) and analyze.

REFERENCE BOOKS:

1. Chiroptical spectroscopy : Fundamentals and applications by Prasad L.Polavarapu, CSR press, 2016.

2. Comprehensive Chiroptical spectroscopy : Instrumentation , methodologies and theoretical simulations, volume 1 , by Nina Berova, Prasad L.Polavarapu, Koji Nakanishi, Robert W.Woody. John Wiley & sons, 2012.
3. Comprehensive Chiroptical spectroscopy : Applications in stereochemical analysis of synthetic compounds, natural products and biomolecules volume 2, by Nina Berova, Prasad L.Polavarapu, Koji Nakanishi, Robert W.Woody. John Wiley & sons, 2012.
4. Vibrational optical activity : Principles and applications by Laurence A.Nafie , Wiley pubublishers, 2011.
5. Chiral analysis : Advances in spectroscopy , chromatography and emerging methods by Prasad L.Polavarapu, 2nd edition . Elsevier publication , 2018.
6. Analytical automic spectroscopy (volume 2 of modern analytical chemistry) by William G. Schrenk , Plenum press, 1975. Dizitized on 2010.
7. Handbook of flame spectroscopy by Michael Loewen Parsons, Benzamin William Smith, Glenn Edward Bentley , plenum press, 1975. Dizitized on 2010.
8. Molecular luminescence spectroscopy : Methods and applications by Stephen Gregory Schulman , Wiley publications 1993, dizitized on 2010.
9. Photoelectron spectroscopy : Principles and applications , by Hufner. s. Springer publications , 2003.
10. Augur and X-Ray Photoelectron spectroscopy in material science by Hofmann, Siegfried . Springer publications, 2013.

Question paper Pattern of 4 Credit Paper

_ Semester (Regular/ Repeater) M.Sc. Degree (CBCS) Examination, June/July-20xx

CHEMISTRY

Paper Code: Subject

Time : 3 Hours Max. Marks : 80

*Instructions: Answer **all** questions*

1. Answer **any eight** of the following questions. (8x2 = 16)
   a)
   b)
   c)
   d)
   e)
   f)
   g)
   h)
   i)
   j)

2. a)
   b)
   c)

   OR

   d) (5+5+6)

3. a)
   b)
   c)

   OR

   d) (5+5+6)

4. a)
   b)
   c)

   OR

   d) (5+5+6)

5. a)
   b)
   c)

   OR

   d) (5+5+6)

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Question paper Pattern of 2 Credit Paper

_ Semester (Regular/ Repeater) M.Sc. Degree (CBCS) Examination, June/July-20xx

CHEMISTRY

Paper CHGT-x: Spectroscopy-x

Time : 2 Hours Max. Marks : 40

*Instructions: Answer **all** questions*

1. Answer **any four** of the following questions. (4x2 = 8)
   a)
   b)
   c)
   d)
   e)
   f)

2. a)
   b)
   c)

   OR

   d) (5+5+6)

3. a)
   b)
   c)

   OR

   d) (5+5+6)

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