FACULTY OF SCIENCES

SYLLABUS

FOR

M.Sc. Chemistry
(Credit Based Evaluation & Grading System)
(SEMESTER: I - IV)

Examinations: 2019-20

GURU NANAK DEV UNIVERSITY
AMRITSAR

M.Sc. Chemistry (Semester System)
(Credit Based Evaluation & Grading System)

SCHEME

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

SEMESTER-I

Sr. No.	Course No.	Paper Title	Course hrs	Credit Hrs.
1	CYL451	Molecular Spectroscopy-I	60	4-0-0
2	CYL452	Organic Synthesis-I (Reaction Mechanism – substitution reactions)	45	3-0-0
3	CYL453	Inorganic Chemistry –I (Transition Metal Chemistry)	45	3-0-0
4	CYL454	Physical Chemistry-I	45	3-0-0
5	CYL455	Supramolecular Chemistry	45	3-0-0
6	CYL299	Computer for Chemists	30	2-0-0
Lab Courses				
7	CYP451	Inorganic Chemistry Lab	90	0-0-3
8	CYP452	Physical Chemistry Lab	90	0-0-3
9	CYP299	Computer Lab	60	0-0-2
		Theory 18 credits; Practical 8 credits		

SEMESTER-II

Sr. No.	Course No.	Paper Title	Course hrs	Credit Hrs.
1	CYL461	Molecular Spectroscopy-II	60	4-0-0
2	CYL462	Organic Synthesis-II (Reaction Mechanism – Addition, elimination and rearrangement reactions)	45	3-0-0
3	CYL463	Inorganic Chemistry-II (Reaction Mechanism and organometalics)	45	3-0-0
4	CYL464	Physical Chemistry-II	45	3-0-0
5	CYL465	Bio-organic & Medicinal Chemistry	45	3-0-0
Lab Courses				
6	CYP461	Organic Chemistry	90	0-0-3
7	CYP462	Electroanalytical Chem. Lab	90	0-0-3
		Theory 17 credits; Practical 6 credits		

Note : PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory 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.

SEMESTER-III:

S.No.	Course No.	Course Title	Credit
1	CYL551	Physical Chemistry-III (Quantum Chemistry)	3-0-0
2	CYL552	Organic Chemistry-III (Photochemistry and Pericyclic Reactions)	3-0-0
3	CYL553	Inorganic Chemistry-III	3-0-0
4	CYP551	Dissertation	0-0-18
5		Interdisciplinary Course-I	4-0-0
Dissertation to be submitted before Dec 31 of the year. Viva exams will be held in January of next year			

SEMESTER-IV:

S.No.	Course No.	Course Title	Credits
1	CYL561	Physical Chemistry-IV	3-0-0
2	CYL562	Organic Chemistry-IV (Biosynthesis of Natural Products)	3-0-0
3	CYL563	Inorganic Chemistry-IV (Inorganic materials and nuclear chemistry)	3-0-0
4	CYP561	Organic Chemistry Lab – II Multi-step Synthesis in Organic Compounds	0-0-3
5	CYP562	Inorganic Chemistry Lab - II	0-0-3
6		Interdisciplinary Course-II	4-0-0
		OPTIONAL COURSES ***Choose any two courses***	
7	CYL564	Physical Chemistry-V (Chemistry of Materials)	4-0-0
8	CYL565	Physical Chemistry – VI (Bio-Physical Chemistry)	4-0-0
9	CYL566	Organic Chemistry-V Advanced Organic Synthesis	4-0-0
10	CYL568	Inorganic Chemistry-V (Inorganic Spectroscopy)	3-0-0
11	CYL570	Inorganic Chemistry-VII (Bioinorganic Chemistry)	4-0-0
12	CYL571	Inorganic Polymers	4-0-0
13	CYL572	Organic Chemistry-VI (Principles and Applications of Non-enzymatic Asymmetric Synthesis and Organocatalysis)	4-0-0

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

CYL-451: Molecular Spectroscopy – I

Credit: 4-0-0 (60 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. 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 (10 Hrs.)
The nuclear spin, precessional motion.Larmor frequency, Energy transitions, the natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei, population ofnuclear 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 forcesaffecting the chemical shifts.

SECTION-B

NMR Spectroscopy continued (15hrs)
Spin – spin interactions, low and high resolution NMR with various examples. Correlation for H-bonded to Carbon.H-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 geminalprotons, long range coupling. First and second order spectra A_2, AB, AX, AB_2, AX_2, A_2B_2, A_2X_2, ABX and ABC spin 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, Nuclearoverhauser Effect (NOE). ^{13}C -^{1}H coupling, ^{13}C spectra, Differences from ^{1}H NMR, DEPT, Intensities of lines in ^{13}C. (Books 5 and 6)

SECTION-C

3. Mass Spectrometry of Organic Molecules: (10Hrs)
Introduction, methods of ionization EI & CI, 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 foraliphatic compounds, amines, aldehydes, ketons, esters, amides, nitriles, carboxylic acids ethers,aromatic compounds, general rules predicting the fragmentation patterns.(Books 2, 3, 5)

4. IR spectroscopy of Organic Molecules (5 hrs)
Introduction, Dispersion IR spectrometer and FT IR spectrometer, sample handling, characteristic group absorption of organic molecules, normal, branched and cyclic alkanes, alkenes, alkynes, mononuclear and polynuclear aromatic compounds.

SECTION-D

IR Spectroscopy Continued (5hrs.)
Characteristic group absorption of organic molecules alcohols, phenols, ethers epoxides, ketones, aldehydes, carboxylic acids, carboxylate ions, esters and lactones, acid halides, amides and lactams, amines, nitriles, isonitriles. (Books 5 and 6)

5. Structure elucidation of organic molecules(10 hrs.)
The combined application of UV, IR, NMR and mass spectra in solving
first 20 problems from reference book 6 and first 20 problems from reference book 7.

Books:
1. C.N. Banwell “Fundamentals of Molecular Spectroscopy”.
2. W. Kemp, “Organic Spectroscopy”.
3. D.H. Williams, I. Fleming, “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

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

Organic Synthesis –1
(Reaction Mechanism-Substitution Reactions)
CYL452

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

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

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Section-A

1. Reaction Mechanism: Structure and Reactivity **12 Hrs**

Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

Effect of structure on reactivity- resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Section-B

2. Aliphatic Nucleophilic Substitutions **10 Hrs**

The S_N2, S_N1, missed S_N1 and S_N2 and SET mechanisms.

The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations. 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. Gabriel synthesis

Section-C

3. Aliphatic Electrophilic Substitutions **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, Hell-Volard-Zelinsky reaction

4. Aromatic electrophilic substitution **7 Hrs**

The arenium ion mechanism, orientation and reactivity in mono substitution and di-substituted aromatics, energy profile diagram, the ortho/para ratio, ipso attack, orientation in other ring systems, quantitative treatment of reactivity in substrates and electrophiles. Diazo coupling, Vilsmeir reaction, Gatterman-Koch reaction, Bechmann reaction, Hoben-Hoesch reaction.

Section-D

5. Aromatic Nucleophilic Substitution **5 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.

Books:

1. Organic Reaction Mechanism by Jerry March, John Wiley Ed. 5, 2002.
2. Advanced Organic Chemistry by Francis Carey, Vol. A and Vol. B

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

Inorganic chemistry-I
(Transition Metal Chemistry)
CYL453

Credit : 3-0-0

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

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

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SECTION-A **(10 Hrs.)**

Symmetry and Group Theory
Symmetry elements, symmetry Operations symmetry elements commonly occurring molecules like NH_3, CH_4, SF_6, PF_5, SF_4, $Ni(CO)_4$, $Fe(CO)_5$, determination of point groups, use of character table for determining the reducible and irreducible representation, determination of symmetry of atomic orbitals under different point groups, determination of atomic orbital involved in sp, sp^2, sp^3, dsp^2, d^2sp^3 hybridization on basis of group theory and quantitative discussion on concept of hybridization (Text 1 & 2).

SECTION-B **(10 Hrs.)**

Complexes of ®-Acid Ligands(
π acceptor character of CO, N_2, O_2, NO molecules in terms of MOEL diagrams, π acid ligands of other groups of periodic table. Semi-bridging in metal carbonyls and isocyanides of metals. Magnetic, IR and X-ray diffraction evidence of their structure, π acidity and softness, Symbiosis and antisymbiosis, π complexes of unsaturated organic molecules (bonding with C_2H_4 only). (Text 4, suppl. 5, Chap. & Suppl.).
Structures & the IR spectral properties representative transition metal carbonyl complexes.

SECTION-C **(13 Hrs.)**

Chemistry of Transition Metals
LS coupling, derivation of spectroscopic terms for d^1 to d^9 electronic configurations, correlation diagram for d^2 ion in octahedral field, splitting of d^1 to d^9 terms in an octahedral and tetrahedral field.
Selection rules of d-d transitions. Vibronic and spin orbit coupling, effecting of weak to strong cubic fields on R-S terms, Comparison of CFSE values of d^1 to d^9 ions in terms of orbit splitting and R-S term splitting. Effect of CFSE on thermodynamic properties, lattice energy, heat of hydration heat of ligation and spinal structure. Orgel and Tenabe Sugano diagrams, spectra of octahedral, tetrahedral, distorted octahedral (Jahn Teller Effect) and square planner complexes spectrochemical series, nephelauxetic effect, Calculation of β and 10 Dq from spectral data.

SECTION-D **(12 Hrs.)**

Molecular orbital theory-composition of ligand groups, orbitals, sigma and pi-molecular orbitals MOEL, diagrams of Oh, Td and D_{4h} complexes with and without pi-bonds, charge transfer spectra.

Magnetic properties of transition metal ions and free ions presentive, Dianagents and Perromgnetier & ferrongrets. Effects of L-S coupling on magnetic properties. Temperature independent paramagnetism (TIP) in terms of crystal field theory CFT and molecular orbital theory (MOT). Quenching of orbital anglor momentum by crystal fields in complexes in terms of term-splitting. Effect of spi-orbit coupling and A, E & T states, Mixing in effect, first order and second order zeeman effects. spin-paired and spin-free equilibria in complexes magnetic properties of polynuclear complexes, involving OH, NH_2 and CN bridges. (Texts 3, 7 suppl. 8 : 1).

Books Recommended:

1. R.S. Drago, Physical Methods in Inorg. Chem. Ist and 2nd Edition, London, 1977.
2. F.A. Cotton, Chemical Application of group theory, 2nd Edition.
3. B.N. Figgis, Introduction to Ligand Fields, First Editor.
4. F.A.Cotton & G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
5. F.Basolo and R.C. Johnson, Coordination Chemistry, 1st Edition.
6. J.E. Hukeey, Inorganic Chemistry, 3rd Edition.
7. A.B.P. Lever, Inorganic Electronic-Spectroscopy, 2nd Edition.
8. A. Earnshaw, Introduction to Magnetic Chemistry, 1st Edition.

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

Physical Chemistry – I
CYL454

Credit: 3 -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

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Section-A (11 Hrs)

1. Thermodynamics:
Laws of Thermodynamics, free energy, chemical potential and entropy, Determination of partial molar free energy, volume and heat content, and their significances. Concept of fugacity and determination of fugacity in liquids and gases.
Non-ideal systems: Excess functions for non-ideal solutions, Activity, activity Coefficient. Debye Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficient, ionic strength. The Debye Huckel Theory and its applications. Numerical Problems.

Section-B (11 Hrs)

2. **Non Equilibrium Thermodynamics** :
Thermodynamic criteria for non equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (for example heat flow, chemical reaction, etc.), generalized forces and fluxes, non equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction, irreversible thermodynamics for biological systems, coupled reactions.

Section-C (11 Hrs)

3. Statistical Thermodynamics
Thermodynamics probability and most probable distribution of a system, Maxwell-Boltzmann distribution law. Ensembles: canonical, grand canonical and micro canonical. Partition functions; translational, rotational, vibrational and electronic. Calculation of thermodynamic properties in terms of partition functions. Application of partition function to calculate heat capacities and equilibrium constants, relation between entropy and thermodynamic probability, Fermi-Dirac and Bose-Einstein statistics. Numerical problems.

Section-D (12 Hrs)

4. Chemical Dynamics:
Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation, concept of energy of activation, potential energy surfaces; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions. Lindemann-Christiansen hypothesis, Hinshelwood treatment and Rice Ramsperger-Kassel-Marcus (RRKM) theories of unimolecular reactions. General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and nuclear magnetic resonance method.
Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen bromine and hydrogen-chlorine reactions).

Books Recommended:

1. Physical Chemistry by P.Atkins & J.Paula, 7th Ed, Oxford Univ. Press London 2002.

2. Thermodynamics for Chemists by S. Glasstone. East West Press, New Delhi 2003.

3. Chemical kinetics by K.J. Laidler. Pearson Education India, 3rd Ed, 2003.

4. Principles of Physical Chemistry, S.H. Maron & C.F. Prutton Collier Mcmillan Ltd. 4th Ed. 1965.

5. Introduction to the Thermodynamics of Biological Processes by D. Jou & J. E. LLebot.

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

Supramolecular Chemistry
CYL455

Credit 3-0-0
45Hrs.
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. **Concepts (5 Hrs)**
   Definition and Development of Supramolecular Chemistry, classification of Supramolecular Host-Guest compounds, Pre- organization and Complementarily, Receptors, Nature of Supramolecular interactions.
2. **Cation Binding Host – A (6 Hrs)**
   Crown ethers, Lariat ether and Podands, Cryptands, spherands, calixarenes, selectivity

SECTION-B

3. **Cation Binding Host – B (4 Hrs)**
   Macro cyclic, Macrobicyclic and Template effects, soft ligands, carbon donor and π- acid ligands, siderophores.
4. **Binding of anions (8 Hrs)**
   Biological anion receptors, concepts on anion host design, From cation to anion hosts- a simple change in pH, Guanidinium- based receptors, Neutral receptors, organometallic receptors, coordination interactions.

SECTION-C

5. **Binding of Neutral Molecules (10 Hrs)**
   Inorganic solid state clathrate compounds, solid state clathrates of organic hosts, intracavity complexes of neutral molecules, supramolecular chemistry of fullerenes.

SECTION-D

6. **Crystal Engineering (5 Hrs)**
   Concepts, crystal structure prediction, Crystal Engineering with hydrogen bonds, weak hydrogen bonds, hydrogen bonds to metals and metal hydrides, π- π stacking, coordination polymers.
7. **Molecular Devices (7 Hrs)**
   Introduction, Supramolecular photochemistry, molecular electronic devices: Switches, wires and rectifiers, machines based on catenanes and rotaxanes.

Book :

1. J.W Steed and J.L Atwood, Supramolecular chemistry, John Wiley & Sons, Ltd. New York.

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

Computer for Chemists
CYL299

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

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1. Computer Programming in C Language **30 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

Loops: 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.

Recommended Books:

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

M.Sc. Chemistry (Semester-I)
(Credit Based Evaluation & Grading System)

Inorganic Chemistry Lab
Paper : CYP-451

Credit:0-0-3

Note: For each of the preparations, apart from the studies written against each preparation, the student must record information about yield, color, melting point, solubility and drying of the sample, preferably in vacuum.

1 Preparation of tris(acetylacetonato)cobalt(III), $Co(acac)_3$, record and interpret its proton and ^{13}C NMR, IR and UV-vis studies.
[Ref. J. Chem. Edu. **1980**, 57(7) 525].

2 Preparation of tris(nitro-acetylacetonato)cobalt(III), $Co(acac\text{-}NO_2)_3$, record and interpret its proton NMR spectrum.
[Ref. J. Chem. Edu. **1980**, 57(7) 525].

3 Preparation of tris(thiourea)mercury(II), record and interpret its IR and how it helps to establish metal-ligand bonding. .
[Ref. Inorg. Synth. Vol. VI, p.26].

4 Preparation of $[Fe(NO)(S_2CNEt_2)_2]$, record and interpret its IR spectrum.
[Ref. Marr and Rockett, 1972, p. 262].

5 Preparation of copper(I) iodide and then prepare the mixed-valent complex, $[Cu(en)_2][CuI_2]_2$. Record and interpret its UV-vis, magnetic susceptibilty. [H. Brauer, Handbook of Preparative Chemistry, Vol 2, p 1007; Inorg. Synth. Vol. V 5, p. 16]

6 Preparation of [chloro(pyridine)cobaloxime(III)], record and interpret its IR, and UV-vis. spectral data [Inorg. Synth. Vol. XI, p. 61].

7 Preparation of $[Zn(acac)_2].H_2O$, record and interpret its IR spectrum TGA/DTA/DSC..
[Ref. Inorg. Synth. Vol. X, p.74].

8 Preparation of polymeric $\{HgCo(NCS)\}_{n,}$], record and interpret its IR, and magnetic susceptibilty.
[Ref. Marr and Rockett, 1972, p. 365].

9 Preparation of tris(acetylacetonato)manganese(III), $Mn(acac)_3$, record and interpret its IR, UV-vis and magnetic susceptibilty. .
[Ref. Inorg. Synth. Vol. VII, p.183].

10 Preparation of tris(ethylenediamine)nickel(II) dichloride, $[Ni(en)_3]Cl_2$, record and interpret its IR, UV-vis, magnetic susceptibilty. Calculation of Dq and B and β values and comparison with hexaaquonickel(II) chloride.
[Ref. Marr and Rockett, 1972, p. 270].

11 Preparation of $[VO(acac)_2]$, record and interpret its IR, UV-vis and magnetic susceptibilty.
[Ref. Marr and Rockett, 1972, p. 243].

12 Preparation of bis(tetraethylammonium)tetrachlorocuprate(II), $[Et_4N]_2[CuCl_4]$, record and interpret its UV-vis and magnetic susceptibility. .
[Ref. Inorg. Synth. Vol. IX, p.141].

13 Preparation of lead tetraacetate. [Ref. Inorg. Synth. Vol. I, p.47].

14 Prepare a sample of tin(IV) tetraiodide and purify it using rotary evaporator or Soxhlet extractor [Ref. H Brauer, Handbook of Preparative Chemistry, Vol 1, p. 735]

Physical Chemistry Lab – I
CYP452

Credits : 0-0-3

1. To determine the freezing point depression constant of camphor using naphthalene as solute. Hence determine the molecular weight of acetanilide by Rast's micro method. (J.B. Yadav, page – 36).
2. Determination of molecular weight of a non-volatile substance by measuring elevation of boiling point (Findlay, page – 126).
3. Determination of heat of solution of a substance by solubility method (J.B. Yadav, page – 94).
4. To construct phase diagram of 3-component system (CH_3COOH + $CHCl_3$ + H_2O) (J.B.Yadav, page – 131).
5. To prepare and study Hardy – Schulze's rule for arsenious sulphide / Ferric hydroxide sols, (Findlay, page – 402).
6. To determine the relative strength of acids by study kinetics of hydrolysis of an ester (J.B.Yadav, page – 260).
7. To determine the iodine value of given sample of oil (Linseed oil), (Cock & van Rede, page-109).
8. To determine the saponification value of given sample of oil (Ground nut oil), (Cock & van Rede page-117).
9. Determination of interplanar distance of given sample (Sodium Chloride, Urea) by X-ray powdered spectrometer.
10. To obtain the mutual solubility curve of phenol + H_2O, and hence the Upper Consolute point, (J.B. Yadav, page – 109).
11. To determine the coefficient of viscosity of given liquid by Ostwald's viscometer (J.B. Yadav, page – 57).
12. To find the molecular weight of polymer by viscosity measurements, (Findlay, page – 96).
13. Determination of surface tension of given liquid by drop no. method by stalgmometer, (J.B. Yadav, page – 75).
14. To determine the C.M.C. of a soap (sodium or potassium lauryl sulphate by surface tension measurements, (J.B.Yadav, page – 82).
15. To determine the distribution coefficient of I_2 between CCl_4 and H_2O, (J.B. Yadav, page – 119).
16. To find the molecular Weight of given liquid by steam distillation method, (J.B. Yadav, page – 107).
17. Determination of transition temperature of given substance by thermometric/ dilatometric method. (J.B.Yadav, page – 82).
18. i) Find water equivalent of Dewar's flask and ii) heat of neutralization of strong acid vs strong base, weak base vs. strong acid using Dewar's flask (Findlay, page 217).

19. Determination of specific and molar refraction of a liquid by Abbe refractometer. (J.B. Yadav, page – 174).
20. Determine the refraction equivalents of C, H, and Cl atoms. (J.B. Yadav, page – 165).
21. Study and verify the freundlich adsorption isotherm for adsorption of CH_3COOH from its aqueous solution by activated charcoal. (Findlay, page 373).

Books Recommended:

1. Findlay's Practical Physical Chemistry.
2. Advanced Practical Physical Chemistry by J.B. Yadav.
3. Laboratory Handbook for Oil & Fat Analysis by L.V. Cock and C. van Rede.

Computer Lab
CYP299

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.

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Molecular Spectroscopy – II

CYL461

Credit 4-0-0
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.

SECTION-A

(15 Hrs.)

1. **Pure Rotational Spectra:**
   Classification of molecules according to their moment of inertia. Rotational spectra of diatomic molecules (rigid rotator), Intensities of spectral lines, isotopic substitution effects, non-rigid rotator, polyatomic linear and symmetric top molecules, Stark effect.
2. **Vibrational Spectroscopy**

   Theory of Infrared Absorption: Harmonic and anharmonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant, frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule, 3N-6 and 3N-5 rules, types of vibrations, overtones, combination and difference bands, examples of CO_2, SO_2 and H_2O, Fermi resonance, group vibrations.

SECTION-B

(15 Hrs.)

3. **Raman Spectroscopy:** Introduction, selection rules, anisotropic polarizabilty, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, polarised and depolarised Raman Lines, rule of mutual exclusion.
   Determination of IR/Raman Active Modes; Significance of nomenclature: used to describe various vibrations, use of symmetry considerations to determining the number of active infrared and Raman Lines (C_{2v} molecules) .

   Applications: Physical state of a sample, cells used, 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- unsaturated, mono- and disubstituted aromatic compounds, metal-ligand vibrations, group frequencies of complex ligands-CN stretching and effect of coordination on it, nitro and nitrite and C=O ligands and effect of their coordination with metal ions.

Nuclear Quadruple Resonance Spectroscopy:

Introduction, experimental considerations, fundamentals of NOR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group elements, transition metals.

SECTION-C

(15 Hrs.

4. **Mössbauer Spectroscopy:**
Experimental considerations, the spectrum and its parameters, simple spin states (I 1/2, 3/2), higher spin states (I > 3/2), magnetic splitting significance of parameters obtained from spectra, quadruple splitting, additive model, interpretation of Mössbauer spectra of ^{57}Fe, ^{119}Sn.
5. **Electron Paramagnetic Resonance Spectroscopy:**
Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, esr spectrum of benzene radical anion, methyl radical. CH_2OH cyclopentedienyl cycloheptatrienyl radical, pyrazine anion, pyrazine anion with ^{23} Na and ^{39}K counter ion and Nitrosyl nitroxide, Factors affecting magnitude of g values, zero field splitting and Krammer's degeneracy. Qualitative survey of EPR spectra of first row transition metal ion complexes (d^1, d^2, d^3, low spin d^5, high spin d^6, d^7, d^9 system). Spectra of triplet states.

SECTION-D

(15 Hrs.)

6. **X-ray Diffraction Methods of Analyis**
Production of X-rays, solid state symmetry, reciprocal lattice, Bragg's law in reciprocal space, the powder method, interpretation of powder pattern of a cubic system, particle size determination by powder method, qualitative and quantitative analysis using powder method. X-ray fluorescence spectroscopy, X-rays emission method, applications (qualitative and quantitative).

7. **Photoelectron Spectroscopy:**
Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron spectroscopy, molecular orbital diagrams of nitrogen and oxygen and their XPS spectra-ESCA, ultraviolet photoelectron spectroscopy (UPS), PES spectrum of nitrogen sample, vibrational structure in the N_2 UPS spectrum, chemical shifts in XPS, exchange splitting and shake up process

Books Recommended:

1. R. S. Drago, "Physical Methods in Chemistry". W.B. Saunders Company.
2. C. N. Banwell "Fundamentals of Molecular Spectroscopy".
3. R. V. Parish, NMR, NQR, EPR & Mossbauer spectroscopy in Inorganic Chemistry. Ellis Horwood, London, 1990.
4. G. M. Barrow "Introduction to Molecular Spectroscopy".
5. E. A. Ebsworth, S.Craddock and D.W. H. Rankin, Structural methods in Inorganic Chemistry, Blackwell Scientific Publications (1991).
6. C.N.R. Rao and J.R. Ferraro, Spectroscopy in Organic Chemistry, Vol. I, Academic Press, 1971.

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Organic Synthesis –1I
(Reaction Mechanism- Addition, Elimination and Rearrangement Reactions)
CYL462

Credit: 3-0-0
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.

Section-A

1. Addition to Carbon-carbon and Carbon-Hetero Multiple Bonds-I: 8 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 epoxidation.

2. Oxidation Reactions-I: 4 Hrs
Indtoduction. Different oxidative processes. Hydrocarbons- alkenes, aromatic rings, saturated C-H groups)activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxyalic acids. Amines, hydrazines, and sulphides.

Section-B

3. Addition to Carbon-carbon and Carbon-Hetero Multiple Bonds-II: 7 Hrs
Addition of Grignard reagents, organozinc, organolithium and Gillman reagents to carbonyl and unsaturated carbonyl compounds. Use of other organometallic reagents in addition reactions. Wittig reaction, Mechanism of condensation reactions involving enolates – Aldol,.Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

4. Oxidation Reactions-II 3 Hrs
Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate, DDQ, PCC, CAN, selenium dioxide, peroxyacids, DCC. Oxidation reactions with special emphasis on Baeyer-villeger reaction, Cannizarro oxidation-reduction reaction,

Section-C

5. Reduction Reactions: 10 Hrs

Introduction. Different reductive processes, Hydrocarbons- alkanes, alkenes, alkynes and aromatic rings, Carbonyl compounds – aldehydes, ketones, acids, ester and nitriles. Epoxides, Nitro, nitroso, azo and oxime groups, Hydrogenolysis. Sodium borohydride, sodium cyano borohydride, LAH, disobutyl aluminium hydride, tin hydride, trialkyl tin hydride, trialkyl silanes, alkoxy substituted LAH, DIBAL, diborane, diisoamyl borane, hexyl borane, 9-BBN, isopinocamphenyl and disiopinocamphenyl borane. Reduction reactions with particular emphasis on Wolf-Kishner reduction, Clemensen reduction.

Section-D

6. Elimination Reactions: 5 Hrs

The E2, E1 and E1cB mechanisms and their spectrum. Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

7. Rearrangements: 8 Hrs

General mechanistic consideration – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements, Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Shapiro reaction, Fries rearrangement

Books:

1. Organic Reaction Mechanism by Jerry March, John Wiley Ed. 5, 2002.
2. Advanced Organic Chemistry by Francis Carey, Vol A and Vol B

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Inorganic Chemistry-II
(Reaction Mechanism and Organometalics)

CYL463

Credit: 3-0-0

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.

SECTION-A **(12 Hrs.)**

Reaction Mechanisms of Transition Metal Complexes
Introduction, ligand replacement reactions, classification of mechanisms, Water exchange rates, formation of complexes from aqueous ions, anation, reaction, aquation and base hydrolysis attack on ligands, reactions, of square planar complexes, mechanism of ligand-displacement reactions; metal carbonyl reactions, reactions of binuclear carbonyls, associative reactions, species with 17 electron, electron transfer processes outer and inner sphere. The Marcus theory, doubly bridged inner-sphere transfer, other electron transfer reactions; two electron transfers, Non-complementary reaction, Ligand exchange via electron exchange, reductions by hydrated electrons.

SECTION-B **(10 Hrs.)**

Streochemical non-rigidity

Streochemical non-rigidity, stereochemically non-rigid coordination compounds, with coordinaiton number four and five, Trigonal bipyramidal molecules, metal carbonyl scrambling cluster, rotation within CO shells. (Texts 1 & 4).

Reaction at Coordinated Ligands:
Hydrolysis of amino acid esters and peptides and amides, Aldol condensation; Imine formaiton, hydrolysis and substituent exchange. Template effect and macrocyclic ligands (Text 5).

SECTION-C **(13Hrs.)**

Organometallics :

I. The basis of 18^{e-} Rule, Exceptions to eighteen electron rule.
II. Preparation of olefin Transition Metal Complexes.
III. Molecular orbital, Description of bonding of two electron ligands to Transition Metals.
IV. Preparation of π- enyl complexes, Molecular orbital description of ligands to transition metals.
V. Dynamic equilibria in allyl complexes.
VI. Differences between unconjugated & conjugated olefin ligands.
VII. The bonding of cyclobutadiene to Transition metals.
VIII. Preparation of cyclobutadine complexes.

SECTION-D **(12 Hrs.)**

Organometallics :

I. Classicfication, Nomenclature of cyclopentdienyl complexes.

II. Preparation of cyclopentadieny T. M. Complexes.

III. Molecular orbital picture of bonding in ferrocene.

IV. Organic Chemistry of cyelopentadienyl Transition Metal Complexes.

V. Preparation of bis π arene complexes, Bonding of Bis-arene complexes.

VI. Organometallic Reagents in Organic synthesis.

VII. Catalysis involving metal complexes intermediates.

Books Recommended:

1. F.A. Cotton & G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
2. William W. Porterfield, Inorganic Chemistry, Ist Edition.
3. K.F. Purcell and J.C. Kotz, An Introduction to Inorganic Chemistry.
4. M. Tstutsui, M.N. Levy, A Nakamura & Mori, Introduction to Metal Complex Chemistry, Plenum Press, New York, 1970.
5. C. Elschenbroich and A. Salzer, Organometalics: A concise Introduction, 2nd Ed., VCH 1992.
6. J.J. Eisch, The Chemistry of Organometallic Compounds, London, 1967.
7. G.E. Coates, M.L. H. Green and K.W. Wade, Organo Metal Compound, Vol. I, Chapman and Hall.
8. J.E. Huheey, Inorganic Chemistry, 3rd Edition.

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Physical Chemistry – II
CYL464

Credit : 3-0-0
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:
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SECTION-A

Solution & Phase Equilibrium (12 Hrs)
Solubility and factors affecting solubility, types of solutions, ideal solution, vapour pressure of ideal solutions, boiling point diagrams of binary miscible mixtures and their Distillation diagrams, azeotropes, critical solution temperatures, solubility of gases in liquids, Henry's law, Nernst distribution law, number of extractions, solutions of solids in liquids & chemical equilibrium. Derivation of Gibb's phase rule, phase equilibria of two component systems showing eutectic congruent and incongruent melting points. Triangular method for graphical representation of three component systems; partially miscible three liquid systems. Applications of ternary liquid diagrams; systems composed of two solids and a liquid.

SECTION-B

Macromolecules (11 hrs)
Types of polymers, regular and irregular polymers, electrically conducting polymers, synthesis of polymers by chain and step reaction polymerization, physical properties of solid polymers (crystallinity, plasticity & elasticity) vulcanization of rubbers, molecular mass determination by osmometry, viscometry, light scattering and ultracertrifuge methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers.

SECTION-C

Adsorption and Surface Phenomena (11 Hrs)
Surface phenomena, capillary action, pressure difference across surface (Laplace equation) vapour pressure of droplets (Kelvin equation) physical and chemical adsorption, adsorption isotherms, Derivation of Langmur, Freundlich, Tempkin and BET absorption isotherms, Estimation of surface area by BET equation. Heterogenous catalysis, surface catalyzed unmolecular and bimolecular reactions, Retarded surface reactions, temporary and permanent catalytic poisons, activation energy for surface reactions.

SECTION-D

Physical Properties & Molecular Structure (11 Hrs)

Molar refraction, polarizability of molecules, dipole moment and its determination, dipole moment and structure of molecules.

Colloidal State

Classification of colloids, charge and stability of colloidal dispersions, Hardy-Schulze Law, gold number, electrical properties of colloids, electrical double layer and its structure, Stern's theory of double layer, zeta-potential, electrophoresis and electro-osmosis, emulsions and their classification, emulsifiers, gels and their classification, thixotropy. Association colloids; miceller formation, cmc, soap action. Application of colloids.

Books Suggested:

1. Principles of physical chemistry, S.H. Maron & C.F. Prutton.

2. Physical Chemistry, K.J. Laidler.

3. Physical Chemistry, P.W. Atkins.

4. Physical Chemistry of Polymers, A. Tager.

5. Text book of Polymers science, F.W. Billmeyer.

6. Hetergenous Catalysis, S.J. Thomson & G Webb.

7. Kinetics and Mechanism, A.A. Frost & R.G. Pearson.

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Bio-Organic and Medicinal Chemistry
Paper : CYL465

Credit: 3-0-0

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

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

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Section-A

1. Enzymes **6 Hrs**

Basic considerations. Proximity effects and molecular adaptation.
Introduction and historical prospective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis.

2. Co-Enzyme Chemistry **6Hrs**

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, LIPOIC ACID, vitamin B_{12}. Mechanisms of reactions catalysed by the above cofactors.

Section-B

3. Drug Design-I **12Hrs**

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAP), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR.

Section-C

4. Mechanism of Enzyme Action 6Hrs

Enzyme kinetics, Michaelis-menten and lineweaver-Burk plots, reversible and irreversible inhibition. Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A.

5. Drug Design-II 5Hrs

Concepts of drug receptors. Elementary treatment of drug receptors interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. LD-50, ED-50 (Mathematical equations excluded)

Section-D

6. Kinds of Reaction Catalysed by Enzymes 10Hrs

Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and the coupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and elimination reactions, enolic intermediates in isomerization reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

Books Recommended:

1. Principles of Biochemistry By Lehninger
2. Principles of Biochemistry By Voet and Voet
3. The organic chemistry of drug design and drug action By R. B. Silverman, 2nd Ed., 2004, Academic press
4. An introduction to drug design by S. S. Pandeya and J.R. Dimmock, New Age International

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Organic Chemistry Lab
Paper: CYP461

Credit: 0-0-3 **Hrs. 90**

S. No.	Experiment	Chemicals required	Apparatus	Reference
1	An NMR study of Keto-Enol Tautomerism in β-Dicarbonyl compounds	Acetylacetone, Ethyl Acetoacetate	NMR Tube, Deutrated solvent	*J. Chem Edu*., **1976,** 53, p392
2	Nitration of o-chloroacetanilide – separation and identification of isomers	o-chloroacetanilide, nitric acid, sulphuric acid, toluene, ethanol	Rbf, reflux condenser, reaction hood, gloves,	*J. Chem Edu*., **2008**, 85, p1541
3	Preparation of bromohydrin of methyl oleate	Methyl oleate, NBS, acetone, N_2, ether, Na_2SO_4	Rbf, stirrer	*Eur. J. Lipid Sci. Technol*. **2004,** 106, p27
4	Dihydroxylation of cyclohexene with peracids and $KMnO_4$ – Product distribution by TLC	cyclohexene, oxone, $KMnO_4$	Rbf, stirrer, TLC,	*J. Chem Edu*., **2008**, 85, p959
5	Solvent free Cannizaro reaction using 2-chlorobenzaldehyde	2-chloro benzaldehyde, KOH, ethanol	Rbf, stirrer, reflux condenser, filtration flask, rotavapor	*J. Chem Edu*., **2009**, 86, p85
6	Reduction of 3-nitroacetophenone using i) NaBH4 ii) using Sn and HCl. Identification of the products with NMR, UV, IR spectra	3-Nitroaceto-phenone, Sn, HCl, absolute ethanol, sodium hydroxide, sodium borohydride	Rbf, stirrer, water bath, centrifuge tube, filteration flask, Buchner funnel	*Modern projects and experiments in organic chemistry. p193*
7	Synthesis of N,N-diethyl-m-toluamide (mosquito repellent) from m-toluic acid	m-Toluic acid, thionyl chloride, anhydrous ether, diethyl amine	Two necked Rbf, dropping funnel, condenser, adapter, separatory funnel	*Modern projects and experiments in organic chemistry. p227*
8	Epoxidation of methyl oleate	Methyl oleate, perbenzoic acid, acetone,	Rbf, stirrer, beaker	*JACS, 1944, 66, p1925 J. Agric Food Chem, 2010, 58, p6234*
9	Preparation of 10-undecynoic acid	10-undecenoic acid, Bromine, dry ether, Sodamide, Hydrochloric acid, acetone, Ferric chloride, metallic sodium, ammonium cloride	Rbf, stirrer, 3-necked flask, condenser, beakers,	*Organic Syntheses, 1963, 4, p969; Organic Syntheses, 1952, 32, p104*

M.Sc. Chemistry (Semester-II)
(Credit Based Evaluation & Grading System)

Electroanalytical Chemistry Lab
Paper: CYP462

Credits: 0-0-3

A. Conductometry

1. Find graphically the equivalent conductance at infinite dilution of weak acid (benzoic acid, succinic acid, acetic acid) and hence determine the thermodynamic dissociation constant of the weak acid.
2. Determine the equivalent conductance of strong electrolytes (KNO_3, KCl) at several concentrations of its aqueous solution and verify the Onsagar's equation.
3. Determine the equivalent conductance at infinite dilution of weak electrolytes (CH_3COOH, NH_4OH) in their aqueous solutions using Kohlraush law.
4. To determine relative strength of monochloroacetic and acetic acid by conductance measurements.

B. Potentiometry and pHmetry

5. To determine the dissociation constant of a dibasic acid(malonic acid)
6. The potentiometric titration of a mixture of Chloride and Iodide with $AgNO_3$.
7. To determine the degree of hydrolysis of aniline hydrochloride and hence hydrolysis constant of the salt.
8. Determination of acid and basic dissociation constants of an amino acid and hence the iso- electric point of the acid .
9. Titration of Phosphoric acid solution with NaOH using quinhydrone electrode.
10. The Potentiometric Determination of Solute Species in a Phosphate Mixture
11. The Potentiometric Titration of Copper with EDTA.

C. Electrogravimetry and Coulometric Titrations

12. Determination of Copper and Lead in a given sample of Brass Electrogravimetrically .
13. Determine coulometrically the concentration of Nickel and Cobalt from a given mixture.
14. The coulometric tritration of cyclohexene.

D. Polarography and Stripping methods

15. The polarographic Determination of Copper and Zinc in the given sample of Brass.
16. Study the polarographic waves produced by dissolved oxygen.
17. Determine the half wave potential of Cd^{2+}, and Zn^{2+}, ions in 0.1 M KCl solution.
18. Plot a polarogram for a mixture of Cd^{2+}, Zn^{2+}, and Mn^{2+}, ions.

19. Determine of formula and the stability constant of complex formation of a metal ion complex.
20. Determine the amount of Copper and Zinc in tap water using DPP.
21. Apply stripping methods to determine the concentration of lead in tap water.

Amperometric titrations:

22. Amperomertic titration of lead solution with potassium dichromate.
23. Amperometric titration of potassium sulphate solution with Lead nitrate solution.
24. Amperometric titration of nickel in solution with dimethyl glyoxime.
25. Determine transport number of silver and nitrate ions by Hittorf"s method.

M.Sc. Chemistry (Semester-III)
(Credit Based Evaluation & Grading System)

Physical Chemistry – III
(Quantum Chemistry)
CYL - 551

Credits : 3-0-0

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.

Section I (11 Hrs)

1.Historical Background of Quantum Theory:
Black Body radiation, Planck's radiation law, photoelectric effect, Compton effect, De-Broglie hypothesis, the Heisenberg's uncertainty principle for atomic spectrum of hydrogen , Rydberg's relation Bohr theory and its limitations. Introduction to well behaved functions. Operators and observables, normality and orthogonality of functions.

2.Application of Schrodinger equation:
Solution of classical wave equation by separation of variable method, eigen value equation, Hamiltonian operator. Interpretation of Ψ.

Section II (11 Hrs)

3. Some Model Systems:
Solution of particle in one, two and three dimensional box, degeneracy.
Hermitian Operators and theorems related to Hermitian operators Postulates of quantum mechanics, the linear harmonic oscillator, and the rigid rotator, quantization of vibrational and rotational energies.

Section III (12Hrs)

4. Angular Momentum:
Commutative laws, need of polar coordinates, transformation of cartesian coordinates into polar coordinates. Angular momentum of one particle system, orbital angular momentum, the ladder operator method for angular momentum, Wave functions and Eigen values of L^2 and L_z operators

5. The Hydrogen Atom:
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.

Section IV (11Hrs)

6. The Approximation Methods:

Need for approximation methods, Perturbation method upto inclusion of perturbation of second order. Variation method, Application of both the methods to Helium atom.

7. Chemical Bonding:

Chemical bondings, linear combination of atomic orbital, overlap integral, coulomb Integral, molecular orbital treatment of H_2^+, Bonding and antibonding orbital.

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, 5^{th} 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.
5. Fundamentals of Quantum Chemistry, R. Anantharaman, 2001, Macmillan India Ltd.

M.Sc. Chemistry (Semester-III)
(Credit Based Evaluation & Grading System)

Organic Chemistry-III
(Photochemistry and Pericyclic Reactions)
CYL552

Credits: 3-0-0
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.

Section-A

1. Photochemical Reactions **2 Hrs**
Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

2. Determination of Reaction Mechanism **3 Hrs.**
Classification, rate constants and life times of reactive energy states – determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photo-dissociation, gas-phase photolysis.

3. Photochemistry of Alkenes **6 Hrs.**
Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1, 4-dienes,

Section-B

4. Photochemistry of Carbonyl Compounds **8 Hrs**
Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, β,γ-unsaturated and α,β -unsaturated compounds, Cyclohexadienones.
Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

5. Photochemistry of Aromatic Compounds **4 Hrs**
Isomerisations, additions and substitutions.

Section-C

6. Pericyclic Reaction **12 Hrs**
Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5- hexatriene and allyl system. Classification of pericyclic reactions. Woodward ---Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions --- conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadddition – antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

Section-D

7. Sigmatropic Rearrangements **5Hrs**

Suprafacial and antarafacial shifts of H, sigmatropic shifts
involoving carbon moieties, 3,3- and – sigmatropic rearrangements. Claisen, Cope and aza-Cope rearreangements. Fluxional tautomerism. Ene reaction.

8. Miscellaneous Photochemical Reactions **5 Hrs**

Photo-Fries reactions of anilides. Photo-Fries rearrangement.
Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

Books:

1. Fundamental of PhotoChemistry By K.K. Rohtagi Mukherji
2. Molecular Photochemistry By N.J. Turro and W.A. Benjamin
3. Introductory Photochemistry By A. Cox and T. Camp
4. Modern Organic Photochemistry By W. H. Horsepool

M.Sc. Chemistry (Semester-III)
(Credit Based Evaluation & Grading System)

Inorganic Chemistry - III
CYL-553

Credits : 3-0-0
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.

SECTION-A (10 Hrs.)

Inorganic Chains: Catenation, heterocatenation, isopolyanions and heteropolyanions.
Inorganic Rings: Borazines, phosphazenes, other heterocyclic inorganic ring systems, homocyclic inorganic systems.

SECTION-B (13 Hrs.)

Inorganic Cages: Cage compounds having phosphours, oxygen, nitrogen and sulphur: boron cage compounds, Boranes, carboranes and metallocene carboranes. **(text 1)**

Transition metal cluster compounds: Introduction, metal carbonyl clusters; Low Nuclearity (M3 M4) clusters: isoelectronic and isolobal relaltionships high nuclearity carbonyl clusters; hetero atoms in metal atom clusters, electron counting schemes for HNCC: HNCC of Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt.

SECTION-C (10 Hrs.)

Lower halide and chalcogenide clusters: octahedral metal halide, chalocogenide clusters, triangular clusters, solid state extended arrays.
Compounds with M-M multiple bonds: Major structural types; quadrupole bonds, other bond orders in the tetragonal context, relation of clusters to multiple bonds, one dimensional solids, (Text 2).

SECTION-D (12 Hrs.)

Inorganic Chemistry in Biological Systems (15 Hrs.) :
Porphyrin rings, metalloporphyrins, photosynthesis and respiration, chlorophyll, structure, function and synthetic model Cytochromes; structure and function, CN and CO poisoning, Farredoxins and rubberdoxins, bioredox agents and mechanism, Heamoglobin and myoglobin, structure and mechanism of function, Coperativity, Enzymes, Vitamin B_{12}, B_{12} Coenzymes; structures and funciton, synthetic model of enzyme action, inhibition on poisoning by ligands and metal ions xanthine oxidase, N_2 fixation. **(Text 1 & 2)**

Books Recommended:
1. J.E.Huheey, Inorganic Chemistry, 3rd Edition, London, 1983.
2. F.A. Cotton, I.G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition, New York, 1988.
3. D.F. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chem., ELMS, Oxford, 1990

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Physical Chemistry-IV
CYL-561

Credit : 3-0-0
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.

Section A (11 Hrs)

a) Liquid State:

Introduction to liquid state, thermodynamic properties of liquids, vapour pressure and its determination, enthalpy and entropy of vaporization, Trouton's rule. Intermolecular forces, models and theories of liquids, surface and transport properties, surface tension and its measurement, viscosity and its measurement. Liquid crystals, smectic, nematic and cholesteric mesophases.

Section B (11 Hrs)

b) Solid State:

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, Schottky and Frenkel defects, colour centres, non-stoichiometry and defects, solid state reactions. Metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, superconductors, magnetic materials (ferrites) and their classification.

Section C (12 Hrs)

c) Electrochemistry of Solutions:

Ion-solvent interactions, the Born model, electrostatic potential at the surface of a charged sphere, Born expression for the free energy of ion-solvent interactions, structural treatment of ion-solvent interactions, ion-dipole moment, evaluation in the ion-dipole approach to heat of solvation, solvation number, static and dynamic pictures of ion-solvent interactions, hydration number, dielectric constant of water and ionic solutions, dielectric constant of liquids containing associated dipoles, ion – solvent non-electrolyte interactions, change in solubility of non-electrolyte due to primary and secondary solvations.

Section D (11 Hrs)

d) Photochemistry:

Difference between thermal and photochemical reactions, laws of photochemistry, Jablonskii diagram, qualitative description of fluorescence, phosphorescence, non- radiative processes (IC, ISC), quantum yield, photosensitized reactions, nuclear geometries of electronically excited states, energy surface description of molecular photochemistry, Excimers and Exciplexes, kinetics of photochemical reactions, chemiluminescence, solar energy conversion and storage.

Books Suggested:

1. Principles of Physical Chemistry, S.H. Maron & C.F. Prutton.
2. Solid State Chemistry, C.N.R. Rao.
3. Principles of Solid State Chemistry, P.P. Budnikov & A.M. Ginstling.
4. Physical Chemistry, P.W. Atkins.
5. Modern molecular photochemistry, N.J Turro.
6. Fundamentals of Photochemistry, K.K.Rohtagi- Mukherjee.
7. Applications of Liquid Crystals, G.Meier, E. Sackmann & J.G. Grabmaier.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Organic Chemistry IV
(**Biosynthesis of Natural Products**)
CYL – 562

Credits : 3-0-0
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.

SECTION-A

1. **Introduction (3 Hrs)**
Functions of metabolism. Primary and secondary metabolism. Biochemical reactions and organic reaction mechanisms. Principle Pathways and technique of elucidation metabolic sequences. The one carbon fragment.

2. **Primary Metabolism (10 Hrs)**
General introduction to catabolic and anabolic pathways. Regulation of metabolic pathways. Structure and functions of ATP, free energy of hydrolysis of ATP. Photosynthesis. Carbohydrate metabolism-Glycolysis, Citric acid cycle, Glycogenesis Glycogenolysis and Glyconeogenesis, pentose phosphate Pathway. Electron Transport System and Oxidative Phosphorylation.

SECTION-B

3. **Secondary Metabolism:**

(a) ***Metabolites derived from acetate (polyketide pathway)*** **(6 Hrs)**
Biosynthesis of unsaturated and saturated fatty acids, prostaglandins, polyphenols *viz.* Orsellinic acid, 6-methylsalicylic acid, usnic acid, penicillic acid, patulin, citrinin, griseofluvin, alizarin, emodin, tetracyclines.

(b) ***Metabolites derived from mevalonic acid pathway (Terpenes)*** **(5 Hrs.)**
Biosynthesis of mevalonic acid and the active isoprene units, monoterpenes *viz*. Citral, geraniol, pinene, camphor, terpineol, thujone, isobornylene, menthol, artemesia alcohol, santolina alcohol, Iridoids, viz. Loganin, iridomyrmecin secolaganin, sweroside.

SECTION-C

(c) ***Metabolites derived from mevalonic acid pathway (Terpenes)*** **(6 Hrs.)**
Sesquiterpenes, viz. Humulene, α-cedrene, γ-bisabolene, ovalicin, juvenile hormone, Diterpenes, viz. Phytol, Sclareol, abietic acid, taxinine. Triterpenes, squalene, lanosterol, cholesterol, cycloartenol, sitosterol, Vitamin D. Biological functions of steroids. Biosynthesis of carotenoids, viz. α-carotene, β-carotene, vitamin A.

(d) ***Metabolite derived from shikimic acid pathway*** **(4 Hrs)**
Biosynthesis of shikimic acid, aromatic amino acids, cinnamic and benzoic acid, coumarines.

SECTION-D

(e) ***The Alkaloids :*** ***(*****6 Hrs)**
Biosynthesis of coacin, tropine, pseudopelletierine, coniine, nicotine, sparteine, ephedrine, morphine, quinine.

4. **Amino acids, Peptides and Proteins: (5Hrs)**
Introduction, amino acid classification and structure, chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding secondary structures. α- helix and β-sheet. Tertiary structure of protein folding. Quaternary structure. Biosynthesis of amino acids.

Books:

1. Primary Metabolism: A Mechanistic Approach by J. Staunton, Oxford University Press, 1978.
2. Secondary Metabolism by J. Mann, Oxford University Press, Oxford, 1980.
3. Natural Product Chemistry - A mechanistic, Biosynthetic and Ecological Approach by Kurt B. G. Torssell, Swadish Pharmaceutical Society, 1997.
4. Principles of Biochemistry by A. L. Lehninger, CBS Publishers, New Delhi.
5. Fundamental of Biochemistry by D. Voet, J.G. Voet and C.W. Pratt, John Willey & Sons Inc., New York,1999.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

CYL – 563: Inorganic Chemistry IV
(Inorganic materials and nuclear chemistry)

Credits : 3-0-0 **(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 (11 Hrs.)

Inorganic Materials: Introduction to the solid state, types of bonding in solids: Ionic, covalent and Metallic bond (bond model). Defects in solids: Point defects, Line defects, Surface defects and Volume defects. p-type and n-type Inorganic semiconductors. Superconductors with special emphasis on synthesis and structure of high temperature superconductors. Properties of inorganic materials: electrical, optical, magnetic and thermal properties.

Section-B (12 Hrs.)

Nanomaterials: Introduction, classification and importance of nanomaterials. The characteristic differences between nanomaterials and their respective bulk materials. Preparation of nanomaterials: Vapor – phase synthesis, Liquid phase synthesis, Solid – state phase synthesis and other methods. Basic principles of electron microscopy, dynamic light scattering, Atomic force Microscopy and characterization of nanomaterials.

Section-C (11 Hrs.)

Nuclear and Radiochemistry
Radioactive elements, nuclear structure and nuclear stability, binding energy and stability of nuclei, nuclear models. Nuclear reactions: fission and fusion reactions, the interaction of nuclear radiations with matter, Q-value, nuclear reactors (Nuclear fission and fusion reactors).

Section-DV (11 Hrs.)
Nuclear and Radiochemistry
Radioactivity, types of radioactivity, units of radioactivity, Radiation hazards, therapeutics, detectors and their principles. Disintegration constant. Radioactive tracer technique and their applications (in medical, agriculture and industry). Rock and carbon dating.

Books:
1. B.C. Harvey, Introduction to Nuclear Chemistry, Prentice-Hall (1969)
2. G. Friedlander, J.W. Kennedy, E.S. Marcus & J.M. Miller Nuclear & Radiochemistry. John-Wiley & Sons (1981)
3. H.V. Keer, Principles of the Solid State, Wiley Eastern Ltd. (1993)
4. A.R. West Solid State Chemistry and Its Applications" John Wiley & Sons (1987)
5. A.K. Cheetham and P. Day Eds. Solid State Chemistry Techniques, Clarendon Press, Oxford (1987)
6. G. Timp Ed. Nanotechnology Springer-verlag (1999)
7. Lesley E. Smart Elaine A.Moor, Solid State Chemistry- An Introduction, 3rd edition, Taylor & Francis (2005).

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Organic Chemistry Lab - II
Multi-step Synthesis of Organic Compounds
CYP561

Credit 0-0-3

The use of multi-step approach in organic synthesis and applications of spectroscopic techniques to determine the structures of the compounds prepared.

S.No.	EXPERIMENT
1	Synthesize (a) 2,4-dinitro-1-chlorobenzene from chlorobenzene, (b) mixture of *o*- and *p*-nitrophenols from phenol and (c) *p*-nitroacetanilide from acetanilide and make comparison of the reactivity of various substrates and reaction conditions used for performing nitration in each experiment. (Book 2, pp 978-979, 919-20)
2	Synthesis of 2-chloro-4-bromo-6-iodoaniline from aniline.(Book 1, pp 292-299)
3	Synthesis of benzalacetophenone by condensation of benzaldehyde with acetophenone and study its bromination and subsequent debromination. (Book 1, pp 242-247, Book 3 pp 361-365)
4	The epoxidation of benzalacetophenone to its epoxide and study its reactivity towards hydroxyl ion. (Book 3, pp 363-364).
5	Michael addition of aniline to benzalacetophenone. (Book 1, p 247)
6	Conversion of benzalacetophenone to its oxime and its transformation to amide and oxazole derivatives. (Book 1, pp 242-247, Book 3 pp 361-365)
7	Synthesis of anthranilic acid from phthalimide. (Book 2, pp 898-899)
8	Synthesis of p-aminobenzenesulfonamide. (Book 1, pp 275-289)
9	Synthesis of Methyl n-pentyl ketone from ethyl acetoacetate. (Book 2, pp 620-621)
10	Synthesis of triphenylcarbinol from bromobenzne. (Book 2, pp 540-541)

Books:

1. An Introduction to Modern Experimental Organic Chemistry, R.M. Roberts,. Gilbert, L.B. Rodewald and A.S. Wingrove. Holt, Ranehart and Winston Inc., J.C New York.1969.

2. Vogel's Text Book of Practical Organic Chemistry, 5th Edition.

3. Laboratory Experiments in Organic Chemistry, R. Adams, J.R. Johnson and C.F. Wilcox, The Macmilan Limited, London, 1970.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Inorganic Chemistry Lab-II
CYP562

Credits: 0-0-3

S.No.	EXPERIMENT
1	Preparation of mercury tetraisothiocyanatocobaltate(II). Determination of its magnetic moment and interpretation of its IR spectrum.
2	Preparation of nitro-and nitrito-pentaamminecobalt(II) chlorides from chloropenta amine cobalt(III) chloride. Recording and interpreting their electronic and IR spectra.
3	Heating the nitro and nitrito isomers at serial 2 to 15o C in an oven for 3 h and recording the infrared spectra again and compare them with the spectra recorded before the isomers were heated.
4	Preparation and resolution of tris(ethylenediamine)cobalt(II) ion. Measurement of optical rotation of these resolved complexes.
5	Preparation of diaquotetraacetatedicopper(II). Determination of its magnetic susceptibility and interpretation of E.P.R., electronic absorption and IR spectra.
6	Preparation of bis(2,4-pentanedione)vanadium(IV) acetate and its piperidine or pyridine complex. Study of both the complexes with the help of infrared, UV-vis spectroscopy and magnetic susceptibility.
7	Preparation of hexaamminenickel(II) chloride and tris(ethylenediamine)nickel(II) chloride. Interpretation of their electronic absorption spectral data and calculation of β and 10Dq values. Measurement of magnetic susceptibility, calculation and interpretation of the values.
8	Preparation of lead tetraacetate.
9	Preparation of potassium trioxalatoaluminate(III) trihydrate. Its TGA and DTA studies and its interpretation of its i.r. data.
10	Preparation of disulphur dichloride
11	Preparation of sodium tetrathionate, potassium dithionate, and interpretation of their IR spectra.
12	Preparation of cis-and trans-potassium dioxalatodiaquochromate(III). Interpretation of their i.r., and selectronic absorption spectral data. Calculation of β and 10 Dq values.
13	Preparation of iron(II) oxalate and potassium trioxalateferrate(III). Interpretation of their magnetic data, E.p.r. and Mossbauer spectra.

14 Preparation of nitrosylbis(diethyldithiocarbamato)iron(II) and interpretation of its IR and EPR spectra.

15 Preparation of chromium(II) acetate hydrate.

16 Preparation of 43anganese(II) phthalocyanine. Interpretation of its IR, and electronic absorption spectra.

Books:

1 G. Marr and B.W. Rockett: Practical Inorganic Chemistry, Van Nostrand Reinhold Company

2 W.L. Jolly, The Synthesis and Characterization of Inorganic Compounds. Prentice Hall.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Optional Courses; Any three to be chosen.
Optional Course

Physical Chemistry-V
(Chemistry of Materials)
CYL564

Credits 4-0-0
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.

SECTION-A (15 Hrs)

Multiphase Materials:
Ferrous alloys; Fe-C phase transformation in ferrous alloys; stainless steels, non-ferrous alloys, properties of ferrous and non-ferrous alloys and their applications.

Glasses, Ceramics, Composites and Nanomaterials
Glassy state, glass formers, and glass modifiers, application. Ceramic structures, mechanical properties, clay particle product. Refractories, characterization, properties, and applications.
Microscopic composites; dispersion–strengthened and particle reinforced, fibre- reinforced composite, macroscopic composites. Nanocrystalline phase, preparation procedure, special properties, applications.

SECTION-B (15 Hrs)

Liquid Crystals
Mesomorphic behaviour, thermotropic liquid crystal, positional order, bond orientational order, nematic and smectic mesophases; smectic – nematic transition and clearing temperature-homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystal. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

SECTION-C (15 Hrs)

High Tc Materials
Defect perovskites, high T_c superconductivity in Cuperates, preparation and characterization of 1-2-3 and 2-1-4 materials, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastics constants, position lifetime, microwave absorption-pairing and multigap structure in high T_c materials, applications of high T_c materials.

SECTION-D (15Hrs)

Thin Films and Langmuir- Blodgett Films

Prepartion techniques; evaporation/sputtering, chemical process, sol gel etc.

Langmuir – Blodgett (LB) films, growth technique, photolithography, properties and applications of thin and LB films.

Materials for Solid State Devices

Rectifiers, transistors, capacitors –IV-V compounds, low–dimensional quantum structure; optical properties.

Organic Solid, Fullerenes, Molecular Devices

Conduction organics, organics, organic superconductors, magnetism in organic materials.

Fullerenes- doped, fullerenes as superconductors.

Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory, switches and sensors.

Nonlinear optical materials: nonlinear optical effects, second and third order – molecular hyperpolarisability and second order electric suspceptibility – materials for second and third harmonic generation.

Books Suggested:

1. Solid State Physics, N.W. Ashcrofy and N.D. Mermin, Saunders College.
2. Material Science and Engineering, An Introduction, W.D. Callister, Willey.
3. Principle of the Solid State, H.V. Keer, Willey Eastern.
4. Material Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS
5. Thermotropic Liquid Crystals, Ed., G.W. Gray, John Willey.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Optional Course
Physical Chemistry-VI
(Bio-physical Chemistry)
CYL565

Credits : 4-0-0

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.

Section-A (15 Hrs)

Fundamentals of Biological Macromolecules

Biological Cell and its Constituents: Prokaryotic and Eukaryotic Cell, Structure and Functions of Ribosomes, Mitochondria, Golgi Apparatus and Cell membrane, and Transport Across Cell Membrane.

Molecular Basis of life: Structure of D-glucose & D-fructose; formation of glucosides & the cyclic structure of D-glucose; D-ribose & D-deoxyribose; Structure and conformation of diasacharides and polysaccharides-cellulose, amylose, amylopectin and, Chitin.

Lipids: Major classes of lipids- Fats & oils; phospholipids, lipoproteins, fatty acids, Structure, classification & role of vitamins & hormones.

Section-B (15 Hrs)

Genetic Material: Nucleic bases-Types and Structure, Structure and Functions of DNA and RNA

Proteins and Enzymes: Structure (Primary, Secondary and Tertiary) and Functions of Proteins, Nomenclature, Classification, Enzyme catalysis and its mechanism, Michaelis-Menten Equation, and Lineweaver-Burk equation, Enzyme Activity and Transition State.

Biopolymer Interactions: Forces involved in biopolymer interactions, Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, interactions with surfactants and characterization.

Section-C (15 Hrs)

Thermodynamics and Biopolymer Interactions

Thermodynamics of Biological Systems: Basic Concepts, Thermodynamics of Protein Denaturation, Thermodynamic Parameters and Biological events, Standard free energy change in biochemical reactions and effect of pH and concentration, exergonic and endergonic reactions, coupled reactions and their utilization, characteristics of high energy molecules, Synthesis, Structure, Function, and Hydrolysis of ATP, Effect of pH, metal ions and concentration on hydrolysis of ATP.

Optical Properties of Biomacromolecules: Light Scattering, fundamental concepts, Rayleigh Scattering, Scattering by Larger particles, Information about size and molecular weight.

Section-D (15 Hrs)

Physical Characterization of Biological macromolecules

Ultracentrifugation: Svedberg equation, sedimentation equilibrium, density gradient sedimentation.

Electrophoresis: General principles, Double layer techniques, moving boundary electrophoresis, zonal electrophoresis, isoelectric focusing.

Osmotic Pressure: Second virial coefficient, Donnan effect, molecular mass and geometry from osmotic pressure measurements.

Isothermal Titration calorimetry: Basic concept, Application to Protein-Protein, Protein-Ligand, Protein-Drug and Protein Surfactant Interactions.

Books Recommended:

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.

2. Biochemistry, L. Stryer, W.H. Freeman.

3. Biochemistry, Voet and Voet, John Wiley.

4. Biophysical Chemistry, J. P. Allen, John Wiley.

4. Macromolecules: Structure and Function, F.Wold., Prentice Hall.

5. Text Book of Polymer Science, F.W. Billmeyer. 6. Physical Chemistry of Polymers, A. Tager.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Optional Course

Organic Chemistry-V
(Advanced Organic Synthesis)
CYL566

Credit: 4-0-0
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. Newer Synthetic Reactions and Reagents **45 Hrs**

Section-A

A. Chemistry of Carbanions **15 Hrs**

Enolates, Thermodynamic versus Kinetic enolates, enonate equivalents and enamines: Applications in carbon-carbon bond formation and related reactions. Applications in chiral synthesis.

Phosphorus, Sulphur and nitrogen ylides: Preparation, applications in organic synthesis and mechanism.

Umpolung reactions (sulphur compounds, nitro compounds, lithiated ethers and related compounds).

Section-B

Phase Transfer Catalysis **5 Hrs**

Principles and applications of phase transfer catalysis, crown ethers and polymer- supported reagents in organic synthesis.

Green Chemistry **10 Hrs**

Principles of Green Chemistry and its applications: Biotransformations: Classification of enzymes, advantages and disadvantages, applications in organic synthesis; Principles of ultrasound and microwave assisted organic synthesis. Reactions in ionic liquids

Section-C

Organosilicon Compounds: **15 Hrs**

Preparation and applications in organic synthesis; Applications of Pd(0) and Pd(II) complexes in organic synthesis- Stille, Suzuki and Sonogashira coupling, Heck reaction and Negishi Coupling. Preparation and applications of lithium organocuparates.

Section-D

2. Disconnection approach: **15 Hrs**

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

Books Recommended:

1. Designing Organic Synthesis, S. Warren, Wiley
2. Organic Synthesis- Concepts, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, Verlag VCH.
3. Advanced Organic Synthesis Part A and B, F.A. Carey and R. J. Sundberg, Plenum Press.
4. Principles of Organic Synthesis, R. Norman and J. M. Coxon, Blackie Acdemic & Professional.
5. *Modern Methods of Organic Synthesis* Cambridge University Press (1971). Carruthers, W.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Optional Course

Inorganic Chemistry-V
(Inorganic Spectroscopy)
CYL-568

Credit 3-0-0

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.

SECTION-A

1. Nuclear Quadruple Resonance Spectroscopy (5 Hrs.)
Introduction, experimental considerations, fundamentals of NOR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the assymetry paremeter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group, elements, transition metals, complications in the spectra. (book 1,2).

SECTION-B

2. Mossbauer Spectroscopy (10 Hrs.)
Experimental considerations, the spectrum and its parameters, simple spin states (1/2, 3/2), higher spin states (I > 3/2), magnetic splitting significance of parameters obtained form spectra, quadrupole splitting, additive model, interpretation of Mossbauer spectra of ion-57, tin-119, complications like unusual intensities, non zero asymetry parameter recol fraction, magnetic ordering and relaxation. (book 1,2).

SECTION-C

3. Electron Paramagnetic Resonance Spectroscopy (15 Hrs.)
Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, est spectrum of benzene radical anion, methylmedical. CH2OH cyclopentedfienyl cycloheptarienyl radical, pyrazine anion, pyrazine anion with 23 Na and 30K counter ion, Nitrosyl nitroxide factors affecting magnitude of g values, zero field splitting and Krammer's degeneracy. Qualitative survey of EPR spectra of first row transition metal ion complexes (d^1, d^2, d^3, low spin d^5, d^5, high spin d^6, d^7, d^9 system). (book 1,2).

SECTION-D

4. Nuclear Magnetic Resonance (15 Hrs.)
Recaptulations, NMR of inorganic compounds, ^{1}H NMR of organometalics- chemical shift, coupling effects, phosphorous and arsine ligands, hydrides, coupling to metals, Main group hydrides, transition metal hydrides, coupling to phosphine ligands, more than one hydride, coupling to metal, effect of trans ligand, dihydrogen complexes, Isotopes other than ^{1}H e.g. ^{31}P, ^{13}C, ^{14}N, ^{15}N, ^{19}F, ^{27}Al, ^{29}Si, transition metals. (books 1, 2 & 3)

Books Recommended:

1. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders Company.

2. R.V. Parish, NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, Eds Elis Horwood.

3. E.A.V. Ebsworth, D.W.H. Rankin and S.J. Cradock, Structural Methods in Inorganic Chemistry, Blackwell Scientific, Oxford, 1987.

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Optional Course
Inorganic Chemistry-VII
(Bioinorganic Chemistry)
CYL570

Credits: 4-0-0

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.

SECTION-A **(15 Hrs.)**

Inorganic Chemistry of Enzymes-I
Introduction, energy sources for life, non-photosynthetic processes, metallopoophyrings, cytochromes, biochemistry of iron, iron storage and transport, ferritin transferring, bacterial iron transport, hemoglobin and myoglobin, nature of heme-dioxygen binding, model systems, cooperativity in hemoglobin, physiology of myoglobin and hemoglobin, structure and function of hemoglobin. Other iron-prophyrin biomolecules, structure and function of hemoglobin. Other iron-porphyrin biomolecules, peroxidases and catalases, cytochrome P450 enzymes, other natural oxygen carriers, hemerythrins.

SECTION-B **(15 Hrs.)**

Inorganic Chemistry of Enzymes-II
Electron transfer, respiration and photosynthesis; ferridoxins, and subredonim carboxypeptidase, carbonic anhydrase, metallothioneins. Blue copper proteins, superoxide dismutase hemocyanines photosynthesis, chlorophyll and photosynetic reaction center.
Enzymes: Structure and function, inhibition and poisoning Vitamin B12 and B12 coenzymes metallothioneins, nitrogen fixation, in-vitro and in-vivo nitrogen fixation, bio-inorganic chemistry of Mo and W, nitrogenases: other elements V, Cr, Ni (essential and trace elements in biological systems).

SECTION-C **(15 Hrs.)**

Metal Ions in Biological Systems
Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA & RNA). Template temperature, stability of DNA.
Role of metal ions in replication and transcription process of nucleic acids.
Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransmitter, calcification reclaiming of barren land.
Metals in the regulation of biochemical events. Transport and storage of metal ions *in vivo*.

SECTION-D **(15 Hrs.)**

Inorganic Medicinal Chemistry

Fundamentals of Toxicity and Detoxification. Nuclear medicines.
Biochemistry of dioxygen, bioinorganic chips and biosensors.
Metal complexes as probes of structure and reactivity with metal substitution.

Books Recommended:

1. J. E. Huheey, E. A. Keiter and R.L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, 4th Edition, Haper Collins.
2. B. Douglas, D. McDaniel and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edition, John Wiley and Sons.
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry: A Comprehensive Text, 5th Edition, John Wiley.
4. Ch. Elschenbroich and A. Salzer, Organometallics. A Concise Introduction, Second Edition, VCH.
5. D.F. Shriver and P.W. Atkins, Inorganic Chemistry, 3rd Edition, Oxford University Press.
6. J.A. Cowan, Inorganic Biochemistry, 2nd Edition, Wiley – VCH.
7. G. Wulfsberg, Inorganic Chemistry, University Science Books.
8. S.J. Lippard, & J. M. Berg *Principles of Bioinorganic Chemistry* Univ. Science Books (1994).
9. S. J. Lippard, *Progress in Inorganic Chemistry* Vols. 18 and 38, Wiley-Interscience (1991).

M.Sc. Chemistry (Semester-IV)
(Credit Based Evaluation & Grading System)

Optional Course
CYL571: Inorganic Polymers

Credit: 4-0-0 **(60 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 (15 Hrs.)

Inorganic Polymers: Introduction, importance of Inorganic Polymers, Types of Inorganic Polymers. Characterization of Inorganic Polymers: Molecular Weights, Molecular Weight Distributions, Other Structural Features, Chain Statistics, Solubility Considerations, Crystallinity, Transitions, Spectroscopy, Mechanical Properties.

Polysiloxanes and Related Polymers: Introduction, History, Nomenclature, Preparation and analysis, General Properties, Reactive Homopolymers, Elastomeric Networks, Some New Characterization Techniques Useful for Polysiloxanes, Copolymers and Interpenetrating Networks, Applications of polysiloxane. [10]

Section-B (15 Hrs.)

Polyphosphazenes: Introduction, History, Alternative Synthesis Routes to Linear Polymers: Ring-opening polymerization and Condensation polymerizations. Surface Reactions of Polyphosphazenes, Hybrid Systems through: Block, Comb, or Ring-Linked Copolymers, Composites, Organometallic Polyphosphazenes, Small-Molecule Models, Molecular Structure of Linear Polyphosphazenes, Structure–Property Relationships, Applications of Polyphosphazenes, Optical and Photonic Polymers. [15]

Section-C (15 Hrs.)

Polysilanes and Related Polymers: Introduction, History, Synthesis, Chemical Modification of Polysilanes, Physical Properties of Polysilanes, Electronic Properties of Polysilanes, Chromotropism of Polysilanes, Electrical Conductivity and Photoconductivity, Luminescence of Polysilane, Photodegradation of Polysilanes, Cross-Linking, Structural Arrangements in Polysilanes, Technology of Polysilanes [10]

Section-D (15 Hrs.)

Ferrocene-Based Polymers, and Additional Phosphorus- and Boron-Containing Polymers: Ferrocene-Based Polymers, Other Phosphorus-Containing Polymers, Boron-Containing Polymers

Miscellaneous Inorganic Polymers: Introduction, Other Silicon-Containing Polymers, Polygermanes, Polymeric Sulfur and Selenium, Other Sulfur-Containing Polymers, Aluminum-Containing Polymers, Tin-Containing Polymers, Arsenic-Containing Polymers, Metal Coordination Polymers

Books

1. James E. Mark, Harry R. Allcock, Robert West, Inorganic Polymers, Second Edition, Oxford University Press (**2005)**
2. P.B. Saxena, Inorganic Polymers, Discovery Publishing House, **2007**
3. Roger De Jaeger, Mario Gleria , Inorganic Polymers, Nova Science Publishers, **2007**
4. Ronald D. Archer, Inorganic And Organometallic Polymers, John Wiley & Sons, **2001**
5. F.A.Cotton & G. Wilkinson, Advanced Inorganic Chemistry, 5^{th} Edition **1988**.
6. J.E. Hukeey, E.A.Keiter And R.L.Keiter, Inorganic Chemistry, Principles Of Structure And Reactivity, 4^{th} Edition, Harper Collins College Publisher **1993**

CYL572 : Organic Chemistry-VI
(Principles and Applications of Non-enzymatic Asymmetric Synthesis and Organocatalysis)

Credit 4-0-0
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.

SECTION-A

1. The Significance of Chirality and Stereoisomeric discrimination (15 Hrs)
Asymmetry: Conditions for Asymmetry, Nomenclature. Determining Enantiomer Composition: Measuring Specific Rotation, The Nuclear Magnetic Resonance Method, Reagents for Nuclear Magnetic Resonance Analysis, Nuclear Magnetic Resonance Method for Relative configuration Determination.Determining the Enantiomer Composition of Chiral Glycols or Cyclic Ketones.Chromatographic Methods Using Chiral Columns, Capillary Electrophoresis with Enantioselective Supporting Electrolytes.Determining Absolute Configuration: X-Ray Diffraction Methods, Chiroptical Methods, etc.

SECTION-B

2. Non-enzymatic Approaches in Asymmetric Synthesis – A (15 Hrs)
Selective examples of asymmetric synthesis: α-Alkylation and catalytic alkylation of carbonyl compounds: preparation of quaternary carbon centers, preparation of α-amino acids, nucleophilic substitution of chiral acetals,chiral catalyst-induced aldehyde alkylation: asymmetric nucleophilic addition, catalytic asymmetric additions of dialkylzinc to ketones: enantioselective formation of tertiary alcohols, asymmetric cyanohydrination, asymmetric α-hydroxyphosphonylation. Aldol and related reactions: Substrate-controlled Aldol reaction: Oxazolidones, Pyrrolidines,Aminoalcohols and Acylsultams and α-silyl ketonsas chiral auxiliaries. Reagent-controlled Aldol reactions: Aldol condensations induced by chiral boron compounds, Aldol reactions controlled by Corey's and miscellaneous reagents. Chiral catalyst-controlled asymmetric Aldol reaction:Mukaiyama'ssystem,asymmetric Aldol reactions with a chiralferrocenylphosphine±gold(I) complex, chiral Lewis acids,bimetallic catalysts. Double asymmetric Aldolreactions. Asymmetric oxidations: oxidation of allylic alcohols, epoxidation of divinylcarbinols, dihydroxylation of olefins, asymmetric aminohydroxylation, epoxidation of aldehydes, asymmetric oxidation of enolates, asymmetric aziridination.

SECTION-C

3. Non-enzymatic Approaches in Asymmetric Synthesis – B (5 Hrs)

Asymmetric Diels-Alder and other cyclization (dipolar cycloaddition, cyclopropanation) reactions, Asymmetric catalytic hydrogenation and other reductions: Reagents for asymmetric hydrogenation, Asymmetric reduction of carbonyl compounds, imines. Asymmetric transfer hydrogenation, hydroformylation.

4. Organocatalysis in Organic Synthesis – A (10 Hrs)

Introduction. Enamine catalysis: Aldol and Mannich type reactions, α-heteroatom functionalization, direct conjugate additions via enamine activation. Iminium catalysis: the catalysis concept, cycloaddition reactions, 1,4-addition reactions, transfer hydrogen, cascade reactions. Ammonium ions as chiral templates: Homogeneous catalysis with chiral quaternary ammonium salts,

SECTION-D

5. Organocatalysis in Organic Synthesis – B (15 Hrs)

Heterogeneous catalysis- chiral phase transfer catalysis. Morita-Baylis-Hillman reaction: addition of ketones and aldehydes to activated olefins, asymmetric MBH reactions. Asymmetric proton catalysis: conjugate addition reactions, hydrocyanation reactions, Mannich reactions, aza-henry reaction, acyl Pictet-Spengler reaction, aza Friedel-Crafts reaction. Chiral Lewis bases as catalysts: allylation reactions, propargylation reactions, hydrocyanation and isonitrile addition, aldol type reactions, reduction of imines, epoxide ring opening. Asymmetric acyl transfer reactions. Ylide based reactions.

Books:

1. Principles and applications of asymmetric synthesis by Guo-Qiang Lin, Yue-Ming Li and Albert S. C. Chan, Wiley Interscience, New York 2001 (sections 1 and 2).
2. Enantioselective organocatalysis by Peter I. Dalko, Wiley-VCH, Weinheim 2007 (section 3).