



**RANI CHANNAMMA UNIVERSITY
(RCU)**

**SCHOOL OF BASIC SCIENCES
Department of Chemistry**

**REGULATIONS
&
SCHEME OF EXAMINATION**

for

M.Sc. degree in ORGANIC CHEMISTRY

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

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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 ORGANIC 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 **2 practicals each of 3 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 2 practicals each of 3 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 for 2 Credit paper (1st & 2nd Sem) and 6 h for 3 Credit Papers (3rd and 4th sem) 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 in ORGANIC CHEMISTRY:** 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.
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Course structure of M.Sc. degree in ORGANIC 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 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
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	2 P	2 × 6 = 12	2 × 6 h	2 × 15	2 × 60	2 × 75	2 × 3 = 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	2 P	2 × 6 = 12	2 × 6 h	2 × 15	2 × 60	2 × 75	2 × 3 = 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/ Project, 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 ORGANIC 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	CHORT - 3.1: Organic Chemistry-III A	4	3	80	20	100	4
	CHORT - 3.2: Organic Chemistry-III B	4	3	80	20	100	4
	CHORT - 3.3: Organic Chemistry-III C	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	CHORPr- 3.6: Organic Chemistry Practicals-III A	6	6	60	15	75	3
	CHORPr- 3.7 : Organic Chemistry Practicals-III B	6	6	60	15	75	3
Total		30	28	480	120	600	24
4th semester							
Hard Core	CHORT- 4.1: Organic Chemistry-IV A	4	3	80	20	100	4
	CHORT- 4.2: Organic Chemistry-IV B	4	3	80	20	100	4
	CHORT- 4.3: Organic Chemistry-IV C	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	CHORPr -4.6: Organic Chemistry Practicals-IV A	6	6	60	15	75	3
	CHORPr -4.7: Organic Chemistry Practicals-IV B	6	6	60	15	75	3
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
Dept. of CHEMISTRY

Syllabus of M.Sc. degree in ORGANIC 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-Landé's equation, calculation of lattice energy from Born-Landé's equation (problems should be solved), conclusions from Born-Landé 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 Boron 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 coordination 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 planar complexes. MO-Theory with π (pi)-bonding applied to octahedral complexes.

Metal Clusters

Dinuclear compounds: Quadrupole 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.

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 $[\text{Co}_2(\text{CO})_8]$, $[\text{Co}_4(\text{CO})_{12}]$ and $[\text{Fe}_3(\text{CO})_{12}]$.

Preparation and structural aspects of $\text{Ni}(\text{CO})_4$, $\text{Fe}(\text{CO})_5$ and $\text{Co}_2(\text{CO})_8$ by direct reaction of metals, $\text{V}(\text{CO})_6$, and $\text{Mn}_2(\text{CO})_{10}$ 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 nitrosyl 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 $\text{Ni}(\text{CO})_4$, $\text{Fe}(\text{CO})_5$ and $\text{Co}_2(\text{CO})_8$

Skill component: Preparation of one metal nitrogen 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

1. Vogel's Textbook of Quantitative chemical analysis, - J Mendham, R.C. Denney, J.D. Barnes M.J.K. Thomas, Pearson 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 in interpreting 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_{NAr} 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 (retention & inversion), rate of reaction and activation energy.

Skill components(SC): S_N1 & S_N2 products may be analyzed by polarimeter method and record and analyze 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, racemic 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 agents, reducing agents, and 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 are recorded/analyzed by suitable data.

REFERENCE BOOKS:

01. Organic reaction mechanisms- V.K. Ahluwalia, R.K. Parashar, 4th 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. 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. A guidebook to mechanisms in organic chemistry by Peter Skyes, 6th edition, peason education India, 2006.
10. P. J. Garratt in Comprehensive organic chemistry, D. Barton and W. D. Ollis, 1st Edn. Pergamon Press, Oxford, 1979.
11. 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 benzoic acid from benzaldehyde
07. Preparation of 2-hydroxynaphthaldehyde 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. 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-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). 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, Debye-Huckel-Onsager equation(derivation) and Debye-Huckel limiting law(derivation), quantitative and qualitative treatment of Debye-Huckel limiting law, Onsager activity co-efficient, mean ionic strength (Debye-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 (T_g) and flow temperature (T_f) and melting temperature (T_m). Thermal behavior of amorphous and crystalline polymers, factors affecting T_g . Plasticizers, properties and their effect on T_g of PVC. Comparison of T_g and T_m , T_g of copolymers and polymer blends, relation between T_g and T_m . Preparation, properties and commercial importance: polyethylene, polystyrene, polyvinyl chloride, poly sulphone, polyurethanes, 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 divergent 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 uncertainty 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-rigid and non rigid rotator model (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-Stokes lines, 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 uncertainty, diatomic molecules, isotopes, polyatomic molecules, moment of inertia, tri-atomic molecules, bond length, dipole moments, Raman Theory and 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 λ_{max} , prediction of λ_{max} 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 simple harmonic 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 Beer's law, Lambert's law, Beer's-Lambert's law, chromophores, auxochromes, and 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, 6th edition New age international publishers. Reprint 2005.
3. Modern spectroscopy by J.Michael Hollas , published by John Wiley& sons, Ltd. 2004.
4. Elementary 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, 2nd 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 sample size. Errors, types of errors, determinate and indeterminate errors, accuracy and precision. Distribution of random errors, frequency distributions normal error curves. Statistical treatment of finite samples, measure central tendency -mean, median, 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 methods, errors, accuracy, precision, central tendency and sampling method.

Skill components(SC): Students should be 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-Deemeter's equation, column resolution, factors influencing resolution.

THIN LAYER CHROMATOGRAPHY

Introduction, stationary and mobile phase systems, R_f value calculation, various techniques 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) applications in 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 solvent extraction, electrophoresis, TGA, DTA and DSC.

Skill components(SC): Students should be able to do the binary mixture separation of given compounds 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. Principles of Instrumental Analysis, D.A. Skoog, E.J. Holler, T.A. Nieman, 5th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
02. Instrumental analysis by D.A. Skoog, E.J. Holler, S.R.Crouch, 11th Indian reprint, cengage learning India Pvt.Ltd. New Dehli, India, 2012.
03. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, E.J. Holler, S.R. Crouch, 8th Edition, Thomson Aisa Pvt. Ltd., Singapore, 2004.
04. Analytical Chemistry – Theory and Practice,, R.M. Verma, 3rd Edition, CBS Publishers ,New Delhi, India, 2012.
05. Principle of Quantitative Chemical Analysis by Robert de levie, International edition , McGraw Hill Co. 1997.
06. Quantitative Analysis- Day and Underwood, Prinitce Hall Indian, Pvt Ltd 6thedition (1993).
07. Vogel's Textbook of quantitative chemical analysis- Revised by G.H.jaffery, J. Bassett, J. Mendhm and R.C. Denney ELBS 5thedition (1998).
08. Quantitative Chemical Analysis: D.C Harris W.M. Freeman and Co, 6th edition NY, USA, Ed, 2003.
09. Physical Methods in Inorganic Chemistry- R. Drago, Affiliated to East west Pvt, (1968).
10. Basic Concepts of analytical Chemistry- S.M Khopkar, New Age Intentional Publishers, IIEd.,(1998).
11. Analytical chromatography- G.R Chatwal, Himalaya Publishing House, VII Ed., (1998).
12. Introduction to Chromatography- Theory and Practice, V.K. Srivatsan and K.K. Srivatsan, S. Chand Company Ltd. 4th Edition (1991).

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-Mauguin 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: Bravais lattices, Miller indices, external features of crystals.

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

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. Arnikaar, 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. $K_3[Al(C_2O_4)_3] \cdot 3H_2O$ & $[Cu(thiourea)_3]_2 SO_4 \cdot H_2O$
02. Estimation of Copper in trithiourea 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-Löffler-Freytag reaction, Stork enamine reaction.

C-O bond forming reactions: Sharpless asymmetric epoxidation, Bayer-Villegier 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 tetraacetate, periodic acid, osmium tetroxide, selenium dioxide, Oppenauer oxidation.

Reduction reactions: Introduction, Catalytic hydrogenation-both heterogeneous (examples Nickel and palladium) and homogeneous, metal hydride reductions ($NaBH_4$ and $LiAlH_4$), 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, Sommet-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, analyze reactants and products using spectral data (record/online source).

UNIT-IV

16 h

HETEROCYCLIC COMPOUNDS

Nomenclature of heterocyclic compounds-Hantz-Wiedemann 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 – azetidines, oxetanes and thietanes

6-Membered heterocyclic compounds with one and two hetero atoms – pyridine, pyrimidine, quinoline.

7-Membered heterocyclic compounds – azepines, oxepines, thiepinines.

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, microcanonical 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-dirac 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 E_a .

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 Reinecke's salt actinometers.

A review of laws of photochemistry -Grotthus-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, TiO₂, solar cells, principle, application of ZnO/TiO₂ 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 TiO₂ nano semiconductors.

REFERENCE BOOKS:

01. Statistical thermodynamics by B.C. Mecllland, 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, Clarendon, 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 H₂SO₄).
- d. Study of kinetics of autocatalytic reaction between KMnO₄ versus oxalic acid.
- e. Evaluation of Arrhenius parameter for the reaction between K₂S₂O₈ 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 colorimetric method and calculation of molar extinction co-efficient (molar absorption co-efficient)
- c. To construct the calibration curve Fe²⁺-KCNS and Cu²⁺-NH₃ systems and estimate the amount of respective salt present in a given solution by colorimetrically

REFERENCE BOOKS:

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

Nature of protons bonded to carbon and other nuclei, Proton 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 magnetic field strength, double resonance, deuterium exchange reactions, and lanthanide shift reagents. Nuclear Overhauser Effect (NOE), variable temperature probe.

¹³C-NMR Spectroscopy: Comparison of ¹H-NMR and ¹³C-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: C₂H₅OH, CH₃-CO-CH₃, C₆H₆, CH₃OH and CH₃CH₂CH₂OH, analyse ¹H, ¹³C 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, ^1H 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 by 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 A₂, 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; Anthelmintics - 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 ORGANIC CHEMISTRY @ RCU
III SEMESTER**

CHORT-3.1: ORGANIC CHEMISTRY-III A

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 reagents in 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-Loefer-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, electrocyclic 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-Paraacetamol, 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, 4th 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 3rd 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. Radicals in organic synthesis, volume 5, by Bernd. Giese, Pergamon Press, 1986.

CHORT-3.2: ORGANIC CHEMISTRY-IIIB

Teaching: 4 h/ week & Credits : 4

Total: 64 h

UNIT-I

16 h

NATURE AND BONDING IN ORGANIC MOLECULE

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes. Aromaticity in benzenoid and non-benzenoid compounds, alternant and nonalternant hydrocarbons, Huckel's rule, energy level of π -molecules orbitals, annulenes, antiaromaticity, homoaromaticity. Aromatic character and chemistry of cyclopentadienyl anion, tropylium cation, tropone and tropolone, bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes, synthetic applications of enamines and imines anions in organic synthesis.

Self study(SS): Basics of bonding, delocalization, hyperconjugation, resonance effect, aromaticity, non-aromaticity, anti-aromaticity, electrophiles and nucleophiles, anions, cations, hydrogen bond, covalent bond, co-ordinate bond, crown ethers and phase transfer catalysts.

Skill components(SC): Analyse benzenoid (Naphthalene, Anthracene) and non-benzenoid (Azulene) compounds by suitable spectral data.

UNIT-II

16 h

DYNAMIC STEREOCHEMISTRY

Prochirality: Homotopic, heterotopic, enantiotopic and diastereotopic ligands and faces, identification using addition, substitution and symmetry criteria, nomenclature of stereoheterotopic ligands and faces, symbols for stereoheterotopic ligands in molecules with one or more prochiral centres, chiral and prochiral centre; prochiral plane, symbols for enantiotopic and diastereotopic faces.

Dynamic Stereochemistry: Stereoselectivity in organic synthesis: stereospecific and stereoselective reactions, principle of stereoselectivity-enantioselectivity and diastereoselectivity, use of chiral auxiliaries, Cram's and Prelog's rules.

Stereoselectivity in addition, elimination, substitution reactions.

Self study(SS): Basics of stereochemistry, enantiomers, diastereomers, R&S configuration, threo & erithro, cis&trans, E&Z configuration, priority order, ligands, chirality, stereoselectivity, diastereoselectivity, addition, elimination and substitution reactions.

Skill components(SC): Students need to differentiate between stereospecific and stereoselective reactions in organic compounds.

UNIT-III

16 h

DYES AND PIGMENTS:

Colour and Constitution (electronic concept). Classification of dyes. Methods of applying dyes to the fibres. A general study of the following dyes (Principle involved and synthesis of typical dyes).

Azo dyes: Orange – II, Mordant brown, Congo red, Methyl orange and Methyl red.

Triphenyl methane dyes: Malachite green, Rosaniline, Crystal violet and Phenolphthalein.

Cyanine dyes: Ethyl red, Cyanine blue and Quinaldine.

Sulphur dyes: Sulphur blue, Sulphur brown and Sulphur blue.

Reactive dyes and Optical brightners: Tinopal and Blankophorppp.

Pigments: Fast violet, Lake red and Orange R.

Self study(SS): Basics of dyes, their classification, and principles involved in the synthesis of typical dyes and pigments.

Skill components: Students need to prepare some derivatives using azo dyes by laboratory method.

UNIT-IV

16 h

OILS, FATS AND LIPIDS

Oils, fats and waxes: Definition, chemical composition, chemical properties-hydrogenation, hydrogenolysis, hydrolysis, drying oils, rancidity, analysis of oils and fats-saponification value, iodine and acid value. Soaps-Manufacture of soaps by hot process, cleansing action. Synthetic detergents, comparison of soaps and detergents, types of detergents (cationic, anionic and nonionic). Animal and plant waxes-composition, examples.

Lipids: Sphingolipids, phospholipids and glycolipids, naturally occurring fatty acids and their triglycerides, essential fatty acids, unusual fatty acids, methods of isolation: Gunstone's partition method, reactions of fatty acids-Fischer and trans esterification, oxidation and acyl group transfer reactions, analytical values-cetane number, emulsions and biodiesel.

Self study: Basics of hydrogenation, hydrogenolysis, hydrolysis, drying oils, rancidity, oils, fats, saponification, soaps, detergents, waxes, esterification, emulsion, biodiesels, and fatty acids.

Skill components: Students need to carry out some small experiments of soaps and detergents with oil and compare the difference between them.

REFERENCE BOOKS:

01. 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.

02. Comprehensive Organic Synthesis – B. M. Trost and I. Fleming series, Pergamon Press, New York, 1992.
03. Dyes and pigments, by Ahmet. Gurses, Metin. Acikyildiz, Kubra Gunes, M.Sadi Gurses, springer publication, 2016.
04. Industrial dyes: Chemistry, properties applications by Dr. Klaus Hunger(editor) , Wiley publication, 2002.
05. Synthetic dyes by Gurdeep R.Chatwal, revised edition, Himalaya publishing house, 2009.
06. S. K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998 .
07. Metal – free synthetic organic dyes by G.M.Ziarani, R.Moradi, N.Lashgari, H.G.Kruger, Elsevier publications , 2018.
08. Colour chemistry by R.L.Allen, illustrated edition, springer science & business media publishers, 2013.
09. 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.
10. Fatty acids and lipid chemistry by Frank Gunstone, Springer publications, 1996.
11. Fats and oils by Richard D.O Brien, 2nd edition, published by Taylor & francis Inc.
12. The colours of life: An introduction to the chemistry of porphyrins and related compounds, L. R. Milgrom, Wiley Chichester, 1995.
13. Handbook of naturally occurring compounds Vol. II: Terpenes, T. K. Davon, I. Scott, Academic Press, NY, 1972.
14. Stereochemistry: Prochirality, enantiotopic and diastereotopic groups and faces : NMR Spectroscopy in stereochemistry. by David. G.Morris. RSC ,2001.
15. Stereoselective synthesis by R.S. Atkinson , John Wiley & sons, Newyork, 1995.
16. Organic chemistry , Jonathan clyden, Nick Greeves and Stuart warren. 2nd edition , Oxford university press , UK 2014.
17. Stereochemistry of Organic compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley & Sons, 1994.
18. Stereochemistry of Organic compounds- Principles and applications, Nasipuri, D, Revised 2nd Edition, New Age International Pvt. Ltd., New Delhi, 2009.
19. Organic chemistry of natural products volume 1 by Gurdeep chatwal. Published by Himalaya publishing house , 2015.
20. Organic chemistry of natural products volume 2 by Gurdeep chatwal edited by M. Arora , by Himalaya publishing house , 2015.

CHORT-3.3: ORGANIC CHEMISTRY-IIIC

Teaching: 4 h/ week & Credits : 4

Total: 64 h

UNIT-I

16 h

POLYMER CHEMISTRY

Preparation and Significance: Preparation of polymers based on different types of monomers. Industrial applications. Nylon, Urea formaldehyde, phenol-formaldehyde and melamine resin. polycarbonates and its applications.

Rubbers: Natural and synthetic rubbers. Structural elucidation of natural rubber. Polymers degradation reactions. Thermal, oxidative and radiative processes.

Synthesis and properties of Buna-S and butyl rubber.

Characterization: Isolation and purification of polymers-Fractional precipitation, partial dissolution, gradient elution and Gel permeation chromatography. Principles of determination of molecular weights-End group analysis, viscosity, light scattering, osmometry, cryoscopy, ebulliometry and ultracentrifugation method. Characterization of the above polymers by Thermogravimetry, Differential thermal analysis and Differential scanning calorimetry.

Self study: Basics of polymers, rubbers, Thermal, oxidative and radiative processes, and analytical chemistry (Electrophoresis, thermal methods of analysis and chromatography)

Skill components: Students need to do the Characterization of the given polymers by Thermogravimetry (TG), Differential thermal analysis(DTA) and Differential scanning calorimetry (DSC) methods.

UNIT-II

16 h

PETROCHEMICALS:

Petroleum refining, constituents of petroleum and their separation. Conversion process (Cracking, reforming, alkylation etc.) for precursors of petrochemicals. Brief description of the chemistry and applications of ethylene, propylene, butylenes, acetylene, benzene and some of their derivatives and conversion into useful products.

Synthetic fibres, rubbers and plastics.

Newer Reactions: Japp-Klingaman reaction, Meerwein arylation, Nef reaction, Raush asymmetric allylation, Sharpless asymmetric dihydroxylation, Ugi-multicomponent reaction and Williamson ether synthesis.

Self study: Basics of petroleum refining, constituents of petroleum their separation, Synthetic fibres, rubbers and plastics.

Skill components: By using the application of the given alkenes(ethylene, propylene, butylenes, acetylene, benzene) and their derivatives , covert them into useful products by laboratory methods.

UNIT-III

16 h

AMINO ACIDS AND SOLUTION PHASE PEPTIDE SYNTHESIS

Amino acids, classification, stereochemistry, acid and base properties, biologically active amino acids, peptides and proteins—enzymatic hydrolysis, N-terminus protection, protecting reagents both acid and base labile, C-terminus protection, Amide bond formation: methods and strategies, Acyl chlorides synthesis, Coupling reactions with acyl chlorides, Limitations of acyl chlorides, Acyl fluorides, fluorinating agents, Acyl azides, Acylimidazoles using CDI, Anhydrides: Symmetric anhydrides, Mixed anhydrides, N-carboxy anhydrides or Leuch's anhydrides Esters, Active esters of pentafluorophenol and Succinimidyl esters synthesis and applications, Phosphonium salts and Uronium salts reagents in peptide formation.

Self study: Basics of amino acids, polypeptides, proteins and nucleic acids – Definition, classification, characteristics and examples.

Skill components: Analyse and interpret with some suitable data for DNA and RNA in protein synthesis

UNIT-IV

16 h

NANO-BIO SYSTEMS

Drug delivery using nanomaterials: Targeted and controlled drug release through covalent, non-covalent and defect functionalization (conjugation) of carbon nanotubes (CNTs).

Conjugation of biomolecules to other nanomaterials (noble metals, metal oxides, fullerenes and graphene) for targeted drug / gene delivery.

Enzymes: Biological significance, analysis and assay of enzymes (pepsin, chymotrypsin, tyrosinase) and hormones (progesterone, oxytocin, insulin), Enzyme catalyzed biotransformation - chemical transformation by Aldolase.

Bio-sensors: An overview, types, design and applications.

RNA/DNA Cleavages: Introduction, methods and applications.

Self study: Basics of drugs, Nanomaterials (CNTs), biomolecules, enzymes, hormones, DNA and RNA.

Skill components: Students need to prepare a model on Bio- sensors.

REFERENCE:

1. Polymer chemistry – An introduction by Malcolm P.Stevens, 3rd edition, Oxford university press, 1998.
2. Organic polymer chemistry by K.J.Saunders 2nd edition, Chapman and Hall publishers, 1973.
3. Polymer science and technology : Plastics, rubbers, blends and composites by Dr. Premamoy Ghosh 3rd edition . McGraw Hill Education (India) Pvt.Ltd. 2011.
4. Amino acids peptides synthesis , structures and applications . Edited by Bernd Gutte , academic press.
5. Amino acids peptides and proteins in organic chemistry volume 5 by Andrew B. Hughes, Wiley publications, 2013.

6. Amino acids and peptides by G.C.Barrett, D.T.Elmore, Cambridge university press, 1998.
7. Amino acids peptides and proteins volume 31, by G.C.Barrett, Don T. Elmore, Jenny A. Littlechild, Anand S.Dutta, Imer sovago, Etelka Farkas. Royal society of chemistry, 2007.
8. Nanotubes and Nanowires- C.N.R. Rao and A. Govindaraj. Editor: Paul O Brien. 2nd illustrated edition. Royal society of chemistry publishing, 2011.
9. Nanoscale materials, edited by Kenneth J. Klabunde, Ryan M.Richards 2nd edition, Wiley publishers, 2009.
10. Synthesis, functionalization and surface treatment of nanoparticles , edited by Marie Isabelle Baraton. Amer scientific publications, 2002.
11. BioMEMS (Microsystems) edited by Gerald A. Urban, 1st edition, springer publications , 2010.
12. Introduction to Nanoscale Science and Technology (Nanostructure Science and Technology volume 6) , edited by -Massimiliano Di Ventra, Stephane Evoy and James R.Heflin, Jr. Springer sciece and business media, 2004.
13. Nanomaterials for drug delivery and therapy by Alexandru Mihai GrumezescuElsevier publication, 2019.
14. Introduction to RNA/DNA cleavage by James K.Bashkin , ACS publication , 1998.

CHORPr-3.5: ORGANIC CHEMISTRY PRACTICALS-III A

Duration: 6 h/ week & Total: 96 h

Credits : 3

ORGANIC ESTIMATIONS

PART A

01. Estimation of phenol.
02. Estimation of aniline
03. Determination of equivalent weight of acids by silver salt method.
04. Estimation of amino groups by acetylation method.
05. Estimation of nitro group.
06. Estimation of sugars by Fehling's method.
07. Determination of saponification value of oils.
08. Determination of iodine value of oils.
09. Estimation of amino acids.
10. Determination of enol content by Meyer's method.
11. Determination of unsaturation by bromination method.
12. Determination of cholesterol by colorimetric method.

PART B

Preparation of any two derivatives.

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.

CHORPr-3.6: ORGANIC CHEMISTRY PRACTICALS IIIB

Duration: 6 h/ week & Total: 96 h

Credits : 3

MULTISTEP ORGANIC PREPARATION

01. Preparation of anthralinic acid from phthalimide.
02. Preparation of p-chlorotoluene from p-toluidine.
03. Preparation of benzophenoneoxime and its rearrangement to benzanilide.
04. Preparation of methyl red from anthralinic acid.
05. Preparation of benzopinacolone from benzophenone.
06. Preparation of 6,8-nitro-4-methyl-7-hydroxycoumarine from resorcinol.
07. Preparation of benzocaine from p-nitrotoluene.
08. Preparation of β -anilino- β -phenyl propiophenone from acetophenone and benzaldehyde.

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.

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 Kramer'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 $\frac{1}{2}$, 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.

REFERENCES:

01. Electronic paramagnetic resonance spectroscopy by Pratik Bertand.
02. Principles and applications of ESR spectroscopy by Andrew Lund, Masaru Shiojiri 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 - Elementary 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 International 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. Elementary 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 ORGANIC CHEMISTRY @ RCU

IV SEMESTER

CHORT-4.1: ORGANIC CHEMISTRY-IVA

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 retrosynthetic 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 and conformations 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, codeine, thebaine and morphine.

Terpenoids: Introduction, classification, isoprene rule, structural elucidation and synthesis of menthol and zingiberone.

Antibiotics: Introduction, classification, structure and their importance of penicillins, chloramphenicol, streptomycin, chloramphenicol and tetracyclins, synthesis of cephalosporin-C.

Self study(SS): Basics of alkaloids, terpenoids and antibiotics, isolation and nomenclature.

Skill components(SC): Analyze each one compound of the above class using various spectra.

UNIT -IV

16 h

STERIODS, 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 cholesterol, total synthesis.

Prostaglandins: Introduction, classification and biological importance, constitution of PGE₁, synthesis of PGE₁ 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, and analyze 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.

CHORT-4.2: ORGANIC CHEMISTRY-IVB

Teaching: 4 h/ week & Credits : 4

Total: 64 h

UNIT-I

16 h

INSECT PHEROMONES

Introduction, Juvenile hormones, precocines, pyretheroids and antifeedant.

Regulation of insect behavior by pheromones. Use of pest control.

Synthesis of:

- i. Z-7,8-epoxy-2-methyl octadecane (Gypsy moth sex pheromone).
- ii. Faranal (Trail pheromone of pharaoh's ants).
- iii. Gradisol (Components of boll weevil pheromone).
- iv. Brevicommin (pheromone from *Dendroctonus brevicomis*).
- v. (+)-Disperlure (Gypsy moth sex pheromone).
- vi. 3,11-Dimethyl-2-nonacosanone (Pheromone of German cockroaches).
- vii. Bombykol (Sex pheromone of silkworm moth).
- viii. Multistriatin (Elm bark beetle sex pheromone).

Self study(SS): Introduction to Pheromones, how essential oils work.

Skill components(SC): Pheromone Autodetection with Evidence and Implications.

UNIT-II

16 h

ANTHOCYANINS CAROTENOIDS AND PORPHYRINS

Anthocyanins: Classification, method of isolation, basic structural features of anthocyanins, structural elucidation of cyanin chloride, pelargonin chloride, delphinin chloride.

Structural elucidation of quercetin and wedelactone (synthesis not included).

Carotenoids: Methods of isolation. Structural relationship of α -, β - and γ -carotenes. Structure elucidation and synthesis of β -carotene.

Porphyryns: Structure elucidation and synthesis of haemin, chlorophyll-a.

Self study(SS): Carotenoids biosynthesis and its pathway, MEP pathway, Structure and its functions.

Skill components(SC): Physiological effects of carotenoids, Anthocyanins, porphyryns & List of aroma chemicals.

UNIT-III

16 h

APPLICATIONS OF ORGANIC PRODUCTS IN LIFE STYLE

Perfumery: Introduction, Compounds used in perfumery and their classification, methods of preparation and importance of phenyl ethanol, Yara yara, Ionone musk ketone, muskambrette, musk xylene, phenyl acetic acid and its esters, benzyl acetate, synthetic musks andjasmine.

Flavours: Introduction, classification, Chemical basis for flavour, flavours in diary products, flavours formed by heating or cooking-caramelisation & Maillard reaction, flavour degradation by oxidation-rancidity, molecular structure & odour/taste, sweetness, acidity & sourness, saltiness, bitterness, synthetic chemicals, Natural flavouring materials & classification. Flavouring materials-Acidulants, sweeteners, potentiators, enhancers & sodium-restricted food flavourings. Organic chemicals used in flavorings & food colorants.

Essential oils: Source, constituents, isolation & uses.

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick and nail polish, shampoos, hair dyes and tooth pastes. A formulary of cosmetic preparation-Godwin.

Self study(SS): Background study of Organic Products in your regional area, Association between organic food consumption and health.

Skill components(SC): Study of Production system and composition of plant foods and Animal based food.

UNIT-IV

16 h

Green chemistry:

Modern Technology: Modern techniques in organic synthesis. Brief outline of microwave. Ultrasound, clay catalyzed techniques and uses of ionic liquids and polymer supports in organic synthesis. Phase-transfer catalysts & Crown-ethers. Super critical fluid extractions

Microwave synthesis: Introduction, reaction vessel, reaction medium, concept, specific effects, atom efficiency, percentage atom utilization, advantage and limitation. N-alkylation and alkylation of active methylene compounds. Condensation of active methylene compounds with aldehydes. Synthesis of Ibuprofen by BHC and BOOTS approach. Diels-Alder reaction, Leuckarts reductive amination of lactones. Oxidation of alcohols and sulphides. Supramolecules

Self study(SS): Basics of chemistry in daily life, green chemistry, choosing of starting materials, reagents, catalysts, solvents, and green synthesis .

Skill components(SC): Real time analysis for pollution prevention, Use of renewable feedstocks, design for energy efficiency.

REFERENCE BOOKS:

01. Natural products: Their chemistry and biological significance-J. Mann,
02. R. S. Davidson, J. B. Hobbs, D. V. Banthorpe & J. B. Harborne, Longman, UK, 1994.
03. Terpenes, J. Verghese, Tata McGraw-Hill, New Delhi, 1982.
04. Chemistry of terpenes and terpenoids, A. Newman, Academic Press, London, 1975.
05. Handbook of naturally occurring compounds Vol. II: Terpenes, T. K. Davon, I. Scott, Academic Press, NY, 1972.
06. Natural products chemistry Vol. I & II, K. Nakanishi, T. Goso, S. Ito, S. Natori & S. Nozoe, Academic Press, NY, 1974.
07. Total synthesis of natural products Vol. I & VI, Apsimon, John Wiley, NY, 1973-1981.
08. Organic chemistry Vol. II, I. L. Finar, 6th Edn. Longman, 1992.

09. Chemistry of natural products Vol. I & II, O. P. Aggarwal, Goel Publishing House, 6th Edn. 1982.
10. Total synthesis of natural products: The chiral approach Vol.III, S. Hanessian Pergamon Press, 1983.
11. Total synthesis of steroids, Akhaun & Titov, Jerusalem, 1969.
12. Medicinal natural products: A biosynthetic approach, P. M. Dewick. John Wiley, Chichester, 1997.
13. The colours of life: An introduction to the chemistry of porphyrins and related compounds, L. R. Milgrom, Wiley Chichester, 1995.
14. Spectral data of natural products Vol. I- K.Yamaguchi, Elsevier Publishing Co, London,1970.
15. Chemistry of natural products: A unified approach, N. R. Krishnaswamy, University Press, India, 1999.
16. Essentials of medicinal chemistry, eds., Korolkovas and Burkhalter, J.H., John wiley & sons, Text book of Organic medicinal and pharmaceutical chemistry by wilson and Gisvold.
17. Synthetic drugs by O. D. Tyagi.
18. Swinyard, E.A.,Remington's phramaceutical sciences ", Ed., Artor Osal, Mack publishing company co., 1980, p.873.
19. "Medicinal Chemistry " Volumes, ed. Burger. '
20. The Organic Chemistry of Drug synthesis by Daniel Lednicer and Lester A. Mitscher
21. Text book of polymer Science. F.W. Billmeyer, Jr., John Wiley. London (1994).
22. Polymer Science. V. R. Gowrikar, N. V. Vishwanathan and J. Srreedhar, Wiley Eastern, New Delhi (1990).
23. Fundamentals of Polymer Science and Engineering. A. Kumar and S.K. Gupta. Tata – McGraw Hill New Delhi (1978).
24. Polymer Characterization, D. Campbell and J. R. White, Chapman and Hall, New York.
25. Fundamental Principles of Polymer materials, R. L. Rosen, John Wiley and Sons, New York.
26. Infrared spectroscopy by R. T. Conley, Allyn and Bacon, Inc. Functional monomers and polymers by K. Takemoto, Y. Inaki and P. M. Ottenbrite, Marcel dekker, Inc., New York, 1987.
27. Comprehensive Organic Synthesis – B. M. Trost and I. Fleming series, Pergamon Press, New York, 1991.
28. A Guide book to mechanism in organic chemistry – Petersykes.
29. S. K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998.
30. R. K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993
31. Green Chemistry-Environment friendly alternatives, R.Sanghi & M.M.Srivatsava, Narosa, 2003.
32. Green Chemistry-Environment benign reactions, V.K. Ahluwalia, Ane Books, India, 2006.

CHORT-4.3: ORGANIC CHEMISTRY-IVC

Teaching: 4 h/ week & Credits : 4

Total: 64 h

UNIT-I

16 h

Insecticides: Introduction, classification, mode of action and synthesis of chlorinated insecticides (DDT, chlordane, heptachlor and hexachlorocyclohexane), Naturally occurring insecticides-pyrethroids-natural pyrethrins-isolation and structures, synthetic pyrethroids, allethrin, cypermethrin, phenvalerate. Organophosphorous insecticides: Malathion, parathion, DDVP, diazenon. Carbamate insecticides: Sevin, carbofluron, aldicab, beygon.

Fungicides: Introduction, Inorganic & organic fungicides, Systemic fungicides-types & examples.

Herbicides: Introduction, study of sulfonyl ureas, heterocyclic sulfonamides, heterocyclic amines, dihydropyrano[2,3-b]pyridylimidazolinones, pyrrolopyridylimidazolinones, 1,2,4-triazine-3,5-diones, hydroxyoxazolidinones & hydroxypyrridolinones, pyridine herbicides & 1,3,4-oxadiazoles. Mechanism of action and toxicities of insecticides, fungicides and herbicides.

Self study(SS): Background and Approach to the Study of Insecticides, fungicides and herbicides, and their types.

Skill components(SC): Applications and effects of Insecticides, fungicides and herbicides.

UNIT-II

16 h

Antineoplastic Agents: Introduction, cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors.

Synthesis of mechlorethamine, cyclophosphamide, melphalan, mustards and mercaptopurine. Recent development in cancer chemotherapy – podophyllotoxin and its derivatives, taxol.

Cardiovascular drugs: Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output direct acting arteriolar dilators, synthesis of diltiazem, verapamil, methyldopa, atenolol, oxprenolol, antihypertensive drugs, lipid lowering agents (atorvastatin, statin derivatives).

Self study(SS): Overview of Antineoplastic, role of Antineoplastic, Toxicity grading scale.

Skill components(SC): Make list of Antineoplastic agents and Cardiovascular drugs, with their uses.

UNIT-III

16 h

DRUGS AFFECTING THE CENTRAL NERVOUS SYSTEM:

Sedatives and hypnotics -Barbiturates (structure-activity relationship, metabolism); benzodiazepines (structure -activity relationship, metabolism)

Synthesis of phenobarbital, hexobarbital nitrazepam and oxazepam.

Anesthetics : General anesthetics; local anesthetics- Mode of action, structure-activity relationships. Synthesis of methohexital and chloro-procaine.

Synthesis of meperidine, methadone and 6,7-benzomorphanes.

Tranquilizers : phenothiazine derivatives - structure- activity relationship, metabolism and mode of action; other tranquilizers.

Synthesis of chlorpromazine.

Self study(SS): Introduction, Neurotransmitter-receptor relationship, Blood-Brain barrier, Mechanism for action of anticonvulsant drugs.

Skill components(SC): List the major neurotransmitters and neurotransmitter system.

UNIT-IV

16 h

FERTILISERS

Introduction, Essential plant Nutrients, Classification of Essential Nutrients, Primary Nutrients, Secondary Nutrients, Micronutrients, Macronutrients,

Classification of Fertilizers-Straight Fertilizers, Compound/Complex Fertilizers, Fertilizer Mixtures,

Feed Stock/ Raw materials- Nitrogenous Fertilizers, Phosphatic Fertilizers, Potassic Fertilizers,

Manufacture and general properties of Fertilizer products- Intermediates- Ammonia, Nitric Acid, Sulphuric Acid, Phosphoric Acid, Nitrogenous Fertilizers- Ammonium Sulphate, Ammonium Nitrate, Calcium Ammonium Nitrate, Calcium Nitrate, Ammonium Chloride, Urea, Phosphatic Fertilizers, Ground Rock Phosphate, Single Superphosphate, Triple Superphosphate, Potassic Fertilizers- Potassium Chloride (Muriate of Potash), Potassium Sulphate (Sulphate of Potash), Potassium Nitrate, Complex Fertilizers- Ammonium Phosphate Sulphate, Ammonium Phosphates, Mono Ammonium Phosphate (MAP), Di-Ammonium Phosphate (DAP), Nitrophosphates, Urea Ammonium Phosphates, NPK Complex Fertilizers, Fertilizer mixtures-Physical Mixtures, Granulated Mixtures.

Self study(SS): Overview on Fertiliser industry, industrial applications, fertiliser characteristics; organic compared to mineral fertilisers.

Skill components(SC): Survey on Global production and consumption of fertilisers.

REFERENCE BOOKS:

1. Synthetic organic chemistry, G R Chatwal, Himalaya publishing house.
2. A formulary of paints and other coatings, M Ash & I Ash
3. Encyclopedia of Chemical Technology, Kulkarni & others.
4. Perfumery Technology, B. Billot and F. V. Wells
5. Lehninger principles of Biochemistry, David L Nelson and Michael M Cox
6. Dairy chemistry and animal nutrition, V.K. Chhokani
7. Principles of Animal nutrition and Feed technology Part I and II, D.V Reddy
8. Feeds and Principles of animal nutrition, G.C. Banerjee
9. Source book of flavors
10. F. A. Carey and Sundberg, Advanced Organic Chemistry – Part 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 Allied (P) Ltd, 1998

11. Principles of organic synthesis, Richard Norman and J. M. Coxon
12. Disconnection approach, by Steurt Warren.
13. Organic Synthesis-Special Techniques, V.K.Ahluwalia and R. Aggarwal, Narosa, New Delhi, 2001
14. Organic Synthesis, R.E.Ireland, Prentice Hall India, 1969.
15. Advanced Organic Chemistry, IV Ed., Part A &B, F.J.Carrey & R.J.Sundberg, Kluwer, 2001.
16. Organic Synthesis- A Disconnection Approach, Stuart
17. Art in Organic Synthesis, Anand, Bindra & Ranganath, Wiley, New Delhi, 1970.
18. Modern Methods of Organic Synthesis, N. Carruthers, Cambridge University, 1996.
19. Organic Reaction Mechanisms, V.K.Ahluwalia & R.K.Parashar, Narosa, 2006
20. Synthesis and Chemistry of Agrochemicals, Vol I & II, ACS, Wahington.
21. Chemistry of Pesticides, K H Buchel. Advances in Pesticide Formulation Technology, ACS.
22. Chemicals for Crop Protection and Pest Managements, M B Green, G.S. Hartley West, Pergamon.
23. Chemistry of Insecticides and Fungicides, Sree Ramulu, Oxford & IBH, 1985.

For Additional Reading

1. A Text Book of Fertilizers, Ranjan Kumar Basak.
2. Agronomy - Theory & Digest, Bidhan Chandra, Krishi Vishwavidyalaya, Mohanpur.
3. Fundamentals of Agronomy, S.S. Cheema, K.Dhaliwal, T.S. Shota, Punjab Agricultural University.
4. Principles and Practices of Agronomy, Shri.S.S.Singh, Allahabad Agricultural Institute.
5. Principles of Agronomy, T. Yellamanda Reddy, Agricultural Research Station, Anantapur.
6. Fertilizers, Organic Manures & Biofertilizers–A Product Quality Guide for Major & Micronutrients, HLS Tandon, Fertilizer Development and Consultation Organisation, New Delhi.
7. Handbook on Fertilizer Technology, Bham Swaminathan & Manish Goswami, The Fertilizer Association of India, New Delhi.
8. Outlines of Chemical Technology, Charles E. Dryden, Affiliated East-West Press, New Delhi.
9. Synthetic Organic Chemistry, G. R. Chatwal, Himalaya Publishing House.
10. Principles of Agronomy, T.Yellamanda Reddy, Agricultural Research Station, Anantapur.
11. Fertilizers, Organic Manures & Biofertilizers–A Product Quality Guide for Major &
12. Micronutrients, HLS Tandon, Fertilizer Development and Consultation Organisation, New Delhi.
13. Handbook on Fertilizer Technology, Bham Swaminathan & Manish Goswami, The Fertilizer Association of India, New Delhi.
14. Outlines of Chemical Technology, Charles E. Dryden, Affiliated East-West Press, New Delhi.
15. 9. Synthetic Organic Chemistry, G. R. Chatwal, Himalaya Publishing House.
16. Synthesis and Chemistry of Agrochemicals, Vol I & II, ACS, Wahington.
17. Chemistry of Pesticides, K H Buchel.
18. Advances in Pesticide Formulation Technology, ACS.
19. Chemicals for Crop Protection and Pest Managements, M B Green, G.S. Hartley West, Pergamon.
20. Chemistry of Insecticides and Fungicides, Sree Ramulu, Oxford & IBH, 1985.

CHORPr-4.6: ORGANIC CHEMISTRY PRACTICALS-IVA

Duration: 6 h/ week & Total: 96 h

Credits : 3

QUALITATIVE ANALYSIS OF TERNARY MIXTURE USING ETHER

Ternary Mixture Analysis : Qualitative analysis of three **component** mixture using ether containing amino acids, low boiling liquids, nitro phenols etc.

SUGGESTED BOOKS

01. Semi-micro qualitative organic analysis, Cheronis, Entrikin & Hoanett.
02. Preparation of organic intermediates, D. A. Hirley, John Wiley.
03. Text book of practical organic chemistry, A. I. Vogel, Pearson, 5th Edition, Delhi, 2004.
04. Organic experiments, L. F. Fieser, 2nd Edn. D. C. Heath & Co. USA, 1974-2000.
05. Practical organic chemistry F.G. Mann and B. C. Saunders 4th Edn. Longman, 2002.
06. Comprehensive practical organic chemistry : Preparation and quantitative Analysis,
07. V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
08. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S.
09. Dhingra, Universities Press (India), 2000.
10. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. K. Nad,
11. New central book agency, Calcutta, 2000.
12. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
13. Practical organic chemistry (Quantitative analysis), B. B. Dey, M V Sitaraman and
14. T. R. Govindachari, Allied Publishers, New Delhi, 1992.

CHORPr-4.7 : ORGANIC CHEMISTRY PRACTICALS-IVB

Duration: 6 h/ week & Total: 96 h

Credits : 3

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.

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. 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.

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 of configuration 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 and phosphorescence. 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 of simple 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 atomic spectroscopy (volume 2 of modern analytical chemistry) by William G. Schrenk , Plenum press, 1975. Dized on 2010.
7. Handbook of flame spectroscopy by Michael Loewen Parsons, Benjamin William Smith, Glenn Edward Bentley , plenum press, 1975. Dized on 2010.
8. Molecular luminescence spectroscopy : Methods and applications by Stephen Gregory Schulman , Wiley publications 1993, dized 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

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

ORGANIC CHEMISTRY

Paper CHORT-4.1: Organic Chemistry-IVA

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)

Question paper Pattern of 2 Credit Paper

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

CHEMISTRY/ ORGANIC CHEMISTRY

Paper CHGT-4.4: Spectroscopy-IV

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)
