FACULTY OF SCIENCES

SYLLABUS

FOR

B.Sc. (HS) CHEMISTRY
(Credit Based Evaluation & Grading System)
(FOR OLD STUDENTS)
(Semester : III-VI)

Examinations: 2019-20

GURU NANAK DEV UNIVERSITY
AMRITSAR

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B.Sc. (Honours School) Chemistry (Semester System)

(Credit Based Evaluation & Grading System)

SCHEME OF COURSE

Note : All Theory Papers having Mid Semester Marks : 20 & End Semester Marks : 80. Total Marks will be 100.

SEMESTER - III

Sr. No.	Course No.	Course Title	Credit L-T-P
1	CYL201	Organic Chemistry of Functional Groups-III	3-1-0
2	CYL206	Physical Chemistry-II	3-1-0
3	MTL241	Mathematics-III	3-1-0
4	PHL291	Modern Physics-II	3-1-0
5	*ESL220	Environmental Studies (Compulsory)	4-0-0
6	PHP291	Modern Physics Lab	0-0-2
7.		Interdisciplinary Course-II	4-0-0

***Note : Credits will not be included in the total.**

SEMESTER -IV

Sr. No.	Course No.	Course Title	Credit L-T-P
1	CYL211	Heterocyclic Chemistry	3-1-0
2	CYL212	Chemical Spectroscopy–I	3-1-0
3	MTL242	Mathematics–IV	3-1-0
4	PHL296	Physics	3-1-0
5	CSL299	Computer for Chemists	2-0-0
6	CYP212	Physical Chemistry Lab–I	0-0-3
7	CSP299	Computer Lab	0-0-2
8.		Interdisciplinary Course-III	4-0-0

Note : 1. PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory ID Paper). Students can opt. this paper in any semester except the 1st Semester. This ID Paper is one of the total ID Papers of this course.

B.Sc. (Honours School) Chemistry (Semester System)

(Credit Based Evaluation & Grading System)

SEMESTER-V

Sr. No	Course No.	Course Title	Credit
1.	CYL-301	Organic Synthesis-I	3-1-0
		Stereochemistry & Structure Reactivity Relationships	
3.	CYL-303	Chemical Spectroscopy-II	3-1-0
4.	CYL-304	Ligand Field Theory	3-1-0
5.	CYL-305	Quantum Chemistry-I	3-1-0
6.	CYL-306	Physical Chemistry-III	3-1-0
7.	CYP-301	Organic Chemistry Lab-III	0-0-3
8.	CYP-302	Physical Chemistry Lab-II	0-0-3

SEMESTER-VI

Sr. No	Course No.	Course Title	Credit
1.	CYL-310	Co-ordination Chemistry	3-1-0
2.	CYL-311	Organic Synthesis-II Reactive Intermediates	3-1-0
3.	CYL-313	Instrumental Methods of Analysis	3-1-0
4.	CYL-314	Physical Chemistry-IV	3-1-0
5.	CYP-304	Physical Chemistry Lab-III	0-0-3
6.	CYP-305	Inorganic Chemistry Lab-II	0-0-3
		Quantitative Analysis	

B.Sc. (Honours School) Chemistry (Semester-III)

(Credit Based Evaluation & Grading System)

CYL201: Organic Chemistry of Functional Groups – III

Credit: 3-1-0 **(45 hrs.)**

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Phenols (5 Hrs)

Nomenclature, structure and bonding. Physical properties, Acidity of phenols and substituent effects, Comparative acidic strengths of alcohols and phenols, Resonance stabilization of phenoxide ion. Preparation and reactions of phenols - electrophilic aromatic substitution, acylation and carboxylation, Kolb-Schmitt reaction. Preparation of aryl ethers, Cleavage of aryl ethers by hydrogen halides, Claisen rearrangement of allyl aryl ethers, Oxidation of phenols. Gatterman synthesis, Hauben-Hoesch reaction, Laderer-Manasse reaction and Reimen-Tiemann reaction.

2. Ethers, Epoxides and Sulphides (4 Hrs)

Nomenclature of ethers, epoxides and sulphides. Structure and bonding in ethers and epoxides. Physical properties of ethers, Preparation of ethers. The Wilamson ether synthesis, Acid catalyzed cleavage of ethers. Preparation of epoxides, Conversion of vicinal halohydrins to epoxides, Reactions of epoxides: Nucleophilic ring opening, acid-catalyzed ring opening. Preparation of sulphides, oxidation and alkylation of sulphides. cleavage and autoxidation, Ziesel's method. Reactions of Grignard and organolithium reagents with epoxides.

SECTION-B

3. Aldehydes and Ketones (7 Hrs)

Nomenclature and structure of the carbonyl group. Physical properties, Sources of aldehydes and/or ketones from alkenes, alkynes, carboxylic acids, acid chlorides, nitriles and alcohols. Reactin of aldehydes with Grignard reagent to produce ketones. Hydroformylation, Synthesis of aldehydes and ketones using 1,3-dithianes. Reactions of aldehydes and ketones: Clemmensen, Wolff-Kishner, $LiAlH_4$, and $NaBH_4$ reductions. Addition of Grignard reagents and organolithium reagents to aldehydes and ketones. Principles of nucleophilic addition: hydration of aldehydes and ketones, cyanohydrin formation, acetal formation. Benzoin, aldol, Perkin and Knoevenagel condensations. Use of acetals as protecting groups. Reactions of aldehydes and ketones with ammonia, primary amines and secondary amines. Enamines and Wittig reaction, Stereoselective addition to carbonyl groups. Oxidation of aldehydes. Mannich reaction. Baeyer-Villiger oxidation of ketones, Cannizzaro reaction. Meerwein-Ponndorf-Verley reaction, Halogenation of enolizable ketone. An introduction to α,β-unsaturated aldehydes and ketones.

4. Carboxylic Acids (5 Hrs)

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effectsof substituents on acid strength . Dicarboxylic acids. Methods of formation and effect of heat and dehydrating agents. Preparation of carboxylic acids: carboxylation of Grignard reagents, oxidation of alkylbenzenes, oxidation of primary alcohols, aldehydes. Preparation and hydrolysis of nitriles. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Intramolecular ester formation. Hydroxy acids: malic, tartaric and citric acids. Methods of formation and chemical reactions of unstaturated monocarboxylic acids.

SECTION-C

5. Carboxylic Acid Derivatives (5 Hrs)

Nomenclature and structure of acid chlorides, esters, amides, acid anhydrides and nitriles. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution in acyl chlorides and acid anhydrides. Sources and physical properties of esters. Acid as well as base catalyzed ester hydrolysis. Reactions of esters with ammonia, amines, Grignard reagents and lithium aluminium hydride. Amides: hydrolysis of amides. Lactams. Preparation of nitriles, hydrolysis, addition of Grignard reagents to nitriles.

6. Carbohydrates (7 Hrs)

Classification of carbohydrates, Fischer projections and D-, L- notations of glyceraldehyde, aldotetroses, aldopentoses and aldohexoses. Cyclic forms of carbohydrates: Furanoses and Pentoses. Mutarotation and mechanism. Introduction to ketoses, deoxy sugars, amino sugars and branched chain carbohydrates. Glycosides: The Fischer glycosidation, mechansm. examples of disaccharides and polysaccharides. Reactions of carbohydrates: Reduction of monosaccharides, oxidation of monosaccharides. Determination of ring size of monosaccharides. Cyanohydrin formation and chain extension. Kiliani-Fischer synthesis. Epimerization, isomerizaion and retro-cleavage: Interconversion of glucose into mannose, fructose. Acylation and alkylation of carbohydrate hydroxyl group. Mechanism of osazone formation, An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

SECTION-D

7. Amines (6 Hrs)

Amine nomenclature, Structure and bonding, physical properties. Basicity of amines. Structural features effecting basicity of amines.tetraalkylammonium salts as Phase Transfer Catalysts. Preparation of primary, secondary and tertiary amines: Nucleophilic substitution by azide ion on alkyl halides, nitration of arenes, nucleophilic ring opening of epoxides by ammonia, nucleophilic addition of amines to aldehydes and ketones, nucleophilic substitution by ammonia on α-halo acids. Nucleophilic acyl substitution. Preparation of amines by alkylation of ammonia, The Gabriel synthesis of primary alkylamines, preparation of amines by reduction of azides, eopxides, nitriles, nitro and amides. Reductive amination, Reaction of amines with alkyl halides, The Hofmann elimination. Electrophilic aromatic substitution in arylamines, nitrosation of alkylamines and arylamines. Synthetic transformations of aryl diazonium salts, azo coupling.

8. Amino Acids, Peptides, Proteins and Nucleic Acids (6 Hrs)

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, the Edman degradation. The strategy of peptide synthesis: amino and carboxyl group protection, peptide bond formation. Solid-phase peptide synthesis: The Merrifield method. Secondary structures of peptides and proteins. Introduction to tertiary and quaternary structures of proteins. Protein denaturation/renaturation. Nucleosides and nucleotides. secondary structure of DNA: The double helix. Tertiary structure of DNA: supercoils. Nucleic acids: Introduction. Constitutents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

Books Recommended:

1. Organic Chemistry. F.A. Carey, McGraw Hill, Inc. 8th edition.
2. Organic Chemistry, Morrison and Boyd, Prentice Hall.

Suggested books:

3. Fundamentals of Organic Chemistry, Solomons, John Wiley.
4. Organic Chemistry, L.G. Wade Jr. Prentice Hall.
5. Organic Chemistry Vol. I, II & III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd (New Age International).
6. Introduction to organic chemistry, Stritwieser, Heathcock and Kosover, Macmilan.

CYL-206: Physical Chemistry-II

Credit: 3-1-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A (11Hrs)

1. Thermodynamics-I:

Definition of Thermodynamic Terms: System, surroundings etc. Types of systems, intensive and extensive properties, state and path functions and their differentials, thermodynamics process, concept of heat and work.

First Law of Thermodynamics: Statement, definition of internal energy and enthalpy, heat capacities at constant volume and pressure and their relationship. Joule's law, Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU&dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Thermochemistry: Standard state, standard enthalpy of formation - Hess's Law of heat summation and its applications. Heat of a reaction at constant pressure and at constant volume, enthalpy of neutralization, bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy and Kirchhoff's equation.

SECTION-B (12Hrs)

2. Thermodynamics-II:

Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

Concept of Entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change. Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A &G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T.

3. Chemical Equilibrium:

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle. Reaction isotherm and reaction isochore - Clapeyron equation and Clausius-Clapeyron equation, applications.

SECTION-C (11Hrs)

4. Colligative Properties:

Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point. Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

SECTION-D (11Hrs)

5. **Chemical Kinetics:**

Chemical kinetics and its scope. Order & Molecularity. Rate constants and rate coefficients. Rate laws. Factors affecting rates: concentration, temperature, pressure, solvent, light, catalyst. Differential method, method of integration, First order, Second order and Third order reactions with examples, half lives, pseudo-molecular reactions, isolation method, reaction of nth order, comparison of methods. Arrhenius equation, Numerical Problems.

Books Suggested:

1. Glasstone,b.2003 Thermodynamics for Chemists, East West Press, NewDelhi.
2. Rock, P.A. (1983) Chemical Thermodynamics, University Science Books, Saisalito, CA.
3. Maron S.H., Pretton C.F. (1965) Principles of Physical Chemistry, 4th Edition, , Mac Millan Publishing Company, New York.
4. Atkin, P., Paula J, (2002) Atkin's Physical Chemsitry, 7th Edition, Oxford University Press, London.
5. Kapoor, K.L (2006) A Text Book of Physical Chemistry, 6th Volume, Macmillan Publishers India Ltd., New Delhi.
6. Laidler, K.J.(1995) The world of Physical Chemsitry, 3rd Volume, Oxford University Press, London.
7. Frost, A.A., Pearson R.G. (1961) Kinetics and Mechanism, A study of homogeneous Chemical Reactions, 2nd Edition, John Wiley & Sons, New York.

B.Sc. (Honours School) Chemistry (Semester-III)

(Credit Based Evaluation & Grading System)

MTL241: Mathematics-III

Credit 3-1-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Integral calculus: **(8 Hrs)**

Integral calculus: double, triple integrals, determination of C.G. using double and triple integrals. Integration by trapezoidal and Simpson's rule.

Section-B

Differential Equations: **(8+7 Hrs)**

Ordinary differential equations. Formation of differential equation, solution of linear differential equation of the first order and first degree. Solution of homogeneous and non homogeneous differential equations with constant coefficient. The chemical application of the first differential equations.

Series solutions of Bessel and Legendre differential equations. Bessel function and Legendre Polynomials. Recurrence and orthognality relations, Rodrigue's Formulae.

Section-C

Parital differential equations **(8 Hrs)**

Formation of partial differential equations. Solution by Charpit's Method. Solution of homogeneous partial differential equations with constant coefficients.

Section-D

(15 Hrs.)

De-Moivre's theorem and its applications: Functions of complex variables. Analytic functions. C-R equations, complex line integral. Cauchy's integral theorem & Cauchy's integral formula.

Taylor's theorem. Laurent's theorem. Cauchy's residue Theorem. Integration round unit circle. Evaluation of integrals of the type $\int_{-\infty}^{\infty} f(x)dx.\infty$

Books Recommended:

1. B.S. Grewal – Higher Engineering Mathematics.
2. Erwin Kreyszig-Higher Engineering Mathematics.
3. Joseph B, Dence-Mathematical Techniques in Chemistry.
4. B.L. Manocha and H.R. Choudhary – A text book of Engineering mathematics.
5. Margenau Murphy – Mathematics for Physical and Chemists.

PHL 291:Modern physics-II

Credits 3-1-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section A

Frames of References: Inertial frame of reference, Galilean transformation, Galilean Invariance of space & time intervals; Newton's laws of motion; law of conservation of linear momentum & energy. Inertial and non-inertial frames and fictitious forces. Effect of rotation of earth on 'g'. Effects of centrifugal and Coriolis forces produced as a result of earth's rotation. Foucault's pendulum and its equation of motion.

15 Lectures

Section B

The Lorentz Transformation: Newtonian relativity. Instances of its failure in electromagnetism, attempts to locate the absolute frame of reference, ether-drag hypothesis and Fizeau's experiment. Michelson-Morley experiment, Lorentz-Fttzgerald contraction, Einstein's basic postulates of relativity and geometric derivation of Lorentz transformation, Invariance of Maxwell's equations, length contraction, relativity of simultaneity, synchronization and time dilation. Einstein's velocity addition rule, transformation of acceleration. Twin paradox and its resolution.

15 Lectures

Section C

P.N. Junction : Intrinsic/Extrinsic semiconductor, Fermi level, Charge carries in semiconductors, PN junctions, depletion region, current components in pn junction, Characteristic of pn junction diode, pn junction as rectifier, characteristics and applications of Zener diode, Photodiode, LED and photocells.

15 Lectures

Section D

Digital Principles : logic gates, AND, OR, NOT, NAND, NOR, XOR, XNOR.
Number System: Decimal, Binary, octal, Hexadecimal.

15 Lectures

References:

(i) Optics by A.K.Ghatak.
(ii) Optical Electronics – A.K.Ghatak & R.Thyagrajan.
(iii) Modern Physics – J.Bernetein, Paul M.Fishbane and Stephen Gasiorowic.
(iv) Interated Electronics Millman & Halkias.

ESL-220 : ENVIRONMENTAL STUDIES (COMPULSORY)

Credits: 4-0-0

Teaching Methodologies
The Core Module Syllabus for Environmental Studies includes class room teaching and field work. The syllabus is divided into 8 Units [Unit-1 to Unit-VII] covering 45 lectures + 5 hours for field work [Unit-VIII]. The first 7 Units will cover 45 lectures which are class room based to enhance knowledge skills and attitude to environment. Unit-VIII comprises of 5 hours field work to be submitted by each candidate to the Teacher in-charge for evaluation latest by 15 December, 2019.

Exam Pattern: **End Semester Examination- 75 marks**
Project Report/Field Study- 25 marks [based on submitted report]
Total Marks- 100

The structure of the question paper being:

Part-A, Short answer pattern with inbuilt choice – **25 marks**
Attempt any five questions out of seven distributed equally from Unit-1 to Unit-VII.
Each question carries 5 marks. Answer to each question should not exceed 2 pages.

Part-B, Essay type with inbuilt choice – **50 marks**
Attempt any five questions out of eight distributed equally from Unit-1 to Unit-VII. Each question carries 10 marks. Answer to each question should not exceed 5 pages.

Project Report / Internal Assessment:

Part-C, Field work – **25 marks [Field work equal to 5 lecture hours]**
The candidate will submit a hand written field work report showing photographs, sketches, observations, perspective of any topic related to Environment or Ecosystem. The exhaustive list for project report/area of study are given just for reference:

1. Visit to a local area to document environmental assets: River / Forest/ Grassland / Hill / Mountain / Water body / Pond / Lake / Solid Waste Disposal / Water Treatment Plant / Wastewater Treatment Facility etc.
2. Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
3. Study of common plants, insects, birds
4. Study of tree in your areas with their botanical names and soil types
5. Study of birds and their nesting habits
6. Study of local pond in terms of wastewater inflow and water quality
7. Study of industrial units in your area. Name of industry, type of industry, Size (Large, Medium or small scale)
8. Study of common disease in the village and basic data from community health centre
9. Adopt any five young plants and photograph its growth
10. Analyze the Total dissolved solids of ground water samples in your area.
11. Study of Particulate Matter ($PM_{2.5}$ or PM_{10}) data from Sameer website. Download from Play store.
12. Perspective on any field on Environmental Studies with secondary data taken from Central Pollution Control Board, State Pollution Control Board, State Science & Technology Council etc.

Unit-I

The multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness

(2 lectures)

Unit-II

Natural Resources: Renewable and non-renewable resources:

Natural resources and associated problems.

(a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

(b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

(c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

(d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

(e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

(f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

(8 Lectures)

Unit-III

Ecosystems

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

(6 Lectures)

Unit-IV

Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity
- Biogeographical classification of India
- Value of biodiversity: consumptive use, productive use, social, ethical aesthetic and option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity

(8 Lectures)

Unit-V

Environmental Pollution

Definition

- Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution
- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

(8 Lectures)

Unit-VI

Social Issues and the Environment

- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Protection Act, 1986
- Air (Prevention and Control of Pollution) Act, 1981
- Water (Prevention and control of Pollution) Act, 1974
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation
- Public awareness

(7 Lectures)

Unit-VII

Human Population and the Environment

- Population growth, variation among nations
- Population explosion – Family Welfare Programmes
- Environment and human health
- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

(6 Lectures)

Unit-VIII

Field Work

- Visit to a local area to document environmental assets river/forest/grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-pond, river, hill slopes, etc

(Field work equal to 5 lecture hours)

References:

1. Bharucha, E. 2005. Textbook of Environmental Studies, Universities Press, Hyderabad.
2. Down to Earth, Centre for Science and Environment, New Delhi.
3. Heywood, V.H. & Waston, R.T. 1995. Global Biodiversity Assessment, Cambridge House, Delhi.
4. Joseph, K. & Nagendran, R. 2004. Essentials of Environmental Studies, Pearson Education (Singapore) Pte. Ltd., Delhi.
5. Kaushik, A. & Kaushik, C.P. 2004. Perspective in Environmental Studies, New Age International (P) Ltd, New Delhi.
6. Rajagopalan, R. 2011. Environmental Studies from Crisis to Cure. Oxford University Press, New Delhi.
7. Sharma, J. P., Sharma. N.K. & Yadav, N.S. 2005. Comprehensive Environmental Studies, Laxmi Publications, New Delhi.
8. Sharma, P. D. 2009. Ecology and Environment, Rastogi Publications, Meerut.
9. State of India's Environment 2018 by Centre for Sciences and Environment, New Delhi
10. Subramanian, V. 2002. A Text Book in Environmental Sciences, Narosa Publishing House, New Delhi.

PHP-291: MODERN PHYSICS LAB

Credit: 0-0-2

1. To determine e/m by short solenoid method.
2. To determine e/m by long solenoid method.
3. To determine e/m by magnetron value.
4. To determine Ionisation potential of Hg.
5. To find planck's constant using photo cell.
6. To determine electronic charge by Millikan's Oil Drop Apparatus.

CYL-211: Heterocyclic Chemistry

Credit: 3-1-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Nomenclature of Heterocycles (4 Hrs)

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles.

2 Aromatic Heterocycles (5 Hrs)

Aromatic resonance energy, structure of six-membered heteroaromatic systems (pyridine, diazines, pyridones and pyrones), structure of five-membered heteroaromatic systems (pyrrole, thiophene, furan, azoles), bicyclic heteroaromatic compounds. Heteroaromatic reactivity and tautomerism in aromatic heterocycles

3. Non-aromatic Heterocycles - A (2 Hrs)

Strain – bond angle and torsional strains and their consequences in small ring heterocycles.

SECTION-B

4. Non-aromatic Heterocycles - B (4 Hrs)

Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction.

Stereo-electronic effect – anomeric and related effects. Attractive interactions – hydrogen bonding and intermolecular nucleophilic-electrophilic interactions

5. Heterocyclic Synthesis (4 Hrs)

Principles of heterocyclic synthesis involving cyclization and cycloaddition reactions

6. Small Ring Heterocycles (4 Hrs)

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes

SECTION-C

7. Benzo-Fused Five-Membered Heterocycles (4 Hrs)
Synthesis and reactions including medicinal applications of benzopyrroles, Benzofurans and benzothiophenes

8. Meso-ionic Heterocycles (4 Hrs)
General classification, chemistry of some important meso-ionic heterocycles of type-A and B and their applications.

9. Purines: Synthesis and Reactions (4 Hrs)
Approaches for the construction of purine ring, reactions of purines with electrophilic reagents, with nucleophilic reagents, reactions with bases, reactions of C-metallated purines

SECTION-D

10. Six-Membered Heterocycles with One Heteroatom (6 Hrs)
Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and pyridones.
Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones.

11. Six-Membered Heterocycles with Two or More Heteroatoms (4 Hrs)
Synthesis and reactions of diazines, triazines, oxadiazoles and thiadiazoles

Books Suggested:
1. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, 3rd edition, Indian reprint, 2004. Chennai Microprint Pvt. Ltd.
2. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical
3. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
4. An Introduction to Heterocyclic Compounds, R.M. Acheson, John Wiley
5. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon Press.
6. Heterocyclic Chemistry, A. Paquett

B.Sc. (Honours School) Chemistry (Semester-IV)

(Credit Based Evaluation & Grading System)

CYL212: Chemical Spectroscopy – I

Credit: 3-1-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. General features of Spectroscopy and Vibrational Spectra : (11 hrs.)

Units and conversion factors, Introduction to spectroscopy, Nature of radiation, Energies corresponding to various kinds of radiation, Intensities of spectral lines, selection rules and transition moments, Line widths, Broadening (Book 1)

Diatomic molecules, Force constants, Fundamental vibration frequencies, anharmonicity of molecular vibrations and its effect on vibrational frequencies, Frequencies of the vibrational transitions of HCl. Vibrational rotation spectra of CO, P,Q and R branches.

SECTION-B

2. Pure Rotational Spectra: (11 Hrs.)

Classification of molecules according to their moment of inertia. Rotational energy levels of hydrogen chloride. Determination of molecular geometry by rotational spectrum, isotopic substitution effects. Stark effect, Estimation of molecular dipole moments, Selection rules, Rotational Raaman Spectra, anisotropic polarizability, specific selection rule in Raman Spectra, Stokes and anti – Stokes lines.

SECTION-C

3. Infrared and Raman Spectra: (12 Hrs.)

Vibrations of polyatomic molecules. Examples of CO_2, H_2O. Mechanics of measurement of infrared and Raman spectra, absorption of common functional groups, their dependence on chemical environment (bond order, conjugation, H – bonding), Use of group theory to determine the number of active infrared and Raman active lines. Fermi resonance, combination bands and overtones, complications due to interactions of vibrations of similar frequency. Application of IR in structure elucidation of organic compounds – Carbonyls and effect of substituents on it, C-H, N-H, O-H vibrations and H-bonding – unsubstituted, mono and di-substitute aromatic compounds – Far IR region, Metal ligand vibrations, Group frequencies of complex ligands – CN stretching and effect of co-ordination on it. Nitro-nitrito- and C=O ligands and the effect of their co-ordination with metal ions and IR spectra.

SECTION-D

4. UV and Visible Spectroscopy of organic molecules: (11 Hrs.)

Measurement technique, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Frank Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra.

Chromophores, auxochromes, electronic spectra of polyatomic molecules, Woodward rules for conjugated dienes and α, β- unsaturated carbonyl groups, extended conjugated and aromatic sterically hindered systems, red shift, blue shift, hypo and hyperchromic effect.

References:

1. R.S.Drago, "Physical Methods in Chemistry".
2. R.M. Silverstein, G.C. Bassler, T.C. Morrill, "Spectrometic Identification of Organic Compounds.
3. W. Kemp, "Organic Spectroscopy".
4. D.H. Williams, I. Pleming, "Spectroscopic Methods in Organic Chemistry".
5. J.R.Dyer, "Application of Absorption Spectroscopy of Organic Compounds".
6. D. H. Williams, I. Fleming, "Spectroscopic Problems in Organic Chemistry" 1967.
7. R.C. Banks, E.R. Matjeka, G. Mercer, "Introductory Problems in Spectroscopy" 1980.
8. G.M. Barrow "Introduction to Molecular Spectroscopy".
9. C.N. Banwell "Fundamentals of Molecular Spectroscopy".
10. D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy" Hartcourt College Publishers, 2001

MTL-242: MATHEMATICS - IV

Credit: 3-1-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section A

Vectors Algebra: **(9 Hrs)**
Definition of vector and scalar. Scalar & Vector product of two vectors. Scalars triple product and vector triple product and their applications. Work done by a force, moment of a force about a point.

Section B

Vectors Calculus : **(12 Hrs)**
Vector differentiation and integration of vectors. Vectors operators, Gradient, Divergence and Curl. Gauss, Stoke and Green's Theorem (Statement only) and their applications.

Section C

Laplace Transform: **(12 Hrs)**
Definition of elementary transforms, transforms of integrals and derivatives. Laplace transforms of periodic functions, inverse Laplace transforms of periodic functions. Solutions of ordinary differential equations and simultaneous differential equations using Laplace transforms.

Section D

Fourier Series : **(12 Hrs)**
Periodic Functions, Dirichlet Conditions, Fourier Series & Fourier coefficient, functions having arbitrary period, Sin and Cosine Series, half range expansions, Fourier integral (definitions), Harmonic Analysis.

Books Recommended:
1. B.S. Grewal – Higher Engineering Mathematics.
2. Erwin Kreyszig-Higher Engineering Mathematics.
3. Joseph B, Dence-Mathematical Techniques in Chemistry.
4. B.L. Manocha and H.R. Choudhary – A text book of Engineering Mathematics.
5. Margenau Murphy – Mathematics for Physics and Chemists.

PHL 296: Physics

Credit 3 1 0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section A

Forces between charges, concept of electric field. Flux of the electric field. Gauss's law and Coulomb's law. An insulated conductor, experimental proof of Gauss's and Coulomb's laws. Applications of Gauss's law. Concept of electric potential. Relationship between potential, electric field strength and energy.

15 Lectures

Section B

The magnetic field, magnetic forces on a current, torque on a current, Biot-Savart Law and its applications. Hall effect. Ampere's law. Magnetic field near a long wire, magnetic field of a solenoid.

15 Lectures

Section C

Faraday's experiments. Faraday's law of induction. Lenz's law. Quantitative study of induction. Time varying magnetic field. Maxwell Equations and Magnetism. Induced magnetic fields, displacement current. Combining all the laws of electromagnetism into Maxwell equations. Poles and Dipoles. Gauss's law and magnetism.

15 Lectures

Section D

Basic concepts of magnetism, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism. Domains and hysteresis, magnetic anisotropy soft and hard magnetic materials, applications of magnetic materials, nuclear magnetism.

15 Lectures

Reference Books:

1. Physics Part/II David Halliday and Robert Resnick (Principal Text).
2. Berkeley Physics Volume II E. M. Pureell.
3. Introduction to Electrodynamics D.J. Griffiths.

CSL-299: Computer for Chemists

Credit: 2-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

1. Computer programming in C language 25 Hrs.

SECTION-A

Principles of programming, algorithms and flowcharts.

Elementary programming, a typical C program, printf function.

Introduction of declarations, assignments and variables: concept of an integer, concept of a variable, rules for naming variables, assignment statement, arithmetic operators.

Integer arithmetic expressions, truncation effects, relative priority of arithmetic operators, use of parenthesis, modulus operator.

SECTION-B

Floating point numbers, scientific notation, converting integers to floating point and vice versa , coercion and cast operator, type char.

Decision making in C, scanf function, relational operators, logical operators, if statement, if else statement, nesting of if statement.

SECTION-C

Loop: do while loop, for loop, nesting of for loop.

Type char and ASCII code, character strings and how to print them, octal and hexadecimal notation.

User defined functions, returning value from a function, functions with more than one parameters.

SECTION-D

Arrays, declaring an array, initializing an array, break statement, strings and character arrays, sorting an array, finding maximum and minimum in an array, multidimensional arrays.
Input and output.

Recommenmded Books:

1. K.V. Raman, Computers in Chemistry, Tata McGraw Hill.
2. Mullish Cooper, The Spirit of C, An Introduction to Modern Programming.

CYP-212: Physical Chemistry Lab- I

Credit: 0-0-3

1. To determine the molecular weight of a compound by Rast's micro method.
2. Determination of coefficient of viscosity of a given liquid by viscometer.
3. To determine the unknown composition of a given mixture of two liquids by viscosity method.
4. To find the mol. wt. of high polymer by using viscosity measurements.
5. To determine surface tension of a given liquid by double capillary rise method.
6. Determination of surface tension of a given liquid by drop number method by stalagmometer.
7. To determine the unknown composition of a mixture of two liquids by surface tension measurements.
8. To determine the critical micelle concentration of a soap (sodium laurate) by surface tension measurements.
9. Determination of molecular weight of a given liquid by steam distillation.
10. To determine the distribution coefficient of I_2 between CCl_4 and water.
11. Determination of transition temperature of given substance by thermometric method.
12. To find the water equivalent of the Dewar's flask.
13. To find heat of neutralization of HCl using Dewar's flask.
14. To determine refractive index of a liquid by Abbe's refractometer and hence the specific and molar refraction.
15. To determine the unknown composition of a given mixture of two liquids by refractive index measurements.
16. To extract oil from given seeds with the help of Soxhlet apparatus.
17. To study the adsorption of acetic acid from its aqueous solution by activated charcoal.

Books Recommended:

1. Findlay's Practical Physical Chemistry.
2. Advanced Practical Physical Chemistry by J.B. Jadav.
3. Quantitative Organic Analysis by Vogel.

CSP-299: COMPUTER LAB

Credit: 0-0-2

Development of small computer codes involving simple formulae in chemistry:

1. Calculation of mean, median, mode.
2. Solution of a quardratic equation.
3. Calculation of linear regression.
4. Calculation of curve linear regression.
5. Calculation of Bohr orbit from de Broglie Lambda for electron.
6. `Calculation of wave number and frequency from value of wave length.
7. Calculation of van der Waals radii.
8. Radioactive decay.
9. Rate constant of a 1st order reaction, 2nd order reaction.
10. Determination
11. Calculation of lattice energy using Born Lande equation.
12. Addition, multiplication and solution of inverse of 3 X 3 matrix.
13. Calculation of average molecular weight of a polymer containing n1 molecules of molecular weight m1, n2 molecules of molecular weight M2 and so on.
14. Program for calculation of molecular weight of organic compound containing C, H,N O and S.
15. Calculation of reduced mass of diatomic molecule.
16. Calculate the RMS and most probable velocity of a gas.
17. Calculate the ionic mobility from ionic conductance values.
18. Determine the thermodynamic parameters for isothermal expansion of monoatomic ideal gas.
19. Calculation of value of g- factor from value of J and S.
20. Calculate the bond length and bond angles using crystal structure data.

B.Sc. (Honours School) Chemistry (Semester-V)

(Credit Based Evaluation & Grading System)

CYL-301: Organic Synthesis - I

Stereochemistry and Structure Reactivity Relationships

Credit: 3-1-0

1. Principles of Reactivity 5 Hrs

Mechanistic significance of entropy, enthalpy and Gibb's free energy. Arrhenius equation. Transition state theory. Uses of activation parameters, Hammond's postulate. Bell-Evans-Polyanyi principle. Potential energy surface model. Mercus theory of electron transfer. Reactivity and selectivity principles.

2. Stereochemistry 10 Hrs

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Zoptical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.
Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

3. Kinetic Isotope Effect 4 Hrs

Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect. Solvent effects.

4. Structural Effects on Reactivity 8 Hrs

Linear free energy relationships (LFER). The Hammett equation, substituent constants, theories of substituent effects. Interpretation of -values. Reaction constant ρ . Deviations from Hammett equation. Dual-parameter correlations, inductive substituent constant. The Taft model, σ_I- and σ_R-scales.

5. Solvation and Solvent Effects 6 Hrs

Qualitative understanding of solvent-solute effects on reactivity. Thermodynamic measure of salvation. Effects of salvation on reaction rates and equilibria. Various empirical indexes of salvation based on physical properties, solvent-sensitive reaction rates, spectroscopic properties and scales for specific salvation. Use of salvation scales in mechanistic studies. Solvent effects from the curve-crossing model.

6. Acids, Bases, Electrophiles, Nucleophiles and Cataylsis 6 Hrs

Acid-base dissociation. Electronic and structural effects, acidity and basicity. Acidity function and their applications. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The α -effect. Ambivalent nucleophiles. Acid-base catalysis- specific and general catalysis. Bronsted catalysis. Nucleophilic and electrophilic catalysis. Catalysis by non-covalent binding-micellar catalysis.

7. Steric and Conformational Properties 6 Hrs

Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates. Steric LFER. Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

Books Suggested:

1. Mechanism and Theory in Organic Chemistry, T.H. Lowry and K.C. Richardson, Harper and Row.
2. Introduction to Theortical Organic Chemistry and Molecular Modelling, W.B. Smith, VCH, Weinheim.
3. Physical Organic Chemistry, N.S. Issacs, ELBS/Longman
4. Supramolecular Chemistry, Concepts and Perspectives, J.M. Lehn, VCH
5. The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press.

CYL-303: Chemical Spectroscopy – II

Credit: 3-1-0

1. General Features of Spectroscopy: (5 Hrs.)

Units and conversion factors. Introduction to spectroscopy, Nature of radiation. Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Linewidths, Broadening. (Book-1)

2. Nuclear Magnetic Resonance Spectroscopy (25 Hrs.)

The nuclear spin, presessional motion. Larnor frequency, the NMR isotopes, population of nuclear spin levels, spin – spin and spin – lattice relaxation, measurement techniques (CW and FT methods). Solvent used, Chemical Shift, shielding constant, range of typical chemical shifts simple applications of chemical shift ring currents and aromaticity, shifts of ^{1}H and ^{13}C, inductive effect, ring current effect and anisotropy chemical bonds, intermolecular forces effecting the chemical shifts.

Spin – spin interactions, low and high resolution NMR with various examples. Correlation for H bonded to Carbon. 1H bond to other nuclei such as nitrogen, oxygen and sulphur. Complex spin – spin interaction. Interaction between two or more nuclei, splitting due to vicinal and geminal protons, long range coupling. ABX and ABC systems with their coupling constants, shifts reagents. Effects of chemical exchange, fluxional molecules, Hindered rotation on NMR spectrum, Karplus relationship. Nuclear magnetic double resonance, spin decoupling, Nuclear overhauser Effect (NOE). ^{13}C ^{1}H coupling, ^{13}C spectra, Differences from ^{1}H nmr, DEPT, Intensities of lines in ^{13}C.

3. Mass Spectra: (15 Hrs)

Introduction, methods of ionization E1 & C1, Laser desorption, Fast Atom Bombardment (FAB). Secondary Ion Mass Spectrometry (SIMS), field desorption etc. Ion analysis methods (in brief), isotope abundance, Metastable ions, Electron Impact mass spectra, fragmentation patterns for aliphatic compounds, amines, aldehydes, ketons, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds, general rules predicting the fragmentation patterns.

(Books 2, 3, 5)

4. Structure elucidation by combined application of UV, IR, NMR and mass spectra. Solving first 20 problems from reference book 6 and first 20 problems from reference book 7. Tutorials

Books:

1. C.N. Banwell “Fundamentals of Molecular Spectroscopy”.
2. W. Kemp, “Organic Spectroscopy”.
3. D.H. Williams, I. Pleming, “Spectroscopic Methods in Organic Chemistry”.
4. R.S.Drago, “Physical Methods in Chemistry”.
5. R.M. Silverstein, G.C. Bassler, T.C. Morrill, “Spectrometic Identification of Organic Compounds”.
6. D.L. Pavia, G.M. Lampan and G. S. Kriz, “Introduction to Spectroscopy” Hartcourt College Publishers, 2001.
7. R.C. Banks, E.R. Matjeka, G. Mercer, “Introductory Problems in Spectroscopy” 1980.

B.Sc. (Honours School) Chemistry (Semester-V)

(Credit Based Evaluation & Grading System)

CYL-304: Ligand Field Theory

Credit: 3-1-0

1. **Symmetry** **(5 Hrs.)**

Symmetry elements, symmetry operations, point group determination, determination of reducible and irreducible representations, character tables, use of symmetry in obtaining symmetry of orbitals in molecules, use of character table to determine which metal orbitals are used in σ and π bond formation in octahedral, tetrahedral and square planar transition metal complexes, qualitative splitting of s, p, d, f orbitals in octahedral, tetrahedral and square planar fields using character tables and without the use of character tables. **(Text 2, 5, 7).**

2. **Orbital Wave Functions** **(5 Hrs.)**

Wave function and shapes of imaginary and real s, p,d and f orbital (cubic and general set in case of f orbitals), Z – component of orbital angular momentum, vector, imaginary and real d orbitals. (Text 1, 2).

3. **Crystal Field Theory** **(10 Hrs.)**

Evaluation of $V_{(x,\ y,\ z)}$, $V_{oct.}$, $V_{sq,\ pl.}$ and $V_{tetragonal}$, evaluation of $V_{oct.}$ .in cartesian co-ordinates, effect of V_{oct} on d-orbital wave functions **(Text 1 & 2).**

4. **Interelectronic Repulsions** **(5 Hrs.)**

Spin-spin, orbital-orbital and spin orbital coupling, L.S. and jj coupling schemes, determination of all the spectroscopic terms of p^n, d^n ions, determination of the ground state terms for p^n, d^n, f^n ions using L.S. scheme, determination of total degeneracy of terms, order of interelectronic repulsions and crystal field strength in various fields, two type of electron repulsion parameters, term wave functions, Bra and Ket notation, derivations of single electron wave functions and their linear combinations for getting the term wave functions of all spectroscopic terms of d^n system, spin orbit coupling parameters (λ) energy separation between different j states **(Texts 1 and 3).**

5. **Free Ions in Weak Crystal Field** **(5 Hrs.)**

The effect of Voct on S, P, D and F terms (with help of the character table and qualitatively), splitting patterns of and G, H and I terms **(Text 1 and 7).**

6. **Free Ions in Medium and Strong Crystal Fields** **(5 Hrs.)**

Strong field configurations, transition from weak to strong crystal fields, evaluation of strong crystal field terms of d^2 and d^3 cases in octahedral and tetrahedral crystal fields (using group theory), construction of the correlation energy level diagrams of d^2 and d^3 configurations in octrahedral and tetrahedral fields, study of energy level diagrams for higher configurations, selection rules of elecronic transitions in transition metal complexes, their proof using group theory, relaxation of the selection rule in centrosymmetric and non centrosymmetric molecules, Orgel diagrams, Tanabe Sugano diagrams, interaction of T_{1g} (P) and T_{1g}(F) terms. **(Text 1, 2, 4 and 5).**

7. **Electronic Spectra of Transition Metal Complexes (10 Hrs.)**
Variation of the Racah parameter, central field covalency, symmetry restricted covalency, differential radial expansion, intermediate coupling, nephlauxetic effect, spectrochemical series, band intensities, factors influencing band widths, variation of 10Dq, vibrational structure, spin orbit coupling, low symmetry components, Jahn-Teller effect, discussion of electronic spectra of octahedral and tetrahedral $d^1 – d^9$ metal ions, calculation of 10Dq and B with and without the use of Tanabe Sugano diagrams, low spin complexes of Mn^{3+}, Mn^{2+}, Fe^{3+}, Co^{3+}, Fe^{2+}, comment on the spectra of second and third transition series, spectra of K_3MoCl_6 and $[Rh(NH_3)_6]^{3+}$, spectra of cis and trans$[Co(en)_2X_2]^+$, $[Mn(H_2O)_6]^{2+}$, $CuSO_4$. $5H_2O$ and anhydrous complex, comparison of d – d band with f – f bands **(Texts 1, 2, 4 and 5).**

Recommended Books:

1. B.N. Figgis, Introduction to Ligand Field, Wiley Eastern.
2. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier.
3. A. Earnshaw, Introduction to Magnetochemistry, Academic Press.
4. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Inter-Science.
5. R.S. Drago, Physical Method in Chemistry, W.B. Saunders Company.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Inter-science.
7. F.A. Cotton, Chemical Application of Group Theory, Wiley Eastern.

B.Sc. (Honours School) Chemistry (Semester-V)

(Credit Based Evaluation & Grading System)

CYL305: Quantum Chemistry – I

Credit: 3-1-0

1. The Dawn of Quantum Mechanics (6 Hrs)

Black body radiation, Planck's radiation law, photoelectric effect, Compton effect, De- Broglie hypothesis the Heisenberg's uncertainly principle, Rydberg's relation for explaining atomic spectrum of hydrogen. Functions, even and odd, well behaved functions, Operators and operator algebra.

2. The Schrodinger Equation: (10 Hrs)

Solution of classical wave equation by separation of variable method, Eigen value equation, Hamiltonian operator. Solution of particle in one, two and three dimensional box, Degeneracy, The Schrodinger Equation in general and its importance. Physical Interpretation of wave function.

3. Angular Momentum (8 Hrs)

Commutative laws, vectors, Angular momentum of one particle system, orbital angular momentum, the ladder operator method for angular momentum.

4. General Principles of Quantum Mechanics (12 Hrs)

Hermitian operator and some important theorems. Eigen functions of commuting operators. Postulates of quantum mechanics, the linear harmonic oscillator, the rigid rotator, Quantization of vibrational and rotational energies.

5. The Hydrogen Atom (5 Hrs)

Outline of various steps in the solution of the electronic Schrödinger equation for hydrogen atom, Radial and angular parts of the hydrogen atomic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Significance of Quantum numbers, orbital angular momentum and quantum numbers m_l and m_s.

6. Electron Spin (4Hrs)

Electron spin and Pauli's Principle, Spin orbital, The Asymmetric wave functions for Heium atom in ground and excited state, Slater determinant for asymmetric wave function.

Books Suggested:

1. Physical Chemistry, A Molecular Approach by D.A. Mcquarrie and J.D. Simon, 2010 university science books.
2. Quantum Chemistry, Ira N. Levine, 5th edition 1999 Prentice Hall.
3. Quantum Chemistry, H. Eyring J. Walter and G.E. Kimball, 1944, John Wiley & Sons Ink.
4. Molecular Quantum Mechanics, P.W. Atkins and R.S. Friedmann, 2010, Oxford University Press.

CYL306: Physical Chemistry-III

Credit: 3-1-0

Equilibrium Thermodynamics: (10 Hrs.)

Revision of zeroth, 1st, 2nd and 3rd Laws of thermodynamics. The work function and free energy relationships, the Gibbs Helmhotz equation, conditions of equilibrium, partial molar properties, physical significance of partial molar property, chemical potential, Gibb's Duhem equation, Duhem-Margles equation, variation of chemical potential with temperature and pressure, fugacity, determination by graphical method, use of equation of state, generalized method for determination of fugacity. Variation of fugacity with temperature and pressure, fugacity of solids and liquids, Numericals.

Non-Equilibrium Thermodynamics: (10 Hrs.)

Thermodynamic criteria for non-equilibrium states, entropy production for heat flow, matter flow and electric current flows. Rate of entropy production, phenomenological equations, flows and fluxes, Onsager reciprocity relations, Principles of microscopic reversibility, Principle of minimum entropy production, electrokinetic effects, diffusion, electric conduction. Applications of irreversible thermodynamics to biological systems.

Solutions and Their Properties: (15 Hrs.)

Factors affecting solubility, types of solutions, thermodynamic properties of solutions, the solution process, condition for equilibrium between phases, equilibrium between a solution and its vapor phase, Ideal solution, the vapor pressure of ideal solution, vapor pressure of actual liquid pairs, boiling point diagrams of miscible binary mixtures, distillation of binary miscible solutions, Azeotropes, the fractionating column, ratio of distillate to residue, solubility of partially miscible liquid pairs; Maximum, minimum, maximum & minimum solution temperature type, type without critical solution temperature, vapor pressure and distillation diagrams of partially miscible liquid pairs, vapor pressure and distillation of immiscible liquids, solubility of gases in liquids, the Nernst distribution law, solutions of solids in liquids, chemical equilibria in solutions.

Dilute Solutions:

Henrys Law, Freezing points of dilute solutions, determination of M. wts, the B. Pts of solutions, temperature and solubility in dil. solutions.

Phase Equilibria: (10 Hrs.)

Statement and meaning of the terms, Phase, component, degree of freedom, deduction of Gibbs phase rule.

Phase equilibria of one component systems – H2O, CO2 and S systems.

Phase equilibria of two component systems-determinatioon of solid –liquid equilibria, simple eutectic diagrams of Bi-Cd, Pb-Ag systems, desilverization of Pb.

Solid solutions – compound formation with congruent M. Pt. – CuCl-FeCl3, Fe2Cl6-H2O and Mg-Zn.

Compound formation with incongruent M.Pt. (peritectic reactions) – NaCl – H2O, FeCl3 – H2O, CuSO4- H2O system.

Three Component Systems

Method of graphical representation, partially miscible three-liquid system –one partially miscible pairs, two partially miscible pairs, three partially miscible pairs, Applications of ternary liquid diagrams.

Books Recommended:

1. Principles of Physical Chemistry, C.F. Prutton and S.H. Maron.

2. Physical Chemistry by G.W. Castellan.

3. Thermodynamics for Chemists, S.Glasstone.

4. Physical Chemistry, P.W. Attkins, 6th edn. Oxford.

5. The Thermodynamics of Biological Processes, D.Jou and J.E. Llebot.

6. Physical Chemistry, W.J. Moore.

7. Physical Chemistry: A Molecular Approach, D.A. MCMarrie & J. D. Simon.

CYP-301: Organic Chemistry Lab–III

Credit: 0-0-3

Note: All reactions in the following experiments are to be monitored by Thin Layer Chromatography (TLC) and characteristic data (UV-visible/fluorescence, IR, NMR, MS) is to be explained.

1. Nitration of o-chlorobenzoic acid and o-chloroacetanalide-separation and identification of isomers. (Ref. 1).
2. Dihydroxylation of cyclohexene with: (a) $KMnO_4$ (Ref 2) and (ii) *p*-toluene sulphonic acid/H_2O_2 (Ref 3) and HCO_2H/H_2O_2 (Ref 4, p 549) Compare product distribution by TLC.
3. Solvent-free Cannizzaro reaction of benzaldehyde (Ref 4, p 1029).
4. Preparation of fluorescein from resorcinol and phthalic anhydride (Ref 4, 3rd Edn., p 935).
5. Preparation of 1,3:4,6-di-*O*-benzylidene-D-mannitol. Also record its optical rotation (Ref 6, p449).
6. Preparation of 1,2-dihydro-1,5-dimethyl-2-phenyl-3*H*-pyrazole-3-one) (antipyrine) Discussion about its pharmacology (Ref 4, p1150).
7. Preparation of 3,5-diethoxycarbonyl-2,4-dimethylpyrrole (Ref 4, p1151).
8. Preparation of 3,5-diphenylisoxazoline using 1,3-dipolar cycloaddition reaction (Ref 6, p646).
9. Preparation of indigo and dyeing of cotton to demonstrate dye-fibre interaction (Ref 6, p661).
10. Synthesis of flavone (**2-Phenyl-4*H*-1-benzopyran-4-one, 2-Phenylchromone) (Ref. 6, p 662).**
11. Synthesis of tetraphenylporphyrin and its Cu^{2+} complex (Ref 6, p 683).
12. Synthesis of 2-phenylindole using Fischer Indole synthesis reaction (Ref 4, p 1161).
13. Acetylation of glucose: Preparation of α-D-glucose pentacetate and β-D-glucose pentacetate (Ref 4, p 644, 645).
14. Synthesis of *p*-nitroaniline from acetanilide (Ref 4, p 919).

Books and references:

1. E. M. Treadwell and T.-Y. Lin, *J. Chem. Edu*., **2008**, 85, p1541.
2. B.T. Burlingham; Rettig, J. C. Rettig, *J. Chem. Edu.* **2008**, 85, p959.
3. A. A. Rosatella, C. A. M. Afonso, and L.C. Branco *J. Chem. Edu.* **2011** *88* (7), 1002-1003.
4. Vogel's text book of practical organic chemistry, B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, 5th Ed., 1989, Longman Group.
5. Techniques and experiments for organic chemistry by Addison Ault, 6th edition.
6. Experimental organic chemistry by Laurence M. Harwood, C. J. Moody, Black well Scientific Publications, Oxford, 1989.

CYP302: Physical Chemistry Lab-II

Credit: 0-0-3

pH metry

1. Determination of strength of given strong acid (HCl).
2. To determine strength and dissociation constant of given weak acid (CH_3COOH).

Electrogravimetry

3. To determine %age purity of given salt ($CuSO_4$) solution.

Conductometry

4. Determine the equivalent conductance of a weak electrolyte at infinite solution by Kohlrausch's law and determine the degree of dissociation and dissociation constant of the electrolyte.
5. To determine strength of given strong acid.
6. To determine strength of given weak acid.
7. To determine solubility of a sparingly soluble salt ($PbCl_2$/$BaSO_4$) in water at room temperature.

Potentiometry

8. Titration of strong acid solution (HCl) with NaOH solution using quinhydrone electrode.
9. Titration of a mixture of strong and weak acids (HCl + CH_3COOH) and hence the composition of the mixture.

Refractometry

10. To determine molar refractivity of given liquids and calculate the refraction equivalents of C, H and Cl atoms.

Colorimetry

11. To test the validity of Beer Lambert law.

Nephaloturbiditymetry

12. To estimate the concentration of ions of given salt solution.

Polarimetry

13. To determine specific and molecular rotation of an optically active substance (say cane sugar).

Flame Photometry

14. To determine the concentration of ions (Na^+/K^+) in given solution by drawing calibration curve.

Polarography

15. To verify Ilkovic equation.

Books Recommended:

1. Findlay's Practical Physical Chemistry.
2. Advanced Practical Physical Chemistry by J. B. Jadav.
3. Quantitative Inorganic analysis by Vogel.

B.Sc. (Honours School) Chemistry (Semester-VI)

(Credit Based Evaluation & Grading System)

CYL310: Co-ordination Chemistry

Credit: 3-1-0

1. Basic Coordination Chemistry (8 Hrs.)

Werner's theory, nomenclature of coordination complexes, isomerism in coordination complexes, chelating agents, metal chelates and chelate effect, names and abbreviations of important ligands, polydentate ligands, polypyrazolyborates , macrocyclic ligands, macrocyclic effect, ketoenolates, troplonates, tripod ligands, conformation of chelate rings, streochemistry of coordination numbers 2 –12 factors detrmining kinetic and thermodynamic stability.

2. Nature of Bonding on Coordination Compounds (20 Hrs)

Application of the valence bod theory to coordination complexes, the electroneutrality principal, the qualitative picture of the crystal field effects in tetrahedral, square planar, octahedral, tetragonal, square pyramidal cases, pairing energy, factors affecting the CFSE, the use of crystal field theory in explaining magnetic properties of transition metal complexes, the thermodynamic effects of the crystal field splitting, the structural consequences of CFSE, the nephalauxetic effect of the spectrochemical series, the limitation of the crystal field theory, the ligand field theory,the jahan theorem and its uses in explaining the distortions in the structures of electrically degenerate system, the molecular orbital treatment of the octahedral, tetrahedral and square planar complexes (qualitative picture only), the comparison of the VBT, CFT and MOT picture of bonding in case of transition metal complexes, the angular overlap model

3. General Properties and Magnetism (7 Hrs)

Definition, general characteristics and positions of transition elements in the periodic table, division into d and f block elements and electronic configurations of the atoms and ions, origin of parmagnetism, diamagnetism, magnetic susceptibility and magnetic moment from magnetic susceptibility, Guoy method to determine the magnetic susceptibility, ferromagnetism, antiferromagnetism.

Electronic configuration of first transition series elements, comparative study of the first transition series elements with reference to atomic and ionic radii, ionization potential, redox potential, oxidation state diagram on the basis of redox potentials, Chemistry of scandium to copper with reference to relative stability of their oxidation states, magnetic and spectral properties. **(Text 2).**

4. Structures of Important Complexes (10 Hrs)

Structure of some important complexes of the first transition series (to be discussed in terms of coordination number, shape or oxidation states or nature of bonding), $Ti(NO_3)_4$, $TiCl_4(diars)_2$, $[Ti(Oet)_4]_4$, VF_5, $VO(acac)_2$ and nature of VO^{2+} bond, $[VOCl_3(NMe_3)_2]$, CrO_4^{2-}, $Cr_2O_7^{2-}$ $[CrO(O_2)_2\ Py]$, $[Cr(O_2)_2(bipy)]$, nature of metal, peroxo bond, Cr_2 (η^{2-} acetate)$_4$ and the nature of Cr-Cr bond in this complex, tetrameric $[Co(acac)_2]_4$, tetrahedral complexes being more common in case of cobalt, oxidation of Co(II), complexes by molecualr O_2, $[Ni(acac)_2]_3$, $Ni(DMGH)_2$, $[Ni(Me_6 - acac)_2]$, $[Ni(MeSal)_2]$,$[Ni(CN)_5]^{3-}$, anomalous behaviour of nickel(II) complexes, copper(II) acetate dihydrate, $[Cu(CN)_2]^{2-}$, cubane complexes $[CuXL]_4$ where X=halide and L=phosphine or arsine (this topic is to be covered from text 2 and 3).

Recommended Books:

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley and Sons.
2. J.E. Huheey, Inorganic Chemistry, Harper International.
3. N.N. Greenwood and A. Earnshaw, Chemistry of the Elements, Pergamon Press.
4. J. Jander, Chemical Topics for students (Ionizing solvents), Vol. 3, John Wiley and Sons.

CYL-311: Organic Synthesis – II
(Reactive Intermediates)

Credit 3-1-0

1. Nature of Bonding in Organic Molecules 4 Hrs

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, annulenes, anti-aromaticity, ψ -aromaticity, homo-aromaticity.

2. Reactive Intermediates: Structure and Reactivity 4 Hrs

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

3. Aliphatic Nucleophilic Substitution 14 Hrs

The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms.
The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Nucleophilicity and SN2 reactivity based on curve cross model.

Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations. Relationship between poar and electron transfer reactions.

The S_Ni mechanisum.
Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.
Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transferr catalysis and ultrasound, ambident nucleophile, regioselectivity.

4. Aliphatic Electrophilic Substitution 5 Hrs

Bimolecular mechanisms- S_E2 and S_Ei. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

5. Aromatic Nucleophilic Substitution 6 Hrs

The S_NAr, S_N1, benzyne an $S_{RN}1$ mechanisms, Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

6. Free Radical Reactions (6 Hrs)

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactvity in the attacking radicals. The effect of solvents on reactivity.
Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

7. Addition to Carbon-Carbon Multiple Bonds (6 Hrs)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity,orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxixation.

Books Suggested:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. sundberg, Plenum.
3. Modern Physical organic chemistry Eric V. Anslyn /Deniis A.Doughutes.
   P 637-655 (2004) University, Science Books.
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
6. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice Hall
7. Modern Organic Reactions, H.O. House, Benjamin.
8. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

CYL313: INSTRUMENTAL METHODS OF ANALYSIS

Credit: 3-1-0

1**. Electro Analytical Methods:** Electrolytic and galvanic cell, Cell components, D.C. & A.C. current in a cell, Reversible and irreversible cells. Nature of electrodes potentials. Description of standard hydrogen electrode. Measurement of potentials. Sign conventions. E^o values and their calculations. Effect of concentration on cell potentials. Concept of Liquid Junction potential. Ohmic potential (IR drop). Polarization (overvoltage) phenomenon and its theories. Limitation to the use of standard electrode potentials. **(8 hrs.)**

2. **Potentiometric Methods:** Reference electrodes (Calomel, Ag/AgCl, TI/TICI) Metallic indicator electrodes (first, second and third type). Metallic Redox indicator electrode: Membrance and ion – selective Electrodes: Principle and design: Glass electrode. Gas sensing probes. Enzyme electrode: Ion Sensitive Field Effect Transistors (ISFETS**)** Principal and Potentiometer methods. **(8 hrs.)**

3. **Voltammetry and Polarography:** General introduction, theoretical consideration of classical polarography, polarographic currents, effect of capillary characteristics on diffusion current, residual current, half wave potential. Effect of complex formation on polarographic waves and mixed anodic cathodic waves, oxygen waves, instrumentation, cell, electrodes and their modifications. Application of polarography. Modified voltametric methods, viz.; current sampled polarography, (TAST), pulse polarography square wave, Fast linear sweep, Cyclic voltammetry, Hydrodynamic Voltametric, stripping methods, amperometric titrations and their applications. **(14 hrs.)**

4. **Electrogravimetry and Coulmetry:** Current voltage relationship, electrolysis at constant applied voltage, constant current electrolysis, coulometric methods of Analysis, potentiostatic coulmetry, Amperostatic Coulmetry, application of coulmetric titrations. **(6 hrs.)**

5. **Conductometric Methods:** Electrolytic conductance, relationships used in conductometry, variation of equivalent conductance with concentration, measurement of conductance, conductometric titrations, Applications to various types of titrations for detection of end points. **(5 Hrs.)**

6. **Turbidimetry and Nephelomatry:** Theory of Nephelomatry and Turbidimetry, Brief Instruments, applications. **(3 Hrs.)**

Books:

1. D.A. Skoog and D.M. West: Prinicples of Instrumental Methods of Analysis.
2. D.A.Skoog and D.M. West, F.J.Hollar: Fundamentals of Analysis Chemistry.
3. G.W.Ewing: Instrumental Methods of Analysis.
4. H.H. Willard, L.L. Marritt & J.A. Dean: Instrumental Methods of Analysis.

Recommended for Further Readings:

1. B.H. Vassos and G.W.Ewing: Electro Analytical Chemistry.
2. J.A. Plamberk: Electro Analytical Chemistry.
3. H.A. Flaschka, A.J. Barnard and P.E. Strurrock, Analytical Chemistry.

CYL314: Physical Chemistry-IV

Credit: 3-1-0

1. Macromolecules (20 Hrs)

Condensation polymerization, kinetics and statistics of linear stepwise polymerization, molecular weight control, addition polymerization, kinetics of polymerization, degree of polymerization and chain transfer, determination of rates constant, enthalpy, entropy, free energy and activation energy of polymerization. Ionic and condensation polymerization, kinetics of copolymerization, kinetics and rate of copolymerization, mechanism of copolymerization, various types of copolymerization Polmer solutions: criteria for polymer solubility, conformation of dissolved polymer chains, thermodynamics of polymer solutions. Molecular mass determination by osmometry, viscometry, light scattering and gel permeation chromatography. Polymer structure and properties, glass transition temperature (Tg), melting point transition temperature (Tm), structure property relations (general), Synthesis and properties of commercial polymers.

2. Adsorption and Surface Phenomenon (10 Hrs)

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapor pressure of droplets (Kelvin equation), Physiosorption and chemisorption, adsorption isotherms, derivation of Langmuir, Freundlich, Tempkin and BET adsorption isotherms, estimation of surface area by BET equation, Heterogeneous catalysis, surface catalysed unimolecular and bimolecular reactions, Retarded surface reaction, temporary and permanent catalytic poisons, Activation energy for surface reactions, Thin films.

3. Colloidal State (5 Hrs)

Definition & classification of colloids. Solids in liquids (sols): kinetic, optical and electrical properties, stability of colloids, protective action, Hardy-Schulze law, gold number. Liquids in liquids (emulsions): types of emulsions, preparation, Emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

4. Physical Properties and Molecular Structure (5 Hrs)

Optical activity, polarization - (Clausius - Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment, dipole moment and structure of molecules, magnetic properties; para-, dia- and ferro- magnetism.

5. Photochemistry (5 Hrs)

Difference between thermal and photochemical processes. Laws of photochemistry; Lambert's Law. Beer's Law. Grotthus–Drapper law. Einstein law of photochemical equivalence. Jablonski diagram depicting various processes occurring in the excited state like fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), Quantum Yield. Kinetics of photochemical reactions. Photolysis of ammonia. Hydrogen- Chlorine and Hydrogen- Bromine reactions. Effect of temperature on photochemical reactions. Photochemical equilibrium. Stren-Volmer equation. Chemiluminescence.

Books Suggested:

1. Hill, T. L. (2012) *Introduction to Statistical Thermodynamics*. Dover.
2. Atkins, P.W. & J. de Paula (2014) *Physical Chemistry*. W. H. Freeman.
3. Laidler, K. J. (1995) *Physical Chemistry*. Oxford University Press.
4. Maron, S. H. & Prutton, C. F. (1965) *Principles of Physical Chemistry*. Collier Macmillan.
5. Tager, A. (1978) *Physical Chemistry of Polymers*. MIR Publisher, Moscow.
6. Billmeyer, F.W. (2007) *Text Book of Polymer Science*. Wiley.
7. Meier, G., Sackman, E. & Grabmaier, J. G. (1975) *Applications of Liquid Crystal.* Springer.
8. Rohtagi–Mukherjee, K. K. (1978) *Fundamentals of Photochemistry*. Wiley.

CYP 304: Physical Chemistry Lab-III

Credit: 0-0-3

Conductometry

1. Titration of a mixture of strong acid (HCl) and weak acid (CH_3COOH) against alkali.
2. Compare the relative strength of acetic acid and mono chloroacetic acid.
3. Titration of $AgNO_3$ with KCl solution.
4. Determine equivalent conductance of a strong electrolyte at several concentrations and hence verify Onsager's equation.

Potentiometry

5. To titrate ferrous ammonium sulphate against potassium dichromate and hence the formal redox potential of Fe^{2+}--Fe^{3+} system.
6. Determine the dissociation constant of given poly basic acid (oxalic/phosphoric acid).

PH metry

7. To determine pKa1 and pKa2 values of given dibasic acid (oxalic acid).
8. To prepare universal buffer solution.

Electrogravimetry

9. To find the content of Cu and Zn in the given mixture.

Flame Photometry

10. To determine the concentration of ions in given solutions.

Refractometry

11. To determine the electron polarization and electron polarizability of given liquids.

Colorimetry

12. To verify Beer Lambert law and determine stability constant of a complex by mole ratio method.
13. To investigate the complex formation between Fe(III) and thio-cyanate ion.

Chemical Kinetics

14. To investigate inversion of cane sugar in the presence of HCl.
15. To study the kinetics of hydrolysis of ethyl acetate by NaOH and determination of energy of activation.

Transport Number

16. Determination of transport numbers of ions of given electrolyte.

Amperometry

17. To determine the Pb^{2+} ion by its titration with $K_2Cr_2O_7$.

Books Recommended:

1. Findlay's Practical Physical Chemistry.
2. Advanced Practical Physical Chemistry by J. B. Jadav.
3. Quantitative Inorganic analysis by Vogel.

CYP305: Inorganic Chemistry Lab – II
Quantitative Analysis

Credit 0-0-3

A. Gravimetric Analysis

1. Determine nickel (II) in a given sample gravimetrically using dimethylglyoxime.
2. Estimate the iron as its ferric oxide from a given solution of ferrous ammonium sulfate gravimetrically.
3. Estimate chromium (III) as its lead chromate.
4. Estimate lead as its lead molybdate gravimetrically.
5. Estimate cobalt as mercury tetraisothiocyanatocobalt (II) [HgCo (NCS)4]n.
6. Determine silver (I) as its chloride gravimetrically.
7. Determine barium (II) as its chromate gravimetrically.
8. Determine cadmium (II) as [Cd(C5H5N)2(SCN)2] gravimetrically.

B. Volumetric Analysis

(1) **Acidimetry and Alkalimetry**

Determination of a mixture of carbonate and hydroxide.

(2) **Oxidation – Reduction Titrations:**

(a) **KMnO4 Titratons.**

(i) Standardisation with sodium oxalate.

(ii) Determination of Fe(II)

(iii) Determination of H2O2

(b) **Ceric Sulphate Titrations:**

(i) Standardisation with Mohr's salt.

(ii) Determination of Cu(II)

(iii) Determination of oxalates.

(c) **K2Cr2O7 Titrations:**

(i) Standardisation with Fe(II)

(ii) Determination of ferric iron (Ferric ammonium sulphate).

(d) **Iodometry and Iodimetry Titrations:**

(i) Standardisation of sodium thiosphate with $K_2Cr_2O_7$ / KIO_3

(ii) Determination of Cu(II)

(iii) Determination of H_2O_2

(iv) Determination of available chlorine in bleaching powder.

(e) **KIO_3 Titrations:**

(i) Determination of copper.

(ii) Determination of hydrazine.

(3) **Precipitation Titrations**

(i) $AgNO_3$ – standardisation by Mohr's method / by using absorption indicator.

(ii) Determination of chloride.

(iii)Volhard's method for chloride determination.

(4) **Complexometric Titrations (EDTA)**

(i) Standardisation of EDTA with $Pb(NO_3)_2$ / $ZnSO_4$. $7H_2O$

(ii) Determination of Mg^{2+}

(iii) Determination of Ca^{2+} (by substitution method).

(iv) Determination of total hardness of water (permanent and temporary

(v) Determination of Cu^{2+} and Ni^{2+} by using masking reagent.

Book: Vogel's book on Inorganic Quantitative Analysis