

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

SYLABII OF INTEGRATED M.Sc COURSE

Ist SEMESTER

CYN-101	Introduction to chemical science	2 credit/ (2 0 0)
CYN-103	Computer Programming	4 credit/ (3 0 2)

11. Suggested Books

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Lowe D.B., "The Chemistry Book: From Gunpowder to Graphene, 250 Milestones in the History of Chemistry", Sterling Publishing Company,	2016
2.	Hill Jr. R.H., and Finster, D.C., "Laboratory Safety for Chemistry Students", John Wiley & Sons, Inc.	2010
3.	Clayden J. , Greeves, N., Warren S., and Wothers, P., "Organic Chemistry", Oxford University Press	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-103** Course Title: **Computer Programming**

2. Contact Hours: **L: 3 T: 0 P: 2**

3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**

4. Relative Weightage: **CWS 15 PRS 25 MTE 20 ETE 40 PRE 0**

5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **ESC**

8. Pre-requisite: **Nil**

9. Objective: To provide students with an entry-level foundation in computer programming.

10. Details of Course:

Sl. No	Contents	Contact Hours
1	Introduction to computer hardware and software, computer operating systems, algorithms, flow charts and programs, programming languages.	4
2	Standard I/O in Fortran/C languages, comments, fundamental data types- character types, integer, short, long, unsigned, single and double-precision. Floating point, declaration, arithmetic instruction, operators-hierarchy and associativity of operators.	6
3	Decision control instructions, conditional operators, loop instructions, complex loops, case control instructions.	8
4	Functions: Use of functions, passing value between functions, library functions, pointer notations, function calls, recursion functions.	8
5	Array notation and representation, manipulating array elements, pointers and arrays, multidimensional arrays. Structures: Purpose and usage of structures, declaring structures, assigning of structures.	8
6	Introduction to numerical methods: Solution of linear and quadratic equations, differentiation and integration, computer programs for chemistry.	8
	Total	42

11. Suggested Books

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprint
1.	Kanetkar Y. "Let us C", 14 th Edition, BPB publications.	2016
2.	Clemen N.S. and Spector, W., "Modern Fortran: Style and Usage", Cambridge University Press India Pvt. Ltd.	2011
3.	Press W.H., Flannery B.P., Teukolsky S.A., and Vetterling, W.T., "Numerical Recipes in C-The art of Scientific Computing", 2 nd Edition, Cambridge University Press India Pvt. Ltd.	2013
4	Sastry S.S., "Introductory Methods of Numerical Analysis", 5 th Ed., PHI Learning, New Delhi.	2012

2nd SEMESTER

CYN-102	Physical Chemistry-I	4 credit/ (3 0 2)
CYN-104	General Organic and Inorganic Chemistry	4 credit/ (3 0 2)
CYN-106	Basic Analytical Chemistry	4 credit/ (3 1 0)

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-102** Course Title: **Physical Chemistry-I**

2. Contact Hours: **L: 3 T: 0 P: 2**

3. Examination Duration (Hrs.): **Theory 3 Practical 0**

4. Relative Weightage: **CWS 15 PRS 25 MTE 20 ETE 40 PRE 0**

5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To provide theoretical and experimental knowledge of fundamental physical chemistry to undergraduate students

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Introductory Quantum Chemistry: Failure of classical mechanics and birth of quantum mechanics, postulates, commuting and non-commuting operators, Schrödinger equation, particle in one, two and three dimensional box and their implications, introduction to rigid rotor and harmonic oscillator, H-atom-radial and angular wave functions, shapes of orbitals (s, p and d), applications of quantum chemistry concepts to hydrogen-like systems.	9
2.	Basic Thermodynamics and Chemical Equilibria: Laws of thermodynamics-zeroth, first, second and third, heat capacity of solids, description of equilibrium, feasibility of chemical reaction, Gibbs-Helmholtz equation, phase transition-Clapeyron equation, Clapeyron-Clausius equation, free energy and entropy changes in reversible and irreversible processes, chemical potential, partial molar quantities, activity coefficient and fugacity.	8
3.	Chemical Kinetics: Types and classification of reactions, integrated and differential rate laws, rate laws of consecutive, parallel, chain and complex reactions, collision theory of bimolecular reactions and its drawbacks, introduction to transition state theory.	8
4.	Catalysis: Homogeneous and heterogeneous catalysis, kinetics of acid, base and enzyme catalysis with suitable examples, principle of adsorption, differences between physisorption and chemisorption, derivation of Langmuir adsorption isotherm, Langmuir-Hinshelwood and Rideal-Eley mechanisms.	6
5.	Solid State Chemistry: Unit cell, Miller indices, directions and planes in crystals, packing types, packing fraction, simple crystal structures, determination of structure of solids- X-ray diffraction and Bragg's Law, defects in solids.	5
6.	Physical Properties of Molecules: Dipole moments and their determination, dielectric constants, interactions between molecules, molar refraction, optical rotation and rotatory dispersion, circular dichroism, transport properties, parachor, magnetic susceptibility and its temperature dependence in para-, ferro- and antiferro- magnetic materials.	6
Total		42

List of Experiments:

1. Determination of iron using potassium dichromate (Internal indicator method)
2. Heat of neutralization of a strong base by a strong acid
3. Determination of surface excess of 1-butanol in aqueous solution
4. To study kinetics of a redox reaction
5. Blue Printing using sunlight
6. pH metry/ potentiometry titrations
 - a) Strong acid – strong base;
 - b) Strong acid – weak base
 - c) Weak acid – strong base;
 - d) Redox titration: Fe^{2+} or Mn^{2+}
7. Spectrophotometry: Determination of Fe (III) by colorimetry
8. Determination of hardness of water by EDTA-complexometry titration
9. Determination of the composition of mixtures of liquids using viscometry
10. Acid-base titrations using conductivity meter
 - a) Strong acid – strong base;
 - b) Strong acid – weak base
 - c) Weak acid – strong base

11. Suggested Books:

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Silbey R.J., Alberty R.A. and Bawendi M.G., "Physical Chemistry", 4 th Ed., John Wiley & Sons, Inc.	2005
2.	Atkins P.W., and de Paula, J., "Physical Chemistry", 9 th Ed., Oxford University Press.	2010
3.	West A.R., Solid State Chemistry and its Applications, Wiley-India Edition	2003
4.	Levine I. N., "Quantum Chemistry", 7 th Ed., Pearson Education	2014

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-104** Course Title: **General Organic and Inorganic Chemistry**

2. Contact Hours: **L: 3 T: 0 P: 2**

3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**

4. Relative Weightage: **CWS 15 PRS 25 MTE 20 ETE 40 PRE 0**

5. Credits: **04** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart basic concepts of organic and inorganic chemistry

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Structure and bonding in organic molecules: Introduction to localized bonding, delocalized bonding, homolytic and heterolytic cleavage of bonds, nucleophiles, electrophiles, amphiphiles.	7
2.	Isomerism and stereochemistry: Definitions of configuration and conformation, optical isomerism, asymmetric carbon and molecular chirality (biphenyl and allenes), R/S notations, geometrical isomerism, E/Z nomenclature, conformational analysis of alicyclic and cyclic systems.	7
3.	Organic reactions & intermediates: Types of organic reactions, generation, structure, stability and reactivity of intermediates such as carbocations, carbanions, free radicals, carbenes, arynes and nitrenes.	10
4.	Periodic properties of elements: Ionization potential, electron affinity, electronegativity and electronegativity scales with their measurements, ionic, covalent and van der Waals radii and their measurements, ionic potential and work function. Periodic trends in chemical properties.	4
5.	Inorganic molecules and their chemical bonding: Electronic theory of valency, chemical bond, bond energy, ionic bond and ionic character, Fajan's rule and lattice energy, ionic ratio, Born-Haber cycle, energetics of covalent bond in hydrogen molecule-valence bond theory. Hybridization and VSEPR theory and geometry of molecules. Molecular orbital theory for homo and heteronuclear diatomic molecules with examples B ₂ , C ₂ , N ₂ , O ₂ , F ₂ , CO, NO, CN ⁻ . Inter- and intra-molecular forces, H-bonding, metallic bonding: band theory.	14
Total		42

Laboratory Experiments

- i. Determination of sodium carbonate in baking/washing soda
- ii. Estimation of Copper by Iodometry
- iii. Estimation of Pb as PbSO₄ by gravimetry
- iv. Preparation of Copper tetraammine complex
- v. Synthesis of potassium trioxalatochromate(III)
- vi. Qualitative analysis of given Inorganic salt mixture containing 4 radicals.
- vii. Determination of λ_{\max} and concentration of KMnO₄/K₂Cr₂O₇

- viii. Identification of functional groups in an organic compound
- ix. Determination of equivalent weight of organic acid
- x. Synthesis of phthalic acid from waste PET bottle
- xi. Preparation of p-nitroacetanilide and determination of its melting point
- xii. Oxidative coupling reaction of β -naphthol
- xiii. Synthesis of azo dye
- xiv. Synthesis of a polymer

11. Suggested Books:

Sl. No	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Solomons T.W.G., Fryhle C.B. and Snyder S.A. "Organic Chemistry", 11 th Ed., Wiley, ISBN: 9788126556847	2015
2.	Bruice P.Y., "Organic Chemistry", 8 th Ed., Pearson, ISBN: 9780134042282	2017
3.	Volhardt K.P.C., and Schore N.E., "Organic Chemistry Structure and Function", 7 th Ed., Macmillan, ISBN: 9781464120275.	2015
4	Eliel E.L.S., and Wilen H., "Stereochemistry of Organic Compounds", 1 st Ed., Wiley, 2008, ISBN, 9788126515707.	2008
5.	Lee J.D., "Concise Inorganic Chemistry" 5 th Ed. Blackwell Sciences.	2010
6.	Shriver D.F., and Atkins, P.W., "Inorganic Chemistry" 3 rd Edition, Oxford University Press.	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **Department of Chemistry**

1. Subject code: **CYN-106** Course Title: **Basic Analytical Chemistry**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs): **Theory: 3** **Practical: 0**
4. Relative Weightage: **CWS 25** **PRS 0** **MTE 25** **ETE 50** **PRE 0**
5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PCC**
8. Pre-requisite: **Nil**
9. Objective: To impart the fundamental knowledge in different areas of analytical chemistry
10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Measurement Basics: Data domain, detector, transducer and sensors, signal and noise, sensitivity and detection, basic electronics, optical components and circuits for instrumentation used in chemical analysis.	5
2.	Data handling: Accuracy and precision, types of error, statistical data treatment, significant figures and propagation of errors, use of spreadsheet and data treatment software, control chart, confidence limit, test of significance, outliers, calibration methods, linear and non-linear data fitting.	7
3.	Gravimetric analysis: Properties of precipitates. Nucleation and crystal growth, factors influencing completion of precipitation. Co-precipitation and post-precipitation, purification and washing of precipitates. Precipitation from homogeneous solution, a few common gravimetric determinations.	6
4.	Volumetric analysis: Acid base titration, complexometric titration, redox titration, precipitation titration,	6
5.	Potentiometry: Fundamentals of potentiometry, different types of electrodes – e.g., indicator and ion selective electrode, membrane electrode, glass electrode. Polarography – principle, instrumentation and applications to qualitative and quantitative analysis, amperometric and biamperometric titrations	6
6.	Separation methods: Solvent extraction: Partition law and its limitations, distribution ratio, separation factor, factor influencing extraction, multiple extractions, solid phase extraction, cloud point extraction. Chromatography: classification, theory of column chromatography, retention time, retention volume, capacity factor, concept of plate and rate theory, resolution, column performance, paper and thin layer chromatography, Ion exchangers	12
	Total	42

11. Suggested Books:

Sl. No.	Name of Authors/Book/ Publisher etc.	Year of Publication/ Reprint
1.	Christian G.D., Dasgupta P.K., Schug K.A., "Analytical Chemistry" 7 th Ed., Wiley	2013
2.	Mendham J., Denny R.C., Barnes J.D. and Thomas M.J.K., "Vogel's Text Book of Quantitative Chemical Analysis" 6 th Ed., Pearson Education	2004
3.	Skoog D.A., West D.M., Holler F.J. and Crouch S.R., "Fundamentals of Analytical Chemistry" 8 th Ed., Thomson Brooks/Cole.	2004
4.	Fifield F.W., and Kealey D., "Principles and Practice of Analytical Chemistry", 5 th Ed., Blackwell Science.	2000
5.	Ewing G.W., "Instrumental Methods of Chemical Analysis", 5 th Ed., McGraw Hill.	2004

3rd SEMESTER

CYN-201	Thermodynamics	4 credit/ (3 1 0)
CYN-203	Coordination Chemistry and Organometallics	4 credit/ (3 1 0)
CYN-205	Organic Chemistry-I	4 credit/ (3 1 0)

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-201** Course Title: **Thermodynamics**
2. Contact Hours: **L: 3 T: 1 P: 0**
3. Examination Duration (Hrs.): **Theory 3 Practical 0**
4. Relative Weightage: **CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**
5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **PCC**
8. Pre-requisite: **Nil**
9. Objective: To provide knowledge of thermodynamics in chemical systems
10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Classical Thermodynamics: Phase rule, phase diagram of simple systems, chemical potential of real gases and solutions, thermodynamic treatment of ideal and non-ideal solutions, thermodynamics of reversible and irreversible systems, thermodynamic theory of ionic interactions, Debye-Huckel theory, interpretation of electrical conductance of electrolytes, thermodynamic treatment of diffusion potential, membranes-artificial and natural, Donnan membrane equilibrium.	10
2.	Statistical Thermodynamics: Concept of microstates and ensembles, micro-canonical, canonical and grand canonical ensemble, average distribution, partition functions and their relation with thermodynamic properties, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics, molecular partition functions, translational, vibrational and rotational partition functions, ideal monoatomic and diatomic gases and their thermodynamic properties	12
3.	Surface and Interfaces: Types of interfaces, surface phenomenon, adsorption isotherms-BET theorem, temperature dependence of adsorption isotherms and determination of surface area of adsorbents, electrical phenomenon of interphases, thermodynamics of surfaces, adsorption by porous, non-porous and microporous solids, adsorption from liquid phase	10
4.	Colloids and Dispersed Systems: Colloids-Electrical double layer and its structure, electrokinetics and zeta potential, surface of shear, properties and structure of gels, rheology, clay colloids, dispersed systems-classification, micellization, thermodynamics of micellization, dispersion and aggregation of solids by surfactants.	10
	Total	42

11. Suggested Books:

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Silbey R.J., Alberty R.A. and Bawendi, M.G., "Physical Chemistry", 4 th Ed., John Wiley & Sons, Inc.	2005
2.	Atkins P.W., and de Paula, J., "Physical Chemistry", 9 th Ed., Oxford University Press.	2010
3.	McQuarrie D.A., "Statistical Mechanics", Student Edition, Viva Books.	2013
4.	Bockris J.O'M. and Reddy A.K.N. "Modern Electrochemistry" Vol 1, Springer.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-203** Course Title: **Coordination Chemistry and Organometallics**

2. Contact Hours: **L: 3 T: 1 P: 0**

3. Examination Duration (Hrs.): **Theory: 3 Practical: 0**

4. Relative Weightage: **CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**

5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart basic knowledge in coordination chemistry and organometallics

10. Details of Course:

Sl. No	Contents	Contact Hours
1	Coordination chemistry: Introduction, ligands and denticity, stability of coordination compounds, types of isomerism, nomenclature.	6
2	Bonding in coordination compounds: Crystal field theory involving d-orbital splitting in linear, trigonal, octahedral, square planar, tetrahedral, square pyramidal, trigonal bipyramidal and cubic complexes, measurement of CFSE in weak and strong ligand fields, Jahn-Teller distortion, variation of lattice energy, ionic radii and heat of hydration across 1 st row transition metal ions.	10
3	Organometallic chemistry: Factors affecting M-C bond formation, general methods for synthesis of organometallic compounds, 18-electron rule, metal carbonyl and nitrosyl complexes, metal-alkyls, -aryls and -carbenes.	8
4	Reactions and applications of organometallic compounds: Kinetics and mechanism of ligand substitution, oxidative addition, reductive elimination, transmetalation, migratory insertions, reactivity at metal bound ligand. Hydrogenation, hydroformylation, Zeigler–Natta catalysis, olefin metathesis, carbonylation and decarbonylation.	10
5	Organotransition compounds with multicenter bonds: Concept of hapticity, transition metal complexes of alkenes, Zeise’s salt, allenes, alkynes, allyls, cyclic π -metal complexes, reaction and bonding in ferrocene.	8
	Total	42

11. Suggested Books:

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Huheey J.E., Keiter E.A., Keiter R.L., Medhi O.K. Inorganic Chemistry: Principles of Structure and Reactivity, 4 Ed. Pearson	2008
2.	Douglas B.E., McDaniel D.H. and Alexander J.J., “Concepts and Models in Inorganic Chemistry”, 3 rd Ed., John Wiley & Sons.	2001
3.	Lever A.V.P., “Comprehensive Coordination Chemistry-II From Biology to Nanotechnology”, McCleverty J.A. and Meyer T.J., Eds., Volume 1, Elsevier	2003
4.	Hill A.F., “Organotransition Chemistry”, RSC Cambridge.	2002
5.	Bochmann M. (Ed.), “Oxford Premier Series on Organometallics”, Vol. 1 and 2. Oxford Press.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-205**

Course Title: **Organic Chemistry-1**

2. Contact Hours:

L: 3

T: 1

P: 0

3. Examination Duration (Hrs.): **Theory: 3**

Practical: 0

4. Relative Weightage: **CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**

5. Credits: **4**

6. Semester: **Autumn**

7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart basic concepts in chemistry of hydrocarbons

10. Details of Course:

Sl No.	Contents	Contact Hours
1.	Alkanes: Synthesis of alkanes, Wurtz reaction, Kolbe reaction, Corey-House synthesis, decarboxylation of carboxylic acids. Reactions of alkanes, halogenation, reactivity and selectivity. Cycloalkanes, ring strain, Baeyer's strain theory, theory of strainless rings, banana bonds, synthesis and reactivity.	6
2.	Alkenes and Alkynes: Methods of synthesis, reactivity, electrophilic and nucleophilic addition, oxidation (epoxidation, dihydroxylation, ozonolysis, hydroboration-oxidation, regioselectivity and stereoselectivity), oxymercuration reduction, metal-ammonia reductions, reactivity of vinyl and allylic systems. Synthesis and reactivity of conjugated and cumulated alkenes, 1,2 vs. 1,4 addition, polymerization reactions.	10
3.	Arenes and aromaticity: Structure of benzene, molecular orbital theory, Hückel rule, aromaticity, antiaromaticity, non-aromaticity, aromatic electrophilic substitutions, activating and deactivating substituents and their <i>o</i> -, <i>p</i> - and <i>m</i> - orientation, Birch reduction, nucleophilic substitution reactions, addition-elimination mechanism, leaving group effect, S _N 1 mechanism, benzyne mechanism.	12
4.	Alkyl, vinyl and allyl halides: Nucleophilic substitution reactions, S _N 1 vs S _N 2, structure and stability of carbocations, transition state for S _N 2 reactions, stereochemistry of substitutions, steric and solvent effects; effect of nucleophiles and leaving groups. Elimination reactions, role of nucleophile and leaving group in eliminations, E1 and E2 mechanisms, substitution vs elimination, stereoselectivity and regioselectivity in eliminations, E2 eliminations of cyclohexyl and vinyl halides, E1cB mechanism, reactions with Gilman reagents, S _N 2' reactions and their stereochemistry.	14
Total		42

11. Suggested Books:

Sl. No	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Solomons T.W.G., Fryhle C.B. and Snyder S.A. "Organic Chemistry", 11 th Ed., Wiley, ISBN: 9788126556847	2015
2.	Bruice P.Y., "Organic Chemistry", 8 th Edition, Pearson, ISBN: 9780134042282	2017
3.	Wade L.G., and Simek J.W., "Organic Chemistry", 9 th Edition, Pearson, ISBN: 9780321971371.	2016
4.	Carey F.A., and Giuliano, R.M., "Organic Chemistry", 10 th Edition, McGraw-Hill, ISBN: 9780073511214	2016
5.	Smith J.G., "Organic Chemistry", 5 th Edition, McGraw Hill, ISBN: 9780078021558	2016
6.	McMurry, J. E., "Organic Chemistry", 9 th Edition, Brooks Cole, ISBN: 9781305080485	2015

4th SEMESTER

CYN-202	Main Group and Cluster Chemistry	4 credit/ (3 1 0)
CYN-204	Organic Chemistry-II	4 credit/ (3 1 0)
CYN-206	Chemical Kinetics	3 credit/ (3 0 0)

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-202** Course Title: **Main Group and Cluster Chemistry**

2. Contact Hours: **L: 3 T: 1 P: 0**

3. Examination Duration (Hrs.): **Theory 3 Practical 0**

4. Relative Weightage: **CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**

5. Credits: **4** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of main group elements, their compounds and structure-property relationship.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Group 1 (Li, Na, K, Rb, Cs): Origin of flame colour and spectra, reactivity with water, air, and dinitrogen, anomalous reactivity of Li, dissolution in liquid ammonia, solvated electrons, oxides, hydroxides, peroxides and superoxides, sulphides, oxo salts, halides and hydrides, carbides and intercalation compounds, complexes of crown ethers and cryptands, soap formation, biological importance.	4
2.	Group 2 (Be, Mg, Ca, Sr, Ba): Reactivity with water, acids and bases, anomalous behaviour of Be, hydrides, oxides, peroxides, hydroxides, sulphates, nitrates, halides, nitrides, carbides. Biological importance of Ca and Mg. Catalytic activity.	4
3.	Group 13 (B, Al, Ga, In, Tl): Inert pair effect, oxides of boron and their properties, amphoteric behaviour of Al(OH) ₃ , reactions of Ga, In and Tl, borohydrides and aluminium hydrides as reducing agents, borides and halides of group 13 elements, hydroboration reactions, reactions with ammonia, low-oxidation boron compounds such as borylene, diborene, diboryne.	4
4.	Group 14 (C, Si, Ge, Sn, Pb): Carbides, silicides, and graphenes, their applications, oxides of carbon and carbon cycle, sulphides of carbon, oxides of Si, Ge, Sn and Pb, silicates and their applications, silicones, organosilicon compounds and polymers, structure and bonding of organosilicon compounds, silanes and polysilanes, halides, Freons, clusters and Zintl phases, low-valent and hypervalent silicon and comparison with carbon.	8
5	Group 15 (N, P, As, Sb, Bi): Structure and bonding of N and P compounds, hydrides, hydrazines and hydroxylamines, azides, trihalides and pentahalides, nitrogen fixation, urea, phosphate fertilizers, oxides of N, P, As and Bi, oxoacids of nitrogen and P, sulphides of P, low-valent N and P such as nitrenes and phosphinidene, phosphazenes, cyclophosphazenes and their polymers.	8
6.	Group 16 (O, S, Se, Te): Structures and allotropes, oxides, peroxides, suboxides, neutral, basic, acidic and amphoteric oxides, oxoacids of S, Se and Te, halides, oxohalides, hydrides.	4
7.	Group 17 (F, Cl, Br, I): Oxidizing power, reactivity, hydrogen halides, halogen oxides, oxoacids, interhalogen compounds, polyhalides, pseudohalogens, pseudohalides.	4

8.	Main Group Organometallics: Preparative routes for metal carbon bond formation of main group elements, general reactivity patterns, organometallic compounds of I, II, III, IV and V group elements. Grignard reagents and their reactivity, electron deficient organometallic compounds, structure and bonding of some important main group organometallic compounds.	6
	Total	42

11. Suggested Books:

S. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Cotton F.A., Wilkinson G., Murillo C.A. and Bochmann M., "Advanced Inorganic Chemistry", 6 th Ed. John Wiley & Sons.	2016
2.	Greenwood N.N., and Earnshaw A. "Chemistry of the Elements" 2 nd Ed. Butterworth-Heinemann,	2015
3	Purcell, K.F., and Kotz, J.C. "Inorganic Chemistry" Cengage Learning, Second Indian reprint.	2012
4.	Housecroft C.E., and Sharpe A.G., "Inorganic Chemistry", 4 th Ed. Pearson	2012
5.	Shriver, D.F., Atkins, P.W., and Langford, C.H., "Inorganic Chemistry", 2 nd Ed. ELBS	1994

11. Suggested Books

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Solomons T.W.G., Fryhle, C.B., and Snyder S.A. "Organic Chemistry", 11 th Edition, Wiley, ISBN: 9788126556847	2015
2.	Bruice P.Y., "Organic Chemistry", 8 th Edition, Pearson, ISBN: 9780134042282	2017
3.	Wade L.G., and Simek J.W., "Organic Chemistry", 9 th Edition, Pearson, ISBN: 9780321971371.	2016
4.	Carey F.A., and Giuliano R.M., "Organic Chemistry", 10 th Edition, McGraw-Hill, ISBN: 9780073511214	2016
5.	Smith J.G., "Organic Chemistry", 5 th Edition, McGraw Hill, ISBN: 9780078021558	2016

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Chemistry**

1. Subject Code: **CYN-206** Course Title: **Chemical Kinetics**

2. Contact Hours: **L: 3 T: 0 P: 0**

3. Examination Duration (Hrs.): **Theory 3 Practical 0**

4. Relative Weightage: **CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**

5. Credits: **3** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of kinetics and photochemistry

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Theories of Reaction Rates: Theories of unimolecular and bimolecular reactions, thermodynamic formulation of transition state theory, applications of transition state theory, theoretical calculation of potential energy surfaces.	7
2.	Kinetics of Complex Reactions: Thermal and photochemical reactions, derivation of rate equations for complex reactions, chain reactions, kinetics of organic and inorganic reactions, kinetics of polymerization reactions.	7
3.	Reactions on Surfaces: Mechanisms of surface reactions, unimolecular and bimolecular surface reactions, transition state theory of surface reactions.	7
4.	Reactions in Solutions: Solvent effects, ion-ion, ion-dipole and dipole-dipole reactions, salt effect in acid base catalysis, kinetic isotope effects.	7
5.	Photochemistry: Primary photophysical processes of atoms and diatomic molecules, Jablonski diagram, Franck-Condon principle and its applications, rates of absorption and emission, quantum efficiencies, life time of electronically excited states, electron and energy transfer processes, quenching mechanisms, delayed fluorescence, ultra fast kinetic techniques - laser flash photolysis and radiation chemical techniques.	14
	Total	42

11. Suggested Books:

Sl. No.	Authors/ Title/ Publisher	Year of Publication/ Reprints
1.	Silbey R.J., Alberty R.A., and Bawendi M.G., "Physical Chemistry", 4 th Ed., John Wiley & Sons, Inc.	2005
2.	Atkins P.W., and de Paula J., "Physical Chemistry", 9 th Ed., Oxford University Press.	2010
3.	Laidler K.J., "Chemical Kinetics", 3 rd Ed., Pearson Education	2008
4.	Lakowitz J.R., "Principles of fluorescence spectroscopy", 3 rd Ed., Springer	2006