<table>
<thead>
<tr>
<th>Course Code</th>
<th>NAME OF PAPER</th>
<th>COURSE</th>
<th>EXAMINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH-1118</td>
<td>Scientific Research Methodology</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>CH-1119</td>
<td>Instrumental methods of chemical analysis</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>CH-1120</td>
<td>Seminar and Report</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>CH-1154</td>
<td>Synthetic Organic Chemistry</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>CH-1155</td>
<td>Coordination and Supramolecular Chemistry</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>CH-1156</td>
<td>Advanced Coordination Chemistry</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>CH-1157</td>
<td>Chemistry of Nanomaterials</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>CH-1217</td>
<td>Project work and dissertation</td>
<td>17</td>
<td>100</td>
</tr>
</tbody>
</table>

**Total** 36 500
CH –1118 : SCIENTIFIC RESEARCH METHODOLOGY

M.Phil. Chemistry  
Semester – I  
Course : Major Core(MC)  
No. of Credits : 6  
No. of hours per week : 6

Objectives
1. To introduce the purpose and importance of research for future development.
2. To know the various indexes and abstracts in science and technology as a source of all information in chemistry.
3. To learn the ways of carrying out literature search for current awareness and for the retrospective survey.
4. To learn the scientific method of collecting data and to compute statistical parameters to arrive at meaningful conclusions.
5. To know the methodology of writing thesis and journal articles.

Unit 1: Scientific Research and the Chemical Literature (25 h)
1.1 The search for knowledge, purpose of research, scientific method, role of theory, characteristics of research.
1.2 Types of research: fundamental or pure research, applied research, action research, historical research, experimental research.
1.3 Indexes and abstracts in science and technology: applied science and technology index, biological abstracts, chemical abstracts, chemical titles, current chemical reactions, current contents, engineering index, index chemicus, index medicus, physics abstracts, science citation index.
1.4 The Chemical Abstracts

Current awareness searching: CA weekly issues, CA issue indexes.
Retrospective searching: CA volume indexes-general subject index, chemical substance index, formula index, index of ring systems, author index, patent index.
CA Collective indexes: Collective index (CI), decennial index (DI).
Access points for searching CA indexes: index guide, general subject terms, chemical substance names, molecular formulas, ring systems, author names, patent numbers.
Locating the reference: finding the abstract, finding the original document, chemical abstract service source index.
Classical and comprehensive reference works in chemistry: Beilstein’s Handbook of Organic Chemistry, Gemelin Handbook of Inorganic Chemistry; compilations of data, synthetic methods and techniques, treatises, reviews.
1.6 A report on literature survey.

Self study
(a) An overview of selected list of compilation of data: Dictionary of Organic Compounds, Merck Index, CRC Handbook of Chemistry and Physics, Lange’s Handbook of Chemistry.
(c) A brief literature survey from Chemical Abstracts for locating relevant journal articles.

Unit 2: Techniques for Analysing Data

2.1 Statistical considerations: population and samples, sampling distributions, interference about the population mean, sampling problems; the conditions of observation-research in natural settings, surveys, laboratory experiments; design of experiments.

2.2 Parametric and nonparametric data; descriptive and inferential analysis.

2.3 Frequency distributions: Graphing frequency distribution-discrete versus continuous scales, bar graphs, frequency polygons; describing frequency distributions-modality and skewness.

2.4 Measures of central tendency: the mode, the median, the mean.

2.5 Measures of variability (dispersion): the total range, the interquartile range, the average deviation, the variance-analysis of variance and covariance; the standard deviation; normal distributions: the normal distribution and the normal probability curve.

2.6 Measures of relative position: standard scores- sigma score ($z$), standard score ($Z$ or $T$), and college board score ($Z_{cb}$); percentile rank.

Unit 3: Correlational methods

3.1 Scatter diagrams and linear regression line; Spearman rank order correlation. Pearson’s product moment correlation.

3.2 Correlation coefficients: Pearson $r$-using Pearson $r$ to predict scores; interpreting the magnitude of $r$-nonlinear relations, restricted ranges.

3.3 Interpreting correlational data: reliability coefficients-internal consistency, test-retest reliability, alternate-forms reliability; validity coefficients-construct validity; regression effects; correlation and causality-cross-lagged panel analysis.

Unit 4: Using data to make decisions

4.1 Nonparametric tests: Chi square test, median test, Mann-Whitney test, Sign test, Wilcoxon matched-pairs signed ranks test.

4.2 Testing statistical significance: the logic of hypothesis testing-the null hypothesis ($H_0$), the level of significance, two tailed and one tailed tests of significance, degrees of freedom, students distribution ($t$), homogeneity of variances.

4.3 The alternate hypothesis, the nature of the test, decision errors and their probabilities, hypothesis about frequencies and hypothesis about mean differences.

Unit 5: The Scientific Writing

5.1 Research reports, theses, journal articles: format and writing style.

5.2 Requirement of technical communications: eliminating wordiness and jargon-tautology, redundancy, imprecise words, superfluous phrases.

5.3 Steps to publishing a scientific article in a journal: types of publications-communications, articles, reviews; when to publish, where to publish, specific format required for submission, organization of the material.

5.4 Documenting: abstracts-indicative or descriptive abstract, informative abstract, footnotes, end notes, referencing styles, bibliography-journal abbreviations (CASSI), abbreviations used in scientific writing.

Self study

(a) Journals which publish only communications in chemistry.

(b) Journals which publish only reviews.
(c) Standard journal abbreviations of select journals in chemistry.

References

5. H. M. Kanare, Writing the Laboratory Notebook; American Chemical Society: Washington, DC, 1985.
CH –1119 : INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

M.Phil. Chemistry
Semester – I
Course : Major Core(MC)
No. of Credits             :  6
No. of hours per week :  6

Objectives

1. To master the basic principles of spectroscopy to apply for structural elucidation.
2. To learn the methods of characterizing compounds by spectroscopic techniques.
3. To learn the various instrumental methods studying a given compound.
4. To learn the separation techniques for organic and inorganic compounds.
5. To learn about industrial analytical processes.

Unit 1: Absorption Spectroscopy

1.1 Infrared and Raman Spectroscopy: FT-IR, basic principles, quantitative IR, resonance Raman and laser Raman spectroscopy, applications of IR and Raman spectroscopy to organic and inorganic compounds.

1.2 Electronic Spectroscopy: term symbols, spin-orbit coupling in free ions, electronic spectra of $O_h$ and $T_d$ complexes, charge transfer transition, structural evidence from electronic spectra.

1.3 Nuclear Magnetic Resonance Spectroscopy: spin-spin splitting, application of spin-spin coupling to structural determination, factors influencing the appearance of NMR spectrum-fast chemical reaction, second order spectra, quadrupole nuclei, NMR double resonance; FT NMR, principles, measurement of $T_1$ and $T_2$, applications of NMR to $^{19}$F and $^{31}$P magnetic nuclei; 2D NMR, NOESY and COSY; magnetic resonance imaging; applications of $^1$H and $^{13}$C NMR in structural elucidation; NMR spectra of paramagnetic compounds—scalar and pseudo contact shift.

1.4 Nuclear Quadrupole Resonance Spectroscopy: effect of magnetic field on the spectra, electric field gradient and molecular structure, structural elucidation of inorganic and coordination compounds.

1.5 Electron Paramagnetic Resonance Spectroscopy: hyperfine splitting in isotropic systems; epr spectra of systems with more than one unpaired electrons-Kramer’s degeneracy, zero field splitting, epr of triplet states, anisotropy in $g$-value, anisotropy in hyperfine splitting, nuclear quadrupole interaction; applications of epr to organic and inorganic compounds.

1.6 Mossbauer Spectroscopy: interpretation of isomer shifts, quadrupole and magnetic interactions, Mossbauer emission spectroscopy, structural elucidation.

Unit 2: Mass spectrometry and Emission Spectroscopy

2.1 Mass Spectrometry: methods of ion generation-molecular ions from volatile samples-EI, CI, PI, FI; molecular ions from non-volatile samples-FAB, ESI, FD, and MALDI; mass analysers-TOF, beam type and ion-trapping.

Tandem mass spectrometry: techniques-multiple tandems, multiple quadrupole devices, Tandem MS with TOF, quadrupole ion trap; applications of MS for structural elucidation of organic and inorganic compounds, mass spectrometry of polymers and biopolymers.

2.2 Photo Electron Spectroscopy: Koopman’s theorem, PES, XPS, ESCA, and Auger spectroscopy, applications.
2.3 Fluorescence and Phosphorescence spectroscopy: X-ray fluorescence spectroscopy and chemiluminescence
2.4 Flame emission spectroscopy: flame photometry, AAS, and ICPAES

Unit 3: Electrochemical Techniques (10 h)
3.1 Cyclic voltammetry, differential pulse voltammetry; principles and applications
3.2 Stripping voltammetry: anodic and cathodic stripping voltammetry-principle and applications.
3.3 Principle and applications of chronoamperometry, chronocoulometry, and chronopotentiometry.

Unit 4: Thermal Methods (10 h)
4.1 Principle, instrumentation and applications of thermogravimetric analysis, Differential thermal analysis, differential scanning calorimetry
4.2 Thermochemical analysis and dynamic mechanical analysis: instrumentation.
4.3 Thermometric titrations: principle and applications.

Unit 5: Separation and Analytical Methods (10 h)
5.1 Chromatography: Gas chromatography, HPLC, supercritical fluid chromatography, and capillary electrophoresis, SEC: instrumentation and applications
5.2 Industrial process analysis, methods based on bulk properties, IR process analysis, oxygen analysis, automated chemical analysers.
5.3 Electron microprobes: SEM, TEM, STM and AFM.
5.4 X-Ray methods of analysis: single crystal and powder X-ray diffraction techniques.

References
13. Srivastava, Chemical Analysis: An Instrumental Approach, S. Chand, New Delhi,
CH –1154 : SYNTHEtic ORGANIC CHEMISTRY

M.Phil. Chemistry
Semester – I  No. of Credits : 6
Course : Subject Elective(ES)  No. of hours per week : 6

Objectives:

01. To know the methods of synthetic strategies and applications
02. To apply the knowledge of chemical reactions in organic synthesis

UNIT 1: Preliminary planning and control elements (15 hours)
1.1 Known and unknowns of synthetic systems, analysis of complex and interrelated carbon frame work, precursors, retrosynthetic approach.
1.2 Yield of synthetic reactions, convergent synthesis.
1.3 Functionalisation and interconversion of functional groups- functionalisation of alkanes, alkenes, alkynes, aromatic hydrocarbons, heterocyclic compounds and inter conversion of functional groups
1.4 Formation of Carbon-carbon bonds- general strategy, disconnections and synthons, electrophilic and nucleophilic carbon species.
1.5 Regiospecific control elements, use of protective groups, activating groups and bridging elements.
1.6 Stereospecific control elements – functional group alterations and transportations.
Self study:
Electrophilic carbon-nitrogen reagents, electrophilic alkenes, Grignard and related organometallic reagents.

UNIT 2: Asymmetric synthesis (10 hours)
2.1 Terminology and analytical methods, Strategy and classification of methods, first, second, third and fourth generation methods. Use of two each of chiral substrates, chiral auxiliaries, chiral reagents.
2.2 Asymmetric catalysis, catalytic asymmetric alkylation, hydrogenation, reactions catalysed by enzemes and other proteins.
2.3 Organotransition metal chemistry, applications to asymmetric organic synthesis.
2.4 Alkylation of active methylene compounds in asymmetric synthesis.
Self study:
Multistage synthetic routes, asymmetric Diels-Alder reaction, alkylation α to nitrogen.

UNIT 3: Silicon and boron in organic synthesis (10 hours)
3.1 Properties of bonds to silicon, nucleophilic substitution at silicon, 1,2-rearrangements.
3.2 Protection of hydroxy groups as silyl ethers, silyl enol ethers and related silyl ethers, synthesis of alkenes(Peteson olefination).
3.3 Alkynyl-, vinyl- and arylsilanes in organic synthesis, aresilanes and acylsilanes.
3.4 Typical organic synthesis involving organosilicon compounds.
3.5 Hydroboration, asymmetric hydroboration, reactions of organoboranes-oxidation, protonolysis, amination, halogenolysis, isomerisation.
3.6 Organoborono routes to unsaturated hydrocarbons- synthesis of alkenes, alkynes, diynes, enynes.
3.7 Alkylboranes and boron enolates in organic synthesis, double asymmetric induction.  
3.8 Boronic ester homologation.

**Self study:**  
Silyl ketene acetals, regioselective electrophilic attack on alkynylsilanes,  
applications of boron compounds in asymmetric synthesis.

**UNIT 4: Redox reactions in organic synthesis**  
(15 hours)  
4.1 Oxidation of hydrocarbons, alcohols, carbon-carbon double bonds, diols, epoxides.  
4.2 Enantioselective epoxidation of allylic alcohols, diastereoselective epoxidation,  
ozonolysis.  
4.3 Oxidation of ketones – Baeyer-Villiger oxidation, oxidation with thallium(III)  
nitrate, selenium reagents and intermediates in organic synthesis, lead tetraacetate.  
4.4 Catalytic hydrogenation, selectivity of reduction, homogeneous hydrogenation,  
reduction by dissolving metals.  
4.5 Reduction by hydride transfer reagents – aluminium alkoxides, LAH, sodium  
borohydride, sodium cycnborohydride, trialkylborohydrides.  
4.6 Electrochemical organic synthesis  
**Self study:**  
Wolff-Kishner reduction, desulphurisation of thio-acetons, di-imide, low valent  
titanium species.

**UNIT 5: Selected Organic synthesis**  
(10 hours)  
Reagents for organic synthesis and their applications - Synthesis of Z-Heneicos-6-
en-11-one, Disparlure, Z-Jasmone, helicenes, annulenes, progesterone, cortisone  
and peptide synthesis.  
**Self study:**  
Wolff-Kishner reduction, desulphurisation of thio-acetons, di-imide, low valent  
titanium species.

**Reference books**

2. Ireland R.E, Organic synthesis, Prentice Hall India, Goel publishing house, 1990  
Objectives
1. To quantify bonding parameters in cubic and distorted geometries from electronic spectra.
2. To identify suitable coordination compounds for the construction of supramolecular assemblies and nanostructures.
3. To learn the methodology of constructing supramolecular assemblies with desired properties for specific application.
4. To identify complexes suitable for application in medicinal inorganic chemistry.
5. To set research goals in the highly topical areas of research in coordination and supramolecular chemistry.

Unit 1: Electronic Structure and Geometry of Coordination Compounds (15 h)
1.1 Electronic spectroscopy: crystal field spectra of $O_h$ and $T_d$ complexes, effect of distortion on the spectra, structural evidence from electronic spectra, evaluation of $\Delta_o$ and $\Delta_t$ values in Co(III) and Ni(II) $O_h$ and $T_d$ complexes, quantification of covalency-nephelauxetic ratio.
1.2 Tetragonal distortion in octahedral complexes and evaluation of $D_q^{xy}$ and $D_q^z$ in tetragonally distorted octahedral Co(III) complexes.
1.3 Nuclear magnetic resonance spectroscopy: application of spin-spin coupling to inorganic structural determinations, NMR spectra of quadrupolar nuclei, NMR of paramagnetic transition metal complexes: scalar shift and pseudocontact shift, scalar shift and covalency.
1.4 Electron spin resonance spectroscopy: hyperfine and zero field effects on the epr spectra of coordination compounds, ligand field interpretation of the $g$- and $A$-tensors, nuclear quadrupole interaction.
1.5 Mossbauer spectroscopy: quadrupole and magnetic interactions, isomer shift and site symmetry of metal ions in coordination compounds, Mossbauer emission spectroscopy and applications.

Self study
(a) Causes of tetragonal distortion in transition metal complexes and their effect on the electronic spectra.
(b) Effect of quadrupole nuclei on spin-spin splitting and hyperfine splitting.
(c) Causes of anisotropy and anisotropic $g$-values.

Unit 2: Supramolecular and Dendritic Chemistry (15 h)
2.1 Supramolecular assemblies and architectures: nature of supramolecular interactions, homo- and heteropolymetallic polypyridyl systems; supramolecular host-guest compounds.
2.2 Templates and self assembly: biochemical self-assembly, self-assembly in synthetic systems, self-assembling coordination compounds, catenanes and rotaxanes.
2.3 Supramolecular devices: photoinduced electron and energy transfer, photo- and electrochemical sensors, light conversion and energy transfer devices, molecular electronic devices (molecular switches, wires, and rectifiers), molecular machines.
2.4 Dendrimers and metalloendrimers: synthetic methodology-divergent and convergent methodologies; types of metalloendrimers, characterization techniques.
2.5 Dendrimer encapsulated metal nanoclusters: silver and gold nanoclusters and nanoparticles, quantum dots, quantum size related photochemical properties, dendrimer encapsulated catalysis.

Self study
(a) Terpyridine and bipyridine-appended spacers, phenazene based spacers.
(b) Different kinds of supramolecular assemblies constructed by covalent-, coordination-, and hydrogen bonding.

Unit 3: Electrochemistry and Photochemistry (12 h)
3.1 Intercomponent energy and electron transfer in supramolecular assemblies: role of bridging ligands.
3.2 Applications of cyclic voltammetry, and differential pulse voltammetry to the study of coordination compounds and metallosupramolecular assemblies: computation of electrochemical parameters and evaluation of reversibility of the redox processes.
3.3 Spectroelectrochemistry: optically transparent electrodes and cells, chronoabsorptometry.
3.4 Solar and renewable energy: light-to-chemical energy conversion in lamellar solids and thin films, solar energy conversion by dye-sensitized photovoltaic cells and by coordination compounds anchored onto semiconductor surfaces.
3.5 Photochemistry of lanthanide complexes: A-ET-E processes, NIR-to-visible photon upconversion, nonlinear optical behavior, exciton multiplication and relaxation dynamics in quantum dots and applications; optical fiber lasers and amplifiers containing lanthanide complexes.

Self study
(a) Causes of electrochemical irreversibility and coupled chemical reactions.
(b) Photochemistry of Ru(II) and Os(II) polypyridyl complexes and Jablonski diagram.
(c) Emission properties and applications of lanthanide emitters.

Unit 4: Bioinorganic and Medicinal Inorganic Chemistry (10 h)
4.1 The supramolecular chemistry of life: photosynthesis-biological photosynthesis, chemical approaches to artificial photosynthesis (light harvesting dendrimers and multiporphyrin arrays); Rhodopsin (a supramolecular photonic device); biochemical self-assembly.
4.2 Contrast enhancing agents for medical diagnostics: theory of MRI imaging, Gd-based contrast agents-synthesis and structural features; optical contrast agents-Ag and AuNPs; metal complexes as photosensitizers.
4.3 Metal complexes for radiotherapy; diagnostic radiopharmaceuticals, non-technitium for diagnostic imaging, Tc-labelled small molecules and peptides as diagnostic radiopharmaceuticals.
4.4 Targeted cancer nanotherapy: magnetic nanoparticles and cancer therapy; gold nanoparticles-tunable optical properties and in vivo cancer detection and therapy.

Self study
(a) Antenna effect and funneling of electronic energy in supramolecular assemblies.
(b) Generation of $^{99m}$Tc chelates.

Unit 5: Synthesis of Novel Coordination Compounds and Supramolecular Assemblies (8 h)
5.1 Templates and self-assembly: synthesis of Schiff base macrocycles and macrocyclic binucleating ligands by coordination template effects, self-assembling coordination compounds-design principles, molecular cubes, squares and boxes; self-assembly of metal arrays; catenanes and rotaxanes.
5.2 Polyazamacrocycles and macrocycles with pendant arms.
5.3 Construction of polynuclear supramolecular assemblies and nanostructures.

Self study
(a) Design of Robson-type compartmental Schiff base macrocycles derived from 2,6-diformyl-4-methylphenol and 2,6-diformylpyridine.
(b) Methods of self-assembling coordination compounds.

References
# CH – 1156: ADVANCED COORDINATION CHEMISTRY

<table>
<thead>
<tr>
<th>M.Phil. Chemistry</th>
<th>No. of Credits : 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester – I</td>
<td></td>
</tr>
<tr>
<td>Course : Subject Elective(ES)</td>
<td>No. of hours per week : 6</td>
</tr>
</tbody>
</table>

## Objectives:

03. To give the students an advanced insight into coordination chemistry

04. To make them familiarize with the structural, spectral and the reactivity of the coordination complexes

05. To introduce the features of organo-metallic and bio-inorganic metal centers and complexes

### 1. Synthesis of Novel Coordination Compounds 5 hrs

- a. Synthesis of macrocyclic ligands by schiff base condensation and by coordination template effects. Preparation of crown ethers
- b. Compartmental Ligands: design and synthesis of macrocyclic and nonmacrocyclic binucleating ligands and their complexes.
- c. Synthesis of triple decker sandwiches and cluster compounds

### 2. Determination of Electronic and Molecular Structure 25 hrs

- a. Electronic spectroscopy – Evaluation of $D_q^{av}$, $D_q^{xy}$ and $D_q^z$ values in cobalt(II) octahedral complexes and tetragonally distorted cobalt(II) octahedral complexes Evaluation of $D_q$ values in the nickel(II) octahedral complexes.
- c. Photoelectron and X-ray photoelectron spectroscopy – principle and applications.
- d. Application of Nuclear Magnetic Resonance Spectroscopy – fluxional behavior (temperature variation, NMR spectral studies), Nuclear Quadrupole Resonance Spectroscopy; relationship between electric field gradient and molecular structure, applications in inorganic and coordination complexes.
- e. Mossbauer Spectroscopy: Significance of Isomer shift and quadrupole splitting, applications to Fe and Sn complexes. Magnetic interactions, Method and two examples of single crystal X-ray analysis of coordination complexes. Significance and applications of EXAFS studies.
- f. Study of chiral coordination compounds by ORD and CD

### 3. Study of paramagnetic and Antiferro magnetic compounds 5 hrs

- a. Magnetic behavior of coordination compounds; Magnetic susceptibility and the geometry of the complexes. Anomalous behavior, Antiferro magnetic interactions, spin-crossover systems
4. **Kinetics of coordination complexes**  
   15 hrs
   b. Trans effect – Synthetic applications. Kinetics of hydrolysis and ligand exchange in square planar complexes.
   c. Inner sphere and outer sphere mechanisms.
   e. Organo metallic chemistry: Allyl complexes, metallo cenes, COT – preparation and properties. Alkenes metathesis, oligomerization Heterogenaiized homogenous catalysis - polynuclear supported catalysis. Sharpless epoxidation (Ti-isopropoxide, t-BuOOH), McMurry Coupling (TiCl4/LiAlH4), Pauson-Khand Reaction - Co2(CO)8, Dotz Reaction – Chromium Carbene, Heck Reaction – Pd(PPh3)4.
   f. Electrochemical methods of studying coordination compounds: Applications of – AC and DC polarography and cyclic voltammetry to coordination compounds. Electrochemical synthesis of complexes. Coupled chemical reactions; EC, CE and ECE mechanisms.

5. **Inorganic Biochemistry**  
   10 hrs
   a. Ferritin and transferritin, carboxypeptidase A, carbonic anhydrase, Blue copper protein, SOD.
   c. Nitrogen fixation and the role of metal ions. Photosynthesis - Photosystem I and Photosystem II.
   d. Essential and trace elements in biological systems, Chelate therapy.

**References:**
Objectives
1. To tackle rational synthesis to control size and shape of both organic and inorganic nanostructures.
2. To connect structure to function by design and extending function to dynamics of nanostructures.
3. To think about new functions for devices based on nanostructures.
4. To know the different kinds of nanoarchitectures and their synthesis and functions.
5. To understand the growing interest in using nanostructures for advanced medicine.

Unit 1: Fabrication and Patterning Nanostructures (15 h)
1. Preparation of nanostructures: nucleation and particle growth-sol process, sol-gel process, chemical precipitation, hydrothermal synthesis, pyrolysis, vapor deposition.
3. Nanofabrication by molding, embossing, and printing: hard pattern transfer elements-step-and-flash imprint lithography, nanoimprint lithography; soft pattern transfer elements-replica molding, solvent-assisted micromolding; electrical microcontact printing; nanotransfer printing.
4. Self-assembly for nanofabrication: nontemplated self-assembly, templated self-assembly, self-assembled monolayers (SAMs) of thiolates on metals-preparation of SAMs, mechanisms of assembly, SAMs as surface layers.
5. Surface modification of nanoparticles, characterization techniques-SEM, TEM, HRTEM, AFM, SAXS, LDI-MS, STM.

Self study
(a) Nanostructures of different shapes and their images.
(b) Growth mechanisms of nanostructures of different shapes.

Unit 2: Nanoarchitectures (10 h)
3. Control of dimensions: outer diameter, inner diameter, length, wall thickness.
5. Mechanical properties and technological applications of nanoarchitectures.

Self study
Inorganic and organic building blocks for the synthesis of various nanoarchitectures.

Unit 3: Devices Based on Nanostructures (10 h)
1. Molecular scale machines-interlocked macromolecules, polyrotaxanes.
2. Chemically-, electrochemically-, and photochemically controllable supramolecular complexes, molecular shuttles, and catenates.
3. Artificial molecular rotors: rotor behavior in non-interacting systems; interacting rotors; rotors in solution-propellers, gears, and cogwheels; rotation in nonsandwich...
porphyrins; rotations of molecular carousels (sandwich complexes); light-driven- and chemically driven molecular rotors.

3.4 Optical and electrical properties of nanoparticles: semiconductor quantum dots, quantum size effects and electron transition, NLO properties, photon upconversion and anti Stokes processes, electron-phonon relaxation.


Self study
(a) Template assembly of interlocked molecules.
(b) Lanthanide-d-metal and lanthanide-s-metal containing edifices.

Unit 4: Metalloendrimers, Nanoreactors, and Nanocatalysis

4.1 Dendrimers and metallodendrimers: evolution of dendrimers, synthetic methodology-divergent and convergent methodologies, types of metallodendrimers, characterization techniques.

4.2 Light harvesting dendrimers and photoactive metallodendrimers.

4.3 Dendrimer encapsulated metal nanoclusters: silver and gold nanoclusters and their chemical and photochemical properties.

4.4 Nanoreactors: molecular nanoreactors-molecular capsules and boxes, micelle-based systems, vesicle-based systems; macromolecular nanoreactors-polymersomes as nanoreactors, polymer micelles as nanoreactors, unimolecular nanoreactors.

4.5 Nanocatalysis: homogeneous catalysis-cross-coupling reactions, electron-transfer reactions, hydrogenation reactions, oxidation reactions; heterogeneous catalysis-reactions catalyzed by supported transition metal nanocatalysts.

4.6 Dendrimer-encapsulated catalysis-dendrimers with catalytically active cores, dendrimer nanoreactor, catalytically-active dendrimer-encapsulated MNPs.

Self study
Techniques of growing dendrimer-encapsulated AuNPs and AgNPs.

Unit 5: Nanostructures in Biology and Medical Technology

5.1 Biomacromolecular nanoreactors: protein cages, viruses-rod-shaped and cage-structured viruses.

5.2 Nanostructure-based detection methods: optical detection of nucleic acids, proteins, biologically relevant small molecules, metal ions; electrical- and electrochemical detection of nucleic acids; magnetic relaxation detection of nucleic acids, proteins, viruses.

5.3 Biological molecular machines: Myosin-structural aspects and chemomechanical properties; ATP Synthases-structure and chemomechanical properties of F_{1}-ATPase and F_{0}-ATPase rotors; purple photosynthetic bacteria-structure, light harvesting functions.

5.4 Fluorescence imaging: single-molecule fluorescence spectroscopy, confocal and two photon microscopy, fluorescent proteins, imaging studies of protein localization, imaging of cell signaling.

5.5 Targeted cancer nanotherapy: magnetic nanoparticles and cancer therapy; gold nanoparticles-tunable optical properties and in vivo cancer detection and therapy.
References
CH –1217 : PROJECT WORK AND DISSERTATION
M.Phil. Chemistry
Semester – II  
Course : Major Core(MC)  
No. of Credits : 17

Objectives

1. To introduce the purpose and importance of research for future development and sustenance.
2. To learn the ways of carrying out literature search for current awareness and for retrospective survey and to plan and carry out experimental work.
3. To know the methodology of writing thesis and journal articles.

The student is counseled regarding facilities available and the professors offering guidance. The student chooses the topic of project and the guide at the beginning of the semester. University rules are followed if the student needs extension of time to submit the dissertation.

Evaluation of the project report:

The controller of examination appoints an external examiner from the panel suggested by the department. The guide also functions as a co-examiner. Viva-voce is conducted.

Quality of work done and written report  50 marks
Oral presentation  25 marks
Viva-voce  25 marks

Total marks  100 marks