**CHOICE BASED CREDIT SYSTEM**

# Syllabus of M.Sc. Chemistry

**[Effective from the Academic Session 2021-2022]**

**JIS UNIVERSITY,**
81, Nilgunj Road, Agarpara
Kolkata -700109

## VISION OF THE UNIVERSITY

**To become a world leader by establishing centres of excellence in the fields of higher education, research, entrepreneurship and skill development**

## MISSION OF THE UNIVERSITY

**The mission of the University is to prepare quality human resource and develop innovative and ethical future leaders capable of managing institutions transform in a globally competitive environment**

## DEPARTMENT OF CHEMISTRY

### Vision

The vision of the department is to impart quality education through innovative teaching-learning and research, critical thinking, entrepreneurship, skill development, industrial competency and societal responsibilities.

### Mission

**M1:**Cultivate the interactive teaching-learning process by proper blending of traditional teaching methodology with modern technological evolution

**M2:** Marching towards academic excellence, outstanding research, and global strategic tie-up with government and industrial sectors to create a chemically literate society

**M3:** Exposing our students to all the facets of chemical sciences in such a manner that they can compete and embark upon the global challenges

**M4:** Encourage and nurture innovative thinking and thereby motivate towards research activities for the sustainable development and environmental protection

**M5:** Train and develop skilful human resources having moral values and ethics

UNIVERSITY

# M.Sc. Chemistry

## Program Educational Objectives (PEO's)

**PEO-1:** To build strong foundation in different branches of chemical sciences for higher studies keeping focuses on scientific reasoning and analytical problem solving with molecular perspective.

**PEO-2:** To develop and refine critical thinking towards problem solving skills and motivate them towards innovation which has societal impacts.

**PEO-3:** To produce skilled manpower with in depth knowledge about synthetic methodology and modern instrumentation techniques for conducting scientific research.

**PEO-4:** To convey chemical information to both professional networks and to the society effectively.

**PEO-5:** To nurture professional excellence, soft skills, moral values and ethics culminating to leadership qualities.

## Mapping of Departmental Mission Statements to PEO's

| | MISSION STATEMENT | PEO-1 | PEO-2 | PEO-3 | PEO-4 | PEO-5 |
|---|---|---|---|---|---|---|
| **M1** | Cultivate the interactive teaching-learning process by proper blending of traditional teaching methodology with modern technological evolution | **3** | **2** | **3** | **2** | **2** |
| **M2** | Marching towards academic excellence, outstanding research, and global strategic tie-up with government and industrial sectors to create a chemically literate society | **2** | **3** | **2** | **3** | **2** |
| **M3** | Exposing our students to all the facets of chemical sciences in such a manner that they can compete and embark upon the global challenges | **3** | **2** | **3** | **3** | **3** |
| **M4** | Encourage and nurture innovative thinking and thereby motivate towards research activities for the sustainable development and environmental protection | **2** | **3** | **3** | **2** | **2** |
| **M5** | Train and develop skilful human resources having moral values and ethics | **2** | **2** | **3** | **2** | **3** |

**Program Specific Objectives (PSOs)**

Upon completion of M.Sc. Chemistry programme, graduates will be able to………..

**PSO-1:** Apply advanced knowledge of chemical science to solve multifaceted problems to improve human life.

**PSO-2:** Design scientific experiments, synthesize, characterize, analyze, and interpret data to provide evidence-based solutions for local and global problems related to interdisciplinary and multidisciplinary areas of chemical sciences.

**PSO-3:** Perform experiments / research to solve practical problems independently / as a member of a team and communicate the results of scientific work in oral, written and ICT formats to both scientific community and society.

**PSO-4:** Demonstrate knowledge and skills in analyzing and identifying entrepreneur opportunities.

## Mapping of Departmental Mission Statements to PSO's

| | MISSION STATEMENT | PSO-1 | PSO-2 | PSO-3 | PSO-4 |
|---|---|---|---|---|---|
| **M1** | Cultivate the interactive teaching-learning process by proper blending of traditional teaching methodology with modern technological evolution | **3** | **2** | **2** | **2** |
| **M2** | Marching towards academic excellence, outstanding research, and global strategic tie-up with government and industrial sectors to create a chemically literate society | **2** | **3** | **2** | **2** |
| **M3** | Exposing our students to all the facets of chemical sciences in such a manner that they can compete and embark upon the global challenges | **3** | **3** | **3** | **2** |
| **M4** | Encourage and nurture innovative thinking and thereby motivate towards research activities for the sustainable development and environmental protection | **3** | **3** | **3** | **2** |
| **M5** | Train and develop skilful human resources having moral values and ethics | **3** | **2** | **2** | **3** |

## Programme Outcomes (POs)

**PO-1: Domain knowledge**

Demonstrate comprehensive knowledge and skills in chemistry to discover, interpret and solve the molecular and industrial problems

**PO-2: Planning and Critical thinking**

Develop eco-friendly protocols/procedures for industrial needs that provide sustainable chemical approach towards planning and execution of research in frontier areas of chemical sciences

**PO-3: Problem Analysis & Solving**

Apply knowledge to identify the problem and experimental skills to synthesize, characterize, and analyze chemicals/materials of immediate need for the society

**PO-4: Experimentation/Investigation**

An ability to conduct investigations/experiments in the field of organic, inorganic, physical, materials, polymer, supramolecular, biophysical, biochemical, biotechnological, nuclear, medicinal, industrial chemistry to reach valid conclusions considering the public health, safety and environmental issues.

**PO-5: Research Ability**

An ability to find solutions for complex molecular and industrial problems which will be cost effective, green and environment friendly.

**PO-6: Modern instrumentation**

An ability to operate modern analytical, microscopic and spectroscopic tools to analyze structure, bonding, reactivity, size, shape, and constituents of the samples.

**PO-7: Leadership skills**

Ability to work effectively and respectfully as an individual as well as part of a team.

**PO-8: Environment and sustainability**

An understanding of the roles and responsibilities as chemical professional in society, to protect the public interest and environment of the planet.

**PO-9: Ethics and equity**

An ability to maintain professional ethics, accountability, and equity in their profession.

**PO-10: Communication**

An ability to disseminate domain knowledge effectively among the scientific bodies, and society. Such ability includes reading, writing, speaking and listening, along with proper documentation and presentation.

**PO-11: Project management**

An ability to submit and run the academic and industrial projects with proper budget planning, which includes financial viability, business strategy, risk management and understanding the limitations of the industry.

**PO-12: Life-long learning**

An ability to acquire knowledge independently through self-learning to meet personal development in respect to updating in domain knowledge, skill development and adaptability with ever changing technology.

**MAPPING OF PEO WITH PROGRAMME OUTCOMES (POs)**

| PO / PEO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PEO-1** | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | - | 2 | 2 |
| **PEO-2** | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | - | - | 2 | 2 |
| **PEO-3** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| **PEO-4** | 2 | - | - | - | 2 | 1 | 2 | - | 1 | 3 | 2 | 1 |
| **PEO-5** | 2 | 2 | - | - | - | 2 | 3 | 2 | 3 | 2 | 2 | 2 |

# COURSE CURRICULUM

# M.Sc. CHEMISTRY

| CREDIT DISTRIBUTION ACROSS THE COURSE | | | | |
|---|---|---|---|---|
| **Course Type** | **Total Papers** | **Credit** | | **Credit** |
| | | **Theory** | **Practical** | |
| CORE COURSES (CC) | 15 | $8 \times 4 = 32$ | $6 \times 2 = 12$<br>$1 \times 6 = 6$ | $32 + 18 = 50$ |
| SPECIAL PAPERS | 4 | $3 \times 4 = 12$ | $1 \times 4 = 4$ | $12 + 4 = 16$ |
| ELECTIVE PAPERS | 3 | $3 \times 2 = 6$ | 0 | 6 |
| CBCS | 2 | $2 \times 4 = 8$ | 0 | 8 |
| | | | **Total Credit** | **80** |
| **NON-CGPA** | | | | |
| AECC | 8 | $1 \times 8 = 8$ | | 8 |
| | | | **Grand Total Credit** | **88** |

**Abbreviations Used:**

CC = CORE COURSES
CBCS = GENERAL ELECTIVES
AECC = ABILITY ENHANCEMENT COMPULSORY COURSES
NON-CGPA = NON CREDIT COURSES

| CREDIT AND MARKS DISTRIBUTION ACROSS THE COURSE | | |
|---|---|---|
| **SEMESTER** | **CGPA CREDIT** | **MARKS** |
| I | 22 | 550 |
| II | 22 | 550 |
| III | 18 | 450 |
| IV | 18 | 450 |
| **TOTAL** | **80** | **2000** |
| | | |
| **SEMESTER** | **NON CGPA CREDIT** | **MARKS** |
| I | 2 | 50 |
| II | 2 | 50 |
| III | 2 | 50 |
| IV | 2 | 50 |
| **TOTAL** | **8** | **200** |

| SEMESTER WISE CREDIT/MARKS DISTRIBUTION<br>SEMESTER I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **COURSE TYPE** | **SUBJECT CODE** | **SUBJECT NAME** | **L** | **T** | **P** | **CREDIT** | **CONTACT HOURS** | **MARKS DISTRIBUTION** |
| CC | PCH1001 | Inorganic Chemistry I | **4** | **0** | **0** | 4 | 4 | 100 |
| CC | PCH1002 | Organic Chemistry I | **4** | **0** | **0** | 4 | 4 | 100 |
| CC | PCH1003 | Physical Chemistry I | **4** | **0** | **0** | 4 | 4 | 100 |
| CC | PCH1101 | Inorganic Chemistry I Practical | **0** | **0** | 2 | 2 | 3 | 50 |
| CC | PCH1102 | Organic Chemistry I Practical | **0** | **0** | 2 | 2 | 3 | 50 |
| CC | PCH1103 | Physical Chemistry I Practical | **0** | **0** | 2 | 2 | 3 | 50 |
| CBCS 1 | **** | **** | **4** | **0** | **0** | 4 | 4 | 100 |
| | | **Total** | **16** | **0** | **6** | **22** | **25** | **550** |
| **NON-CGPA** | | | | | | | | |
| AECC-1 | PCH1501 | Seminar, Moocs & Other Activities | **0** | **0** | **1** | 1 | 1 | 25 |
| AECC-2 | PCH1502 | Skillx & NSS | **0** | **0** | **1** | 1 | 1 | 25 |
| | | **Total** | **16** | **0** | **8** | **24** | **27** | **600** |

| SEMESTER WISE CREDIT/MARKS DISTRIBUTION<br><br>SEMESTER II | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **COURSE TYPE** | **SUBJECT CODE** | **SUBJECT NAME** | **L** | **T** | **P** | **CREDIT** | **CONTACT HOURS** | **MARKS DISTRIBUTION** |
| CC | PCH2001 | Inorganic Chemistry II | **4** | **0** | **0** | 4 | 4 | 100 |
| CC | PCH2002 | Organic Chemistry II | **4** | **0** | **0** | 4 | 4 | 100 |
| CC | PCH2003 | Physical Chemistry II | **4** | **0** | **0** | 4 | 4 | 100 |
| CC | PCH2101 | Inorganic Chemistry II Practical | **0** | **0** | 2 | 2 | 3 | 50 |
| CC | PCH2102 | Organic Chemistry II Practical | **0** | **0** | 2 | 2 | 3 | 50 |
| CC | PCH2103 | Physical Chemistry II Practical | **0** | **0** | 2 | 2 | 3 | 50 |
| CBCS 2 | **** | **** | **4** | **0** | **0** | 4 | 4 | 100 |
| | | **Total** | **16** | **0** | **6** | **22** | **25** | **550** |
| **NON-CGPA** | | | | | | | | |
| AECC-3 | PCH2501 | Seminar, Moocs & Other Activities | **0** | **0** | **1** | 1 | 1 | 25 |
| AECC-4 | PCH2502 | Skillx & NSS | **0** | **0** | **1** | 1 | 1 | 25 |
| | | **Total** | **16** | **0** | **8** | **24** | **27** | **600** |

**SEMESTER WISE CREDIT/MARKS DISTRIBUTION**

**SEMESTER III**

| COURSE TYPE | SUBJECT CODE | SUBJECT NAME | L | T | P | CREDIT | CONTACT HOURS | MARKS DISTRIBUTION |
|---|---|---|---|---|---|---|---|---|
| CC | PCH3001 | Principles And Applications Of Molecular Spectroscopy | **4** | **0** | **0** | 4 | 4 | 100 |
| SPECIAL 1 | PCH3002/ PCH3003/ PCH 3004 | Special Paper I Inorganic/Organic/Physical | **4** | **0** | **0** | 4 | 4 | 100 |
| SPECIAL 2 | PCH3005/ PCH3006/ PCH3007 | Special Paper II Inorganic/Organic/Physical | **4** | **0** | **0** | 4 | 4 | 100 |
| ELECTIVE 1 | PCH3008/ PCH3009 | Supramolecular Chemistry And Drug Design / Nuclear Chemistry | **2** | **0** | **0** | 2 | 2 | 50 |
| SPECIAL 3 | PCH3101/ PCH3102/ PCH3103 | Special Paper III Inorganic Special Practical/Organic Special Practical /Physical Special Practical | **0** | **0** | **4** | 4 | 6 | 100 |
| | | **Total** | **14** | **0** | **4** | **18** | **20** | **450** |
| **NON-CGPA** | | | | | | | | |
| AECC-5 | PCH3501 | Seminar, Moocs & Other Activities | **0** | **0** | **1** | 1 | 1 | 25 |
| AECC-6 | PCH3502 | Skillx & NSS | **0** | **0** | **1** | 1 | 1 | 25 |
| | | **Total** | **14** | **0** | **6** | **20** | **22** | **500** |

### ❖ SPECIALIZATION PAPER I

PCH3002: Advanced Bioinorganic and Organometallics

PCH3003: Advanced Organic Synthesis I

PCH3004: Advanced Quantum Mechanics

### ❖ SPECIALIZATION PAPER II

PCH3005: Advanced Topics in Inorganic Chemistry I

PCH3006: Biomolecules and Pericyclic Reaction

PCH3007: Solid State Chemistry

### ❖ SPECIALIZATION PAPER III

PCH3101: Inorganic Special Practical

PCH3102: Organic Special Practical

PCH3103: Physical Special Practical

### ❖ ELECTIVE PAPER I

PCH3008: Supramolecular Chemistry and Drug Design

PCH3009: Nuclear Chemistry

**SEMESTER WISE CREDIT/MARKS DISTRIBUTION**

**SEMESTER IV**

| COURSE TYPE | SUBJECT CODE | SUBJECT NAME | L | T | P | CREDIT | CONTACT HOURS | MARKS DISTRIBUTION |
|---|---|---|---|---|---|---|---|---|
| CC | PCH4001 | Spectroscopy For Structure Elucidation | 4 | 0 | 0 | 4 | 4 | 100 |
| SPECIAL 4 | PCH4002/ PCH4003/ PCH4004 | Special Paper IV Inorganic/Organic/Physical | 4 | 0 | 0 | 4 | 4 | 100 |
| ELECTIVE 2 | PCH4005/ PCH4006/ PCH4007 | Polymer Chemistry / Advanced Spectroscopy/ Medicinal Chemistry | 2 | 0 | 0 | 2 | 2 | 50 |
| ELECTIVE 3 | PCH4008/ PCH4009/ PCH4010 | Materials Chemistry/ Industrial Chemistry/ Applied Electrochemistry | 2 | 0 | 0 | 2 | 2 | 50 |
| CC | PCH4101 | Project | 0 | 0 | 6 | 6 | 9 | 150 |
| | | **Total** | **12** | **0** | **6** | **18** | **21** | **450** |
| **NON-CGPA** | | | | | | | | |
| AECC-7 | PCH4501 | Seminar, Moocs & Other Activities | 0 | 0 | 1 | 1 | 1 | 25 |
| AECC-8 | PCH4502 | Skillx & NSS | 0 | 0 | 1 | 1 | 1 | 25 |
| | | **Total** | **12** | **0** | **8** | **20** | **23** | **500** |

## ❖ SPECIALIZATION PAPER IV

PCH4002: Advanced Topics in Inorganic Chemistry II
PCH4003: Advanced Organic Synthesis II
PCH4004: Electrochemistry and Statistical Mechanics

## ❖ ELECTIVE PAPER II

PCH4005: Polymer Chemistry
PCH4006: Advanced Spectroscopy
PCH4007: Medicinal Chemistry

## ❖ ELECTIVE PAPER III

PCH4008: Materials Chemistry
PCH4009: Industrial Chemistry
PCH4010: Applied Electrochemistry

# Detailed Syllabus of First semester

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH1001 | | | |
| **Course Title** | Inorganic Chemistry I | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge in Inorganic Chemistry | | | |

**COURSE OBJECTIVES**

- To develop fundamental theoretical foundation in group theory
- To develop the basics of coordination chemistry and magnetic properties of coordination compounds
- To understand the fundamentals of electronic spectra of transition metal complexes
- To know about the different environmental pollutants

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Construct the character table of a given compound and interpret characteristics properties following great orthogonality theorem

**CO2:** Understand the basics of coordination chemistry including coordination numbers, geometry, and chelate effect and describe the bonding theories VBT, CFT, and MOT in turn describe CFSE, high and low spin complexes, magnetic moment of coordination compounds

**CO3:** Interpret the electronic spectra of coordination compounds explaining color, allowed and forbidden transitions through Orgel and Tanabe-Sugano diagrams

**CO4:** Familiarize the basics of Environmental chemistry and its numerous facets

**COURSE CONTENT**

**Module I: Elements of Group Theory** **12L**

Symmetry elements (operations), Point group determination. Concept of groups and how it is related to chemistry. Groups, subgroups, classes, cyclic groups, group multiplication table. Matrix representation of symmetry elements. Construction of character tables. Character tables properties with the help of great orthogonality theorem. Splitting of orbitals in different symmetries. Mulliken symbols and their significance (A, B, E, T and their superscript subscripts).

**Module II: Coordination Chemistry** **12L**

Crystal field theory, Splitting of d orbitals in linear, triangular, tetrahedral, square planar, trigonal bipyramidal, square pyramidal, octahedral and pentagonal bipyramidal fields of similar and dissimilar ligands. Kinetic aspects of crystal field stabilization, crystal field activation energy, labile and inert complexes. Limitations of CFT, evidences of metal-ligand orbital overlap, nephelauxetic series; spectrochemical series. Magnetic properties – elementary idea.

**Module III: Electronic Spectra of Transition Metal Complexes** **12L**

Electronic spectra of transition metal complexes – determination of free ion terms, microstates, determination of ground and all excited state terms of $d^n$ terms in octahedral and tetrahedral fields, Orgel diagrams (qualitative approach), hole formalism, inversion and equivalence relations, selection rules for spectral transitions, d-d spectra and crystal field parameters, Nephelauxetic series, qualitative idea of Tanabe–Sugano diagrams, charge transfer spectra.

**Module IV: Environmental Chemistry** **12L**

*Air pollution:* major air pollutant, Greenhouse effect, mechanistic pathways of smog formation and ozone hole, acid rain, global warming, technology of air pollution abatement.

*Water pollution:* classification of water pollutants, characteristics of waste water, water quality parameters and their measurements, biochemical effects of As, Pb, Cd, Hg and their chemical speciation, eutrophication, waste water treatment: preliminary, primary, secondary, and tertiary treatment.

*Soil pollution:* chemical composition of the soil, the exploitation of the mineral resources and abuse of the earth, soil pollution due to natural and artificial agencies and its effects, remedial measures to check the pollution.

**Text/Reference Books**

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John Wiley & Sons, New York.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, Principles of structure and reactivity, Harper Collins 1993.
3. R. S. Drago, Physical Methods in Inorganic Chemistry, International Edn. (1971), Affiliated East-West Press, New Delhi.
4. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, W. B. Sauders Com. (1987), Hong Kong.
5. B.N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd. New Delhi (1976).
6. D. J. Newman, Betty, Crystal Field, Science, 2000
7. M. Chanda, Structure and Chemical bond, Tata McGraw Hill Atomic Edition, 2000.
8. D. F. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, Oxford University Press, 1990.
9. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd Edition (1976), John Wiley, New York.
10. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.

11. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
12. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Edition (1990), Saunders Holt, London.
13. Mani Vasakam, Physico Chemical Examination of Water, Sewage and Industrial effluents, Pragati Prakashan, 1991
14. F. W. Fifield and W. P. J. Hairens, Environmental Analytical Chemistry, 2nd Edition (2000), Black Well Science Ltd.
15. Colin Baird, Environmental Chemistry, W. H. Freeman and Company, New York (1995).
16. A. K. De, Environmental Chemistry, 4th Edition (2000), New Age International Private Ltd., New Delhi.
17. Peter O. Warner, Analysis of Air Pollutants, 1st Edition (1996), John Wiley, New York.
18. S. M. Khopkar, Environmental Pollution Analysis, 1st Edition (1993), Wiley Eastern Ltd., New Delhi.
19. S. K. Banerji, Environmental Chemistry, 1st Edition (1993), Prentice-Hall of India, New Delhi.

## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **3** | **-** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **2** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **2** | **3** | **2** | **2** | **2** | **-** | **-** | **2** | **-** | **-** | **2** |
| **CO4** | **2** | **-** | **-** | **-** | **2** | **3** | **2** | **-** | **-** | **-** | **2** | **1** |

| Course Code | PCH1002 | | | |
|---|---|---|---|---|
| Course Title | Organic Chemistry I | | | |
| Category | Science | | | |
| LTP & Credits | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| Total Contact Hours | 48 | | | |
| Pre-requisites | Fundamental knowledge in Organic Chemistry | | | |

**COURSE OBJECTIVES**

- To learn the concept of aromaticity and reactions of aromatic compounds
- To understand and apply various concepts such as stereochemistry and fundamental principles of stereoselectivity in organic chemistry
- To learn the basics of reaction mechanism and the mechanistic concepts of substitution, elimination and addition reactions

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Apply the concept of aromaticity and reactions of aromatic compounds

**CO2:** Understand the stereochemistry of organic molecules in detail.

**CO3:** Illustrate the reaction mechanism aspects in the context of addition, elimination and substitution reactions and assess the structural effects of organic molecules and functional groups on the tendency to participate in various types of organic reactions.

**COURSE CONTENT**

**Module I: Aromaticity** **8L**

Huckel's rule, concept of aromaticity in benzenoid and nonbenzenoid systems, alternate and non-alternante hydrocarbons, annulenes, heteroannulenes, fullerenes, anti-aromaticity, pseudo-aromaticity, homo-aromaticity.

**Module II: Stereochemistry** **18L**

Different projection formulae and their interconversions. Conformational and configurational enantiomers. Stereochemical nomenclatures: (E, Z), chiral centre, chiral axis, chiral plane, helicity, threo-erythro, pref-parf, chiral simplex. Stereogencity and chirotopicity. Symmetry and molecular chirality. point group, *conformation:* conformational analysis of acyclic, cyclic, fused, spiro and bridged bicyclo-systems with typical examples. Computation of stereoisomers of different systems. Conformation and relative reactivity of diastereomers. 2-, 3-, and 4- Alkyl ketone effects. Stereoisomerism, configuration: relative and absolute, determination of relative configuration: Prelog's rule, Cram's rule, Felkin and Karabatsos and Sharpless rule.

**Module III: Reaction Mechanism** **22L**

Concise review on nucleophilic, electrophilic substitution reactions, and elimination reactions, neighbouring group participation: the phenonium ion, participation by π and σ bonds, Anchimeric assistance, classical versus non-classical carbonium ions- the present status.

*Addition to carbon-carbon multiple bonds*: mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity, hydrogenation, hydroboration reaction.

*Addition to carbon-hetero multiple bonds:* mechanism of metal hydride reaction of substituted and unsubstituted carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organocopper, organozinc, organolithium and organosilane reagents to saturated and unsaturated carbonyl compounds.

**Text/Reference Books**


1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
4. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
5. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd Edition (1994), Wiley Eastern Ltd., New Delhi.
6. E.L. Eliel, S.H. Wilen and L.N. Mander, Stereochemistry of Organic Compounds, Wiley Interscience, New York (2004).


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **-** | **1** | **-** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **3** | **1** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **3** | **-** | **3** | **2** | **2** | **2** | **2** | **-** | **2** | **-** | **-** | **2** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH1003 | | | |
| **Course Title** | Physical Chemistry I | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge in Physical Chemistry | | | |

## COURSE OBJECTIVES

- To learn the essential concepts and applications of thermodynamics and their molecular interpretations from statistical thermodynamics
- To develop advanced concepts of chemical kinetics and establish the relations among theories of unimolecular reactions
- To understand the fundamentals of surface chemistry in terms of adsorption and micelles
- To impart correctness and depth of sophistication of conceptual arguments in context of Physical Chemistry

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Apply the fundamental and advanced concepts of classical thermodynamics, statistical thermodynamics, chemical kinetics and surface chemistry to solve the real life problems

**CO2:** Explain the origin of partial molar quantities, residual entropy, Gibb's paradox, interrelations among distribution laws, fast reaction kinetics, and formation of micelles

**CO3:** Evaluate the numerical problems based on thermodynamics, statistical thermodynamics, and chemical kinetics

**CO4:** Identify the parameter responsible for micellization, factors affecting critical micellization concentration of surfactants and Kraft temperature

## COURSE CONTENT

**Module-I: Thermodynamics** **10L**

Concise review of thermodynamics, concept of partial molar quantities and their significances, Nernst heat theorem, consequences of Nernst heat theorem, entropy and third law of thermodynamics: determination of absolute entropy, concept and significance of residual entropy.

**Module-II: Statistical Thermodynamics** **12L**

Thermodynamic probability and entropy, distribution laws: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac, concept of partition function: rotational, translational, vibrational and electronic partition functions of diatomic molecules, concept of ensembles, relation between partition functions with various thermodynamic functions, Gibb's paradox.

**Module-III: Chemical Kinetics** **16L**

Concise review of chemical kinetics, fast reactions: luminescence and energy transfer processes, kinetics study of fast reactions by stopped–flow and relaxation, and flash photolysis methods.

Rate equations of photochemical, chain and oscillatory reactions, thermodynamic treatment of transition state theory, theories of unimolecular reactions: Lindemann-Christiansen hypothesis, Hinshelwood, Rice-Ramsperger- Kassel (RRK), and Rice- Ramsperger-Kassel-Marcus (RRKM).

**Module-IV: Surface Chemistry** **10L**

*Adsorption:* different types of adsorption, absorption versus adsorption, different adsorption isotherms, unimolecular and bimolecular surface reaction, activation energy of such reactions, volcano curve.

*Transition state theory of surface reactions:* rates of chemisorptions and desorption, unimolecular and bimolecular surface reaction.

*Micelles:* Surface active agents and their classifications, micellization, factors affecting cmc of surfactants. Thermodynamics of micellization: phase separation and mass action models. Emulsions and reverse micelle.

**Text/Reference Books**


1. G.W. Castellan, Physical Chemistry, 3rd Edition, Narosa Publishing House
2. P.W. Atkins, Physical Chemistry, 8th Editions, Oxford University Press, New York
3. K.J. Lailder, Chemical Kinetics, 3rd Edition, Pearson
4. I.N. Levine, Physical Chemistry, 5th Edition, Tata McGraw Hill Publication Co, Ltd, New Delhi
5. B.K. Agarwal and M. Eisner, Statistical Mechanics, Wiley Eastern, New Delhi
6. D.A. Mcquarrie, Statistical Mechanics, California University Science Books
7. R. K. Patharia, Statistical Mechanics, Butterworth, Heinemann, Elsevier
8. Y. Moroi, Micelles: Theoretical and Applied Aspects, Plenum Press, New York (1992)
9. T. Engel, P. Reid, Thermodynamics, Statistical thermodynamics and Kinetics, Pearson
10. E. S. R. Gopal, Statistical Mechanics and Properties of Matter, Ellis Horwood, England, 1974.


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 2 | - | - | - | - | - | 2 | 2 |
| CO2 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 2 |
| CO3 | 2 | 3 | 3 | - | 2 | - | - | - | - | - | - | 2 |
| CO4 | 2 | - | 2 | - | 2 | - | - | 1 | - | - | - | 1 |

| Course Code | PCH1101 | | | |
|---|---|---|---|---|
| Course Title | Inorganic Chemistry I Practical | | | |
| Category | Science | | | |
| LTP & Credits | L | T | P | Credits |
| | 0 | 0 | 3 | 2 |
| Total Contact Hours | 36 | | | |
| Pre-requisites | Fundamental knowledge in Inorganic Chemistry | | | |

## COURSE OBJECTIVES

- To conduct chemical analyses by quantitative analysis of metal
- To conduct the experiments for the preparation, characterization of metal complexes
- To conduct separation and estimation of amount of metal ions in binary metal ion mixture

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Prepare the exact solutions for quantitative analysis and quantify the metal ions in binary mixture by complexometric titrations
**CO2:** Synthesize, purify and characterize inorganic complexes
**CO3:** Separate and estimate binary mixture through ion-exchange chromatography
**CO4:** Identify respective cations or anions in a mixture by paper chromatography

## COURSE CONTENT

- Quantitative analysis of metal ions in binary mixture by complexometric titrations
- Synthesis and characterization of different coordination complexes
- Separation and estimation of binary mixtures by ion-exchange method
- Separation of cations or anions in a mixture by paper chromatography

## Text/Reference Books


1. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
2. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
3. G. N. Mukherjee, Handbook of Practical Chemistry


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **2** | **3** | **-** | **2** | **-** | **-** | **-** | **-** | **2** | **2** |
| **CO2** | **3** | **2** | **-** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **2** | **2** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO4** | **2** | **-** | **2** | **3** | **2** | **-** | **-** | **1** | **-** | **-** | **-** | **1** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH1102 | | | |
| **Course Title** | Organic Chemistry I Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 3 | 2 |
| **Total Contact Hours** | 36 | | | |
| **Pre-requisites** | Fundamental knowledge in Organic Chemistry | | | |

## COURSE OBJECTIVES

- Impart training in synthesis of organic molecules and in analysis of chemical and instrumental methods.
- Understand importance of different instrumental methods in chemical analysis of materials.

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Separate the organic solids and their qualitative analysis and identification of functional groups

**CO2:** Demonstrate purification of organic liquids using fractional & vacuum distillations

## COURSE CONTENT

- Detection and identification of organic compounds (solid/liquid) through chemical test.
- Separation of binary mixtures of solid-solid/liquid-solid/liquid-liquid organic compounds and identification of individual components

## Text/Reference Books


1. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
2. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
3. G. N. Mukherjee, Handbook of Practical Chemistry
4. A.I. Vogel, A Textbook of Practical Organic Chemistry


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **-** | **3** | **2** | **1** | **2** | **2** | **-** | **-** | **2** | **2** |
| **CO2** | **2** | **-** | **3** | **2** | **2** | **-** | **1** | **1** | **-** | **-** | **-** | **2** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH1103 | | | |
| **Course Title** | Physical Chemistry I Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 3 | 2 |
| **Total Contact Hours** | 36 | | | |
| **Pre-requisites** | Fundamental knowledge in Physical Chemistry | | | |

## COURSE OBJECTIVES

- To provide hand-on training about how to set up physical chemistry experiments
- To enable problem solving ability and to interpret the experimentally obtained data

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Design experiments in chemical kinetics, adsorption, thermochemistry and surface chemistry utilizing modern instruments
**CO2:** Determine the rate constant acid/base catalyzed hydrolysis of ester at different temperature and thereby evaluate the energy of activation
**CO3:** Construct phase diagram of water, acetic acid, and benzene
**CO4:** Analyze and interpret the experimental data

## COURSE CONTENT

- Determination of specific rate constant of acid catalyzed hydrolysis of ester at two different temperature and evaluate the corresponding thermodynamic parameters
- Compare the strength of acids (HCl vs $H_2SO_4$) by studying the hydrolysis of ester
- Evaluate the energy of activation for saponification of ester
- Determination of rate constant of acid catalyzed hydrolysis of sucrose by a polarimeter
- To construct the phase diagram of three component systems
- Determination of heat of solution of oxalic acid from its solubility at different temperature
- Determination of isoelectric point
- Verification of adsorption isotherm by adsorption of acetic acid on charcoal
- Any other experiments related to thermodynamics, kinetics, adsorption and micelle performed in the laboratory during the semester

## Text/Reference Books

1. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
2. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry

3. G. N. Mukherjee, Handbook of Practical Chemistry
4. A.I. Vogel, A Textbook of Practical Organic Chemistry
5. A. M. James, F. F. Prichard, Practical Physical Chemistry
6. Shoermaker, Garland, Experimental Physical Chemistry

## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **2** | **2** | **3** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **2** | **-** | **3** | **2** | **-** | **-** | **2** | **2** | **-** | **-** | **2** | **-** |
| **CO3** | **2** | **-** | **-** | **3** | **2** | **-** | **2** | **2** | **-** | **-** | **1** | **-** |
| **CO4** | **2** | **-** | **3** | **2** | **2** | **-** | | | **-** | **-** | **-** | **2** |

# Detailed Syllabus of Second semester

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH2001 | | | |
| **Course Title** | Inorganic Chemistry II | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of inorganic chemistry and quantum mechanics | | | |

## COURSE OBJECTIVES

- To develop strong theoretical foundation in chemical bonding, organometallics, bioinorganic and analytical chemistry
- To interpret the properties of lanthanides and actinides
- Enable students to apply modern concepts and instrumentations to perform research in academics as well as in industry

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Understand the quantum mechanical interpretation of VBT, MO and Huckel theory in the context of chemical bonding

**CO2:** Demonstrate the spectral and magnetic properties of Lanthanides and Actinides

**CO3:** Explain substitution, oxidative addition, reductive elimination, electrophilic and nucleophilic reactions in terms of organometallic compounds

**CO4:** Unravel and interpret the functions of metal ions in biological systems through electron transfer, oxygen transport, oxygen storage and oxygen activation processes

**CO5:** Classify boranes in terms of closo, nido, arachno-borane and will evaluate Styx number of neutral and boron hydrides

**CO6:** Apply the modern instrumentation techniques to characterize the samples and operate the same in the academic and industrial research

**COURSE CONTENT**

**Module-I: Quantum Mechanical approach to Chemical Bonding 10L**

Valence bond theory for $H_2$ molecule. LCAO-MO and Huckel approximation to $H_2^{2+}$, $H_2$, homo and hetero diatomic, triatomic and polyatomic molecules/ions, application of V.B. and M.O. theories to diatomic and polyatomic molecules. Secular determinants, Koopmans' theorem, Molecular term symbols for homonuclear diatomic. Secular determinants construction for organic resonating $\pi$- systems (cyclic and non cyclic).

**Module-II: Chemistry of f-Block Elements 6L**

Lanthanide and actinide elements: terrestrial abundance and distribution, relativistic effect, variation of atomic and ionic radius, ionization energy, electronic configuration and oxidation states, magnetic properties, electronic spectra, aqueous and complex chemistry in different oxidation states, use of lanthanide compounds as NMR-shift reagent.

**Module-III: Organometallics-I 8L**

Concepts of 16 and 18 electrons rule for organometallic compounds and their applications. Reaction of organometallic complexes: substitution, oxidative addition, reductive elimination, insertion and elimination, electrophilic and nucleophilic reactions of coordinated ligands. Stereochemical non-rigidity and fluxional behaviour of organometallic compounds.

**Module-IV: Bioinorganic Chemistry-I 8L**

Role of alkali and alkaline earth metal ions in biology; $Na^+$-$K^+$ Pump, ionophores and crown ethers. Metal site structure, function. Electron Transfer: Cytochromes, Iron-Sulfur Proteins and Copper Proteins. Oxygen transport and storage: Hemoglobin, myoglobin, hemerythrin, hemocyanin. Oxygen activation: Cytochrome P450, Cytochrome c oxidase. Chlorophyll and photosynthesis; PS-I, PS-II, oxygen evolving center.

**Module-V: Structure and Bonding in Boranes 6L**

Structure and bonding of higher boranes, Lipscomb's tropological diagrams and Wade's rules. Geometric and electronic structure, three-, four- and higher connect clusters, the *closo, nido, arachno*-borane structural paradigm, Styx No. of neutral and boron hydrides, Structure, synthesis and reactivity of the borane compounds.

**Module-VI: Analytical Chemistry 10L**

Principle and application of Chromatography: thin-layer chromatography, size-exclusion chromatography, ion chromatography, gas chromatography, high performance Liquid chromatography and supercritical fluid chromatography.

Theory, instrumentation and applications of voltammetry, linear sweep voltammetry, anodic stripping voltammetry, cyclic voltammetry, amperometry, coulometry, electrogravimetry and polarography.
Theory, methodology and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), and differential scanning calorimetry (DSC).

**Text/Reference Books**


1. F. A. Cotton, Chemical Applications of Group Theory
2. R. H. Crabtree, The Organometallic Chemistry of Transition Metals
3. B.D.Gupta and A.J. Elias, Basic Organometalltic Chemistry
4. I. Bertini, H. B. Grey, S. J. Lippard, J. S. Valentine, Bioinorganic Chemistry
5. Asim K. Das, Bioinorganic Chemistry
6. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, $2^{nd}$ Edition (1976), John Wiley, New York.
7. G. D. Christian, Analytical Chemistry, $5^{th}$ Edition (1994), John Wiley & Sons, New York.
8. D.A. Skoog, Principles of Instrumental Analysis, 5th Edition (1998), Saunders College of Publishing, Philadelphia, London.
9. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, $7^{th}$
10. Edition (2000), Saunders College Publishing, Philadelphia, London.
11. J. H. Kennedy, Analytical Chemistry: Principles, $2^{nd}$ Edition (1990), Saunders Holt, London.
12. A. J. Bard, Electroanalytical Chemistry
13. J. W. Robinson, Atomic absorption Spectrometry
14. D. A. Skoog, D.M. West, F.J. Holler, Fundamentals of Analytical Chemistry
15. H. H. Willard, L. L. Meritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis
16. H.A. Strobel, Chemical Instrumentation: A Schematic Approach, 2nd Edition (1973)


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **-** | **2** | **1** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **2** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **2** | **-** | **-** | **3** | **-** | **-** | **2** | **-** | **-** | **-** | **2** |
| **CO4** | **3** | **2** | **-** | **-** | **2** | **-** | **-** | **2** | **-** | **-** | **1** | **3** |
| **CO5** | **3** | **1** | **2** | **-** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO6** | **-** | **2** | **2** | **2** | **3** | **3** | **-** | **-** | **-** | **-** | **2** | **2** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH2002 | | | |
| **Course Title** | Organic Chemistry II | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge in Organic Chemistry | | | |

## COURSE OBJECTIVES

- To know the fundamentals of the different structural effects
- To learn the reaction method of popularly named reactions
- To learn how to apply reagents in the stereo-selective reactions using mild reagents
- To develop knowledge about the organic synthetic strategies using the disconnection approach

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Know the fundamentals of the different structural effects
**CO2:** Plan to synthesize molecules using popularly named reactions
**CO3:** Apply reagents in the stereoselective reactions using mild reagents
**CO4:** Develop organic synthetic strategies using the disconnection approach

## COURSE CONTENT

**Module-I: Structural Effects on Reactivity** **8L**

Linear free energy relationships (LFER), the Hammett equation, substitutent constants, theories of substitutent effects, interpretation of σ-values, reaction constant ρ, deviations from Hammett equation, dual - parameter correlations, inductive substituent constant, the Taft equation.

**Module-II: Organic Name Reaction** **16L**

Birch reduction, Aldol condensation, Wittig reaction, Simmons-Smith cyclopropanation, Nef reaction, Favorskii reaction, Baeyer-Villiger oxidation, Claisen rearrangement, Beckmann rearrangement, Shapiro reaction, Mitsunobu reaction, Hofmann-Loffler-Freytag reaction, Barton reaction, Ene reaction, Mannich reaction, Stork enamine reaction, Michael addition, Robinson annulation, Barton decarboxylation and deoxygenation reaction, Sharpless asymmetric epoxidation, Norrish type-I & II reaction, di-pi methane rearrangement, paterno-Buchi reaction.

**Module-III: Reagents and Reactions** **12L**

(i) Gilman's reagent–Lithium dimethylcuprate, (ii) Lithium diisopropylamide (LDA), (iii) Dicyclohexyl carbodiimide (DDC), (iv) 1,3-Dithiane (Umpolung reagent), (v) Peterson's synthesis, (vi) Bakers yeast, (vii) DDQ, (viii) Palladium catalysed reactions, (ix) Woodward and Prevost hydroxylation, (x) Iodotrimethyl silane, Trimethylsilyl cyanide, and Trimethylsilyl azide

**Module-IV: Retrosynthetic Analysis** **12L**

Basic principles, guidelines for disconnection with special emphasis on chemoselective, regioselective, stereoselective and stereospecific reactions, functional group inter conversion, synthon and reagent, synthetic equivalent, illogical electrophile and illogical nucleophile, Umpolung synthesis. designing synthesis of some target molecules with proper retrosynthetic analysis : Menthol, Taxol, Penicillin V, Reserpine, Progesterone, Testosterone, Estrone, Periplanone B, L-Hexoses etc.

**Text/Reference Books**


1. Clayden, Greeves, Warren, Organic Chemistry
2. F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry
3. W. Carruthers, I. Coldham, Modern method of Organic Synthesis
4. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry. Reactions, Mechanisms, and Structure
5. Jie Jack Li , Name Reactions: A Collection of Detailed Reaction Mechanisms
6. Bradford P. Mundy, Michael G. Ellerd, Frank G. Favaloro, Name Reactions and Reagents in Organic Synthesis
7. I. L. Finar, Organic Chemistry (Volume 1 & 2)
8. S. Warren Designing Organic Syntheses John Wiley & Sons Chichester. New York . Brisbane . Toronto


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **-** | **3** | **2** | **-** | **2** | **2** | **-** | **-** | **1** | **2** |
| **CO2** | **2** | **-** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **-** | **-** | **3** | **2** | **-** | **2** | **2** | **-** | **-** | **1** | **2** |
| **CO4** | **2** | **-** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |

| | |
|---|---|
| **Course Code** | PCH2003 |
| **Course Title** | Physical Chemistry II |
| **Category** | Science |
| **LTP & Credits** | L: 4, T: 0, P: 0, Credits: 4 |
| **Total Contact Hours** | 48 |
| **Pre-requisites** | Fundamental knowledge of quantum mechanics, electrochemistry and mathematics |

## COURSE OBJECTIVES

- To learn the physical and mathematical interpretation of quantum mechanics and electrochemistry
- To develop problem-solving ability in quantum chemistry
- Expose students to advanced topics of electrochemistry

- **COURSE OUTCOME**
- Upon successful completion of the course, the student will be able to

**CO1:** Devise desired operators for quantum mechanical problems
**CO2:** Apply the in depth knowledge of quantum mechanics to solve quantum mechanical problems
**CO3:** Determine the energy and wave function of unknown systems applying approximation methods utilizing modern softwares
**CO4:** Explain the effect of finite size on Debye-Hückel theory of ion-ion interaction, current-overpotential relationship, and importance of Tafel equation

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## COURSE CONTENT

**Module-I: Introduction to Quantum Mechanics** **5L**
Origin of quantum mechanics, Black-body radiation, photoelectric effect, Compton effect, Pair production, de Broglie's hypothesis: Davisson-Germer's and Thomson's experiment, Wave-particle duality: Franck-Hertz experiment, Young's double slit experiment, Heisenberg's uncertainty principle.

**Module-II: Operators of Quantum Mechanics** **9L**
Operators, Eigen functions, Hermitian operator, Postulates of quantum mechanics, Angular momentum, its commutative relations, Ladder operator, Pauli spin operator, Schrodinger wave equation and its formulation as an eigen value problem.

**Module-III: Application of Quantum Mechanics** **20L**

Translational motion of a particle, particle in one, two and three dimensional boxes, harmonic-oscillator, rotational motion of a particle: particle on a ring, particle on a sphere, rigid rotator, step-potential, tunneling, hydrogen atom.

Introduction to approximation methods: Perturbation theory and Variation method.

**Module-IV: Electrochemistry** **14L**

Quantitative treatment of Debye-Hückel theory of ion-ion interaction, its applications and limitations, modification of Debye-Hückel law for finite-sized ions, Debye-Hückel-Onsagar equation, association of ions: Bjerrum and Fuoss model, electrode kinetics, current-overpotential relationship, Tafel equation and its importance.

**Text/Reference Books**


1. I. N. Levine, Quantum Chemistry, 5th Edition (2000), Pearson Educ., Inc. New Delhi
2. Donald A McQuarrie, Quantum Chemistry, Viva Student Edition, Viva Books, NewDelhi
3. D. J. Grffiths, Introduction to Quantum Mechanics
4. J. L. Powell, B. Crasemann, Quantum Mechanics
5. D. A. McQuarrie, J. D. Simon, Physical Chemistry, A Molecular Approach, (1998), Viva Books, New Delhi
6. Richard L. Liboff, Introductory Quantum Mechanics
7. R.K. Prasad, Quantum Mechanics
8. Samuel Glasstone, An Introduction To Electrochemistry, Affiliated East-West Press Pvt. Ltd.-New Delhi (2000)
9. J. O'M. Bockris, A. K. N. Reddy, Modern Electrochemistry, Vol. 2 A & B, 2nd Edition, Plenum Press, New York (1998)


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | 2 | - | - | - | - | - | - | 2 |
| CO2 | 2 | 2 | 2 | - | 3 | 2 | - | - | - | - | - | 3 |
| CO3 | 2 | 3 | 2 | 2 | 3 | 2 | - | - | - | - | - | 2 |
| CO4 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | - |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH2101 | | | |
| **Course Title** | Inorganic Chemistry II Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 3 | 2 |
| **Total Contact Hours** | 36 | | | |
| **Pre-requisites** | Fundamental knowledge in inorganic chemistry | | | |

**COURSE OBJECTIVES**

- Impart training in qualitative analysis of inorganic compounds
- Quantitative estimation of metal ions in a given mixture by complexometric and spectroscopic methods
- To enable problem solving ability and to interpret the experimentally obtained data

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Demonstrate the underlying principle behind qualitative analysis of inorganic mixture and thereby identify the radicals within the sample including rare earth elements

**CO2:** Determine the concentration of metal ions in a supplied solution

**CO3:** Predict the composition of an unknown inorganic complex utilizing Job's method

**COURSE CONTENT**

- ➢ Qualitative analysis of mixture of compounds containing six radicals of which two are rare elements (Sessional only)
- ➢ Tritrimetric estimation of mixtures of metal ions by EDTA
- ➢ Spectroscopic estimation of inorganic complexes
- ➢ Job's method of continuous variation

**Text/Reference Books**


1. A.I. Vogel, Qualitative Inorganic Analysis
2. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
3. G. N. Mukherjee, Handbook of Practical Chemistry


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 2 | - | - | 2 | - | - | - | - | - |
| **CO2** | 2 | - | 2 | 3 | - | - | 2 | - | - | - | 2 | - |
| **CO3** | 2 | 2 | 1 | 2 | 3 | 2 | - | - | - | - | - | - |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH2102 | | | |
| **Course Title** | Organic Chemistry II Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 3 | 2 |
| **Total Contact Hours** | 36 | | | |
| **Pre-requisites** | Fundamental knowledge in Organic Chemistry | | | |

**COURSE OBJECTIVES**

- To introduce the students to have hands on experience to perform various reactions.
- The students can Separate and characterize the two component and three component mixtures.

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Synthesize the biologically important molecules having carbonyl functionality

**CO2:** Verify the purity of organic compounds by employing a thin layer chromatography

**COURSE CONTENT**

- Small scale organic synthesis by exploiting common organic reactions **(**Nitration, Bromination, Condensation, Oxidation, Reduction, Esterification and Hydrolysis) and their purification (Recrystallization /Chromatography)

**Text/Reference Books**


1. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
2. G. N. Mukherjee, Handbook of Practical Chemistry
3. A.I. Vogel, A Textbook of Practical Organic Chemistry


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **-** | **2** | **2** | **2** | **-** | **2** | **2** | **-** | **-** | **2** | **2** |
| **CO2** | **2** | **-** | **-** | **3** | **2** | **-** | **2** | **2** | **-** | **-** | **1** | **-** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH2103 | | | |
| **Course Title** | Physical Chemistry II Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 3 | 2 |
| **Total Contact Hours** | 36 | | | |
| **Pre-requisites** | Fundamental knowledge in Physical Chemistry | | | |

**COURSE OBJECTIVES**

- Impart training in operating conductometer, potentiometer and colorimeter and UV-vis spectrophotometer
- To enable problem solving ability and to interpret the experimentally obtained data

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Design experiments based on conductometer, potentiometer and colorimeter and UV-vis spectrophotometer

**CO2:** Determine rate constant of ester hydrolysis, individual strengths of acids/bases and salts, critical micellization concentration of surfactants, formal redox potential of a system, pKin of an indicator and determine the strength of unknown solution from calibration curve

**CO3:** Predict the composition of an inorganic complex by potentiometric titration

**COURSE CONTENT**

- Determination of rate constant of alkaline hydrolysis of ester conductometrically
- Conductometric titration of mixture of acids (HCl and $CH_3CO_2H$)
- Determination of the individual strengths of $(NH_4)_2SO_4$ and $Na_2SO_4$ in a mixture conductometrically
- Conductometric titration of Zn(II) vs $K_4[Fe(CN)_6]$ and determination of composition of the complex
- Determination of CMC of SDS conductometrically
- Potentiometric titration of mixture of acids (HCl and $CH_3CO_2H$)
- Determination of the formal redox potential of $Fe^{2+}/Fe^{3+}$ system potentiometrically
- Potentiometric titration of $K_4[Fe(CN)_6]$ by $ZnSO_4$ or $Pb(NO_3)_2$ and determination of composition of the complex

- Verification of Lambert and Beer's law. Also determine the concentration of an unknown solution from calibration curve
- Determination of pKin of bromocresol green indicator

**Text/Reference Books**


1. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
2. G. N. Mukherjee, Handbook of Practical Chemistry
3. A. M. James, F. F. Prichard, Practical Physical Chemistry
4. Shoermaker, Garland, Experimental Physical Chemistry


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **3** | **-** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **2** |
| **CO2** | **2** | **2** | **2** | **3** | **1** | **2** | **-** | **-** | **-** | **-** | **2** | **1** |
| **CO3** | **2** | **-** | **3** | **2** | **3** | **2** | **-** | **-** | **-** | **2** | **2** | **2** |

# Detailed Syllabus of Third semester

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3001 | | | |
| **Course Title** | Principles And Applications Of Molecular Spectroscopy | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of spectroscopy and quantum mechanics | | | |

**COURSE OBJECTIVES**

- To develop fundamental principles behind each kind of molecular spectroscopy
- To exhibit the correlation between quantum mechanics and molecular spectroscopy
- To demonstrate different applications of molecular spectroscopy

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Understand the underlying principles and applications of different molecular spectroscopy

**CO2:** Devise selection rules for rotational, vibrational, Raman and electronic spectroscopy considering time dependent perturbation theory

**CO3:** Illustrate the energy level, spacing and spectra of diatomic and polyatomic molecules

**CO4:** Explain the origin of LASER and its different mode of action along with its applications in spectroscopy

**CO5:** Interpret generation of NMR signal in terms of physical chemist perspective

**CO6:** Predict the structure of compounds utilizing IR, Raman spectroscopy, NMR and photoelectron spectroscopy

**COURSE CONTENT**

**Module-I: Fundamentals 4L**

Interaction of electromagnetic radiation with matter, Einstein coefficient, transition probability, transition dipole moments and selection rules, intensity of spectral lines, line-widths and line shapes, Fourier transforms in spectroscopy.

**Module-II: Rotational and Vibrational Spectroscopy 10L**

Classifications of molecules based on topicity, microwave and vibrational spectroscopy of diatomic and polyatomic molecules, energy levels, selection rules, isotope effect, non-rigidity on spectral features, vibration and group frequency, vibration-rotation spectra of diatomic molecules, origin of P, Q, and R branch, hot bands, applications.

**Module-III: Raman Spectroscopy 4L**

Raman spectra of diatomic molecules, rotational and rotation- vibrational Raman transitions, effects of nuclear spin, polarization of Raman lines, applications.

**Module-IV: Electronic Spectroscopy 6L**

Origin, selection rules, spectral features, Franck-Condon principle, dissociation and pre-dissociation, rotational fine structure, charge transfer spectra, fluorescence and phosphorescence spectra, applications.

**Module-V: LASER 10L**

General features, principles, characteristics of laser, population inversion, basic elements in laser pulsed, lasers, laser cavity modes, Q-switching, mode locking, harmonic generation, different lasers: He-Ne, Nd-YAG, titanium-sapphire, dye lasers, semiconductor lasers, and applications of lasers in spectroscopy.

**Module-VI: Photoelectron Spectroscopy 4L**

Photoexcitation and photoionization, core level (XPS, ESCA) and valence level (UPS) photoelectron spectroscopy, XPS and UPS of simple molecules, applications.

**Module-VII: Nuclear Magnetic Resonance Spectroscopy 10L**

Basic principles, relaxation times, intensity of NMR signals, electronic shielding, NMR in liquids: chemical shifts, origin of spin-spin couplings, and qualitative idea about NMR spectra of AX, $AX_2$, $A_3X$ and AB systems.

*FT-NMR:* Rotating frame of reference, effect of radiofrequency pulses, FID, Multi pulse operation, measurement of $T_1$ by inversion recovery method, spin echo and measurement of $T_2$.

**Text/Reference Books**

1. J. M. Hollas, Modern Spectroscopy, 4th edition (2004) John Wiley & Sons, Ltd., Chichester.
2. C. N. Banwell and E.M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th edition (1994), Tata McGraw Hill, New Delhi.
3. J. D. Graybeal, Molecular spectroscopy
4. I. N. Levine, Molecular spectroscopy
5. G. Herzburg, Infrared and Raman Spectra (1945), Spectra of Diatomic Molecules (1950), Van Nostrand, New York.
6. J. R. Lakowicz, Principles of Fluorescence Spectroscopy
7. W. Demtroder, Laser Spectroscopy
8. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill International Book Company, Tokyo, 1982.
9. R. K. Harris, Nuclear Magnetic Resonance Spectroscopy, (1986) Addison Wesley, Longman Ltd, London.
10. A Carrington and A. D. Mc Lachlan, Introduction to Magnetic Resonance, (1979) Chapman and Hall, London.

**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | 2 | - | 2 | 2 | - | - | - | - | - | 2 |
| CO2 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 |
| CO3 | 2 | - | 3 | 2 | 2 | 2 | - | - | - | - | - | 2 |
| CO4 | 2 | - | - | 2 | 2 | 3 | 2 | - | - | - | 2 | 2 |
| CO5 | 3 | 2 | 2 | - | 2 | 2 | - | - | - | - | - | 2 |
| CO6 | 2 | 2 | 3 | - | 3 | - | - | - | - | - | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3002 | | | |
| **Course Title** | Advanced Bioinorganic And Organometallics | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of Bioinorganic chemistry | | | |

**COURSE OBJECTIVES**

- To understand the pivotal role of metals in bioinorganic chemistry
- Detailed interception of bonding concepts in organometallic and bioinorganic chemistry
- To introduce the students to the basics of solid state chemistry and structural paradigms in main group and early transition elements, and their rings, cages and cluster compounds
- Mechanistic aspects of several well-known industrial catalytic techniques

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Understand the inherent principles of metal in bioinorganic chemistry
**CO2:** Interpret the catalytic behavior of organometallic compounds
**CO3:** Explain isolobal analogy and structural paradigms in cluster chemistry
**CO4:** Apply the gained knowledge to construct inorganic polymer and polymer based hybrid materials as per the requirement of the society

**COURSE CONTENT**

**Module-I: Bioinorganic II** **12L**

Metal ion transport and storage: Ferritin, Transferrin, Siderophores and metallothionein. Role of alkaline earth metal ions in biological systems: (i) Catalysis of phosphatetransfer by $Mg^{2+}$ ion, (ii) Ubiquitous regulatory role of $Ca^{2+}$ in muscle contraction. Metalloenzymes**:** Urease, Hydrogenase, and Cyanocobalamine Catalase, peroxidase, superoxide dismutase, alcohol dehydrogenase, carbonic anhydrase, carboxypeptidase, xanthine oxidase, nitrogenase, vitamin B12 coenzyme.

Trace elements and their chemical speciation with special reference to Cu, Zn, Cd, Hg, Pb, Ag, Sb, Se, Ti, Si, Be etc. Toxic chemicals in air, water, soil, diet, fertilizer, their effects and remedial measures. Metal ion toxicity, metal dependent diseases, remedial measures, Bio-mineralogy.

*Toxicity and drugs:* Toxic effects of metal ions, detoxification by chelation therapy, metal dependent diseases and metal complexes as drugs, Pt, Ru, Rh and Au drugs.

**Module-II: Organometallics II** **14L**

Application of 18- electron and 16- electron rules to transition metal organometallics, structure, bonding (pictorial mo-approach) and reactions of $\eta$2-ethylinic, $\eta$3-allylic and $\eta$5-cyclo-pentadineyl compounds, structure and bonding of carbonyls, nitrosyls and related pi- acids, alkyl, alkene, alkyne, $\pi$-allyl, polyene and cyclopolyene compounds; metal carbenes and carbynes, isolobal analogy, Dewar-Chatt model, oxophilicity, Agostic interaction, organo-metallic catalysts.

Catalysis by organometallic compounds: Wilkinson's catalyst, Tolman's catalytic loops; synthesis gas, water gas shift reaction, synthesis of methanol, hydroformylation (oxo process), hydrogenation of unsaturated compounds, Masanto acetic acid process, Waker process, synthetic gasoline, Fischer-Tropsch process; Polymerisation, oligomerisation and metathesis reactions of alkenes and alkynes; Zieglar-Natta catalysis.

**Module-III: Cluster, Cage, Ring of main group Transition-metal Clusters 14L**

Structure and bonding of higher boranes, Capping rules, metal-ligand complexes vs heteronuclear cluster, isolobal analogs of p-block and d-block clusters, closo, nido, arachno and Wade-Mingos rule. limitations and exceptions, clusters having interstitial main group elements, cubane clusters and naked or Zintl clusters, metal-carbonyl clusters, structures, capping and electron counting, molecular clusters in catalysis, clusters to materials, boron-carbides and metalborides, illustrative examples from recent literature. Metal-metal bonded complexes of transition metals (structure and bonding): dirhenium complexes, molybdenum blue, tungsten blue, tungsten bronze, ruthenium red, Creutz-Taube complex, transition metal dioxygen and dinitrogen complexes (structure, bonding and reactivity).

**Module-IV: Inorganic Polymers 8L**

Classification, types of inorganic polymerization, comparison with organic polymers, Boron-oxygen and boron-nitrogen polymers, silicones, coordination polymers, sulphur-nitrogen, sulphur-nitrogen-fluorine compounds, binary and multi-component systems, hemolytic inorganic systems.

**Text/Reference Books**


1. M. N. Hughes, Inorganic Chemistry of Biological Processes, 2nd Ed.(1981), John-Wiley & Sons, New York.
2. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, An Introduction and Guide, Wiley, New York (1995).
3. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University Science Books, (1994).
4. I. Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd., New Delhi (1998)
5. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Ed. (1999) John Wiley & Sons.
6. J. E. Huheey, Keiter and Keiter, Inorganic Chemistry.
7. R. H. Crabtree, The Organometallic Chemistry of Transition Metals, John Wiley.
8. Ch. Elschenbroich and A. Salzer, Organometallics, VCH.
9. J. P. Collman, L. S. Hegedus, J. R. Norton and R.G. Finke, Principles and Applications of Organotransition metal Chemistry, Univ. Sci. Books, Mill Valley, California.


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | 2 | 2 | - | 2 | - | - | 2 | 1 |
| CO2 | 2 | 2 | 3 | 2 | 2 | 2 | - | - | - | - | - | 2 |
| CO3 | 3 | 2 | - | - | 3 | 2 | - | - | - | - | 2 | 2 |
| CO4 | 2 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | 2 |

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|---|---|---|---|---|
| **Course Code** | PCH3003 | | | |
| **Course Title** | Advanced Organic Synthesis I | | | |
| **Category** | Science | | | |
| **LTP &Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Prerequisites** | Fundamental knowledge of Organic chemistry | | | |

## COURSE OBJECTIVES

- To learn the fundamentals of radical chemistry and its applications in organic synthesis
- To learn the various protection and deprotection of important functional groups
- To learn the use of important reagents in organic synthesis
- To learn about the selected name reactions in organic synthesis

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Understand the fundamental principle of radical reaction and applications

**CO2:** Understand the various protection and deprotection of important functional groups

**CO3:** Apply the basic oxidation and reduction reactions on organic molecules.

**CO4:** Demonstrate the steps involved in the structure elucidation of various natural products using chemical, analytical and synthetic methods

## COURSE CONTENT

**Module-I: Radical Reactions in Organic Chemistry** **13L**

Definition, generation of free radicals, detection, shapes and stability, stable free radicals. Example of addition, substitution, oxidation, cyclization and rearrangement involving radical reaction mechanism. Photochemical Cis-trans mechanism, photo chemical reactions of carbonyl compounds, olefins and conjugated carbonyl compounds, photo induced fictionalization of organic molecules involving Norrish type, Paterno Buchi Reaction, di-π- methane rearrangement, photo reduction of ketones.

**Module-II: Protection and Deprotection Chemistry** **8L**

The role of protective groups in organic synthesis, principle of protection and deprotection, Different procedure for protection and deprotection of hydroxyl (including 1,2- and 1,3- dihydroxy), phenols, amines, carbonyls and carboxylic groups.

**Module-III: Redox Reactions in Organic Synthesis** **15L**

Fundamentals, *Oxidation of alcohols:* By Chromium and Manganese reagents, Silver carbonate, oxidation via alkoxysulphonium salts and other methods. *Oxidation of Carbon-Carbon double bonds:*

dihydroxylation, diastereoselective epoxidation of homoallylic alcohols, photosensitized oxidation of alkenes, Pd-catalyzed oxidation of alkenes, use of Ruthenium tetroxide and Thallium (III) nitrate as oxidizing agents for organic substrate, other oxidizing agents. *Reduction by dissolving Metals*: reduction with metal and acid (reduction of carbonyl compounds), desulphurisation of thio-acetals, reduction of organic compounds by di-imide, low valent Titanium reagents, trialkyltin hydrides, trialkylsilanes and other reagents (oxidation reaction without oxidant).

**Module-IV: Natural Products** **12L**

Biosynthesis of (i) Non-nitrogenous secondary metabolites from flavonoids and related polyphenolics, (ii) mono- and di-terpenoids from Mevalonic acid (iii) tri-terpenoids from geranyl pyrophosphate.

Structure and stereochemistry of alkaloids (Atropine/ Quinine); Terpenoids (Abietic acid/ β-Carotene); Steroids (Cholesterol). Biosynthesis of Atropine, Quinine, Abietic acid, β-Carotene, Cholesterol.

**Text/Reference Books**


1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
4. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
5. F.A. Carey and R.J. Sundburg,, Advanced Organic Chemistry, Part-A
6. F.A. Carey and R.J. Sundburg, Advanced Organic Chemistry, Part-B
7. P. G.M. Wuts, T.W. Greene, Greene's Protective Groups in Organic Synthesis, 4th Edition, Wiley


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **3** | **-** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **-** |
| **CO2** | **2** | **2** | **2** | **3** | **1** | **2** | **1** | **2** | **-** | **-** | **2** | **-** |
| **CO3** | **2** | **3** | **-** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **-** |
| **CO4** | **2** | **2** | **2** | **3** | **1** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3004 | | | |
| **Course Title** | Advanced Quantum Mechanics | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of quantum mechanics and mathematics | | | |

**COURSE OBJECTIVES**

- To develop fundamental principles required to study advanced quantum mechanics
- To demonstrate the importance of approximation methods in quantum mechanics
- To exhibit the correlation between quantum mechanical treatment of many electron atoms and molecules
- To generate problem-solving ability in quantum chemistry

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Apply the in depth knowledge of perturbation theory, Variation method and JWKB approximation to solve the quantum mechanical problems

**CO2:** Interpret transition probability, Einstein coefficients and selection rules considering time-dependent perturbation theory

**CO3:** Employ Pauli's antisymmetry principle, Coulomb and exchange integrals, SCF and Hatree-Fock-Roothaan method to explain the result of many electron atoms in light of quantum mechanics

**CO4:** Determine the energy of polyatomic molecules considering Born-Oppenheimer approximation, Valence bond theory, Molecular orbital theory and Hückel MO theory

**COURSE CONTENT**

**Module-I: Fundamental Principles** **6L**

Postulates of quantum mechanics, Schmidt orthonormalisation, Fourier transformation, delta function with examples, tunneling, bound states, the Virial theorem.

**Module-II: Approximation Methods in Quantum Mechanics** **12L**

Stationary perturbation theory for non-degenerate and degenerate systems and its applications to rotator, Stark effect, the Helium atom, Variation method, principles of linear and non-linear variation methods and its applications, JWKB approximation, time-dependent perturbation theory, radiative transitions, transition probability and rates, Einstein coefficients, selection rules.

**Module-III: Quantum Mechanics of Many Electron Atoms** **16L**

Pauli's antisymmetry principle, antisymmetry of many electron wave function, spin and spatial orbitals, Slater determinant, closed-shell and open-shell electron configurations, multi-electron pure-spin state wave functions, formulation of a multi-electron closed-shell electron configuration energy, introduction of core, Coulomb and exchange integrals with their properties, independent particle model, multi-electron atomic Hartree Hamiltonian and related SCF equations solution, vertical ionization potential and Koopman’s theorem, Hatree-Fock-Roothaan method for closed cell systems, Roothaan equation, discussion of electron correlation, Condon Slater rule.

**Module-IV: Quantum Mechanics of Molecules** **14L**

Born-Oppenheimer approximation, Valence bond theory, Molecular orbital treatment for homonuclear molecule, Hückel MO treatment of simple polyenes, separation of electronic and nuclear motion, basis sets for the molecular orbital calculations of polyatomic molecules, configuration interaction calculations of polyatomic molecules, illustrative examples of Ab initio HF and post HF calculations, atomic charge and bonding indices in polyatomic molecules.

**Text/Reference Books**


1. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, 3rd edition (1997), Oxford University Press. Oxford.
2. I. N. Levine, Quantum Chemistry, 5th edition (2000), Pearson Educ., Inc., New Delhi.
3. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A Molecular Approach, (1998), Viva Books, New Delhi.
4. A. K. Chandra, Introductory Quantum Chemistry, 4th edition (1994), Tata McGraw Hill, New Delhi.
5. L. Pauling and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, (1935), McGraw Hill, New York.
6. G. C. Schatz and M. A. Ratner, *Quantum Mechanics in Chemistry*, Dover Publication, Inc, New York, 2002.
7. Richard L. Liboff, Introductory Quantum Mechanics
8. D. J. Grffiths, Introduction to Quantum Mechanics
9. J. L. Powell, B. Crasemann, Quantum Mechanics
10. R. K. Prasad, Quantum Mechanics


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | - | 2 | 2 | - | - | - | - | 2 | 2 |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| CO3 | 2 | - | 3 | - | 2 | 2 | - | - | - | - | - | 2 |
| CO4 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3005 | | | |
| **Course Title** | Advanced Topics In Inorganic Chemistry I | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of Inorganic chemistry | | | |

**COURSE OBJECTIVES**

- To introduce the students to the molecular orbital theory from the group theory perspectives to interpret the molecular structures from IR and Raman spectroscopy
- To introduce the students to the bonding, reactions and spectra of coordination compounds
- To provide them a brief idea about the inorganic reaction mechanism

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Apply group theory to interpret bonding in inorganic compounds
**CO2:** Predict the molecular vibrations and thereby molecular structure of compounds utilizing IR and Raman spectroscopy
**CO3:** Analyze and propose the mechanistic pathway of inorganic reactions

**COURSE CONTENT**

**Module-I: Molecular Orbital from Group theory 14L**

Introduction, transformation properties of atomic orbitals, Application of group theory in bonding theory. calculation of MO's of $AB_n$ type, organic conjugated π and sandwich type molecules. Crystal field splitting in octahedral and tetrahedral complexes. M.O. construction of Octahedral Tetrahedral complexes. Splitting of MO level due to symmetry lowering (e.g. Jahn Teller Distortion)

**Module-II: IR and Raman Spectroscopy 14L**

Brief introduction to molecular vibrations, selection rules for fundamental transitions, symmetry of normal modes of molecules, Infrared and Raman activity of some typical molecules (molecules of $C_{2v}$, $C_{3v}$, $C_{4v}$, $D_{2h}$, $D_{3h}$, $D_{4h}$, Td and Oh point groups).

**Module-III: Inorganic Reaction Mechanism** **20L**

General remark, complementary and non-complementary redox reactions, outer-sphere reaction, inner-sphere reaction, effect of bridging ligand in inner-sphere reaction, kinetics and mechanism, electron tunneling hypothesis, heteronuclear redox reaction and simplified Marcus theory, Marcus cross relationship and its application, remote attack, doubly-bridged process, ligand exchange, intervalence electron transfer, induced reaction, electron transport in biological systems and their simulations.

Substitution reactions in square planar, tetrahedral and octahedral geometries with special reference to $d^n$ ion complexes: operational tests, aquation and anation, reactions without metal-ligand bond breaking, kinetics of chelate formation, reaction mechanisms of organometallic systems, studies on fast reactions, kinetic and activation parameters-tools to propose a plausible mechanism; stereochemical changes: types of ligand rearrangements, isomerism in 4-, 5- and 6-coordinated complexes; reactions of coordinated ligands: model choice of metal and ligand, acid-base reaction, hydrolysis of esters, amides and peptides, aldol condensation, trans-amination, template reactions, organic synthesis with special reference to macrocyclic ligand; reactions in fluxional organometallic compounds.

**Text/Reference Books**


1. F. A. Cotton and G.Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John-Wiley & Sons,New York.
2. James E. Huheey, Inorganic Chemistry, 4th Edn. (1993), Addison Wesley Pub. Co., New York
3. N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd Edn. (1997), Butterworth Heinemann, London.
4. F. A. Cotton, Chemical Applications of Group Theory, 3rd Edn. (1999), John Wiley & Sons,
5. New York.
6. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 2nd Edn. (1999), Prentice Hall International Inc., London.
7. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd., New Delhi (1999).
8. A. Vincent, Molecular Symmetry and Group Theory, John Wiley & Sons, New York, 1998.
9. D. M. Bishop, Group Theory and Chemistry, Oxford University. Press, 1993.
10. V. Heine, Group Theory in Quantum Mechanics: An Introduction to Its Present Usage, Dover Publication, New York, 1991.
11. R. McWeeny, Symmetry: An Introduction to Group Theory and Its Applications, Dover Publications, New York.


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | 3 | 2 | - | - | - | - | 2 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 3 | 2 | - | - | - | - | - | 2 |
| CO3 | 2 | - | 3 | 2 | 2 | - | - | - | - | - | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3006 | | | |
| **Course Title** | Biomolecules and Pericyclic Reaction | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of Biochemistry | | | |

**COURSE OBJECTIVES**

- To learn the fundamental ideas of photochemical excitation/de-excitation events, and the molecular events that can intervene at different levels and their applications
- To provide the students a broad idea about amino acids, steroids, carbohydrates and heterocycles

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Know various types of amino acids, their structures, and importance

**CO2:** Understand the bio-functions of steroids and their structures and get a comprehensive knowledge about carbohydrates and some heterocycles

**CO3:** Plan synthetic routes to complex organic molecules through cycloaddition reactions

**COURSE CONTENT**

**Module-I: Proteins and Nucleic Acids** **14L**

Natural and synthetic amino acids, different synthetic strategy of peptides, structure and function of protein and nucleic acids, Ramachandran plot, denaturation of proteins, factors affecting denaturation, protein folding, doble helical structure of DNA, RNA, various forms of DNA (a, b, c, z) and RNA (m, r & t), Unnatural Amino Acid.

**Module-II: Enzymes, Carbohydrates, Lipids, Hormones, Steroids and Bioenergetics** **20L**

Classification, function and regulation of enzymes, active sites, Vitamins as coenzymes and co-factors, enzyme kinetics. Structure, function and reactions of carbohydrates, lipids, hormones and steroids; Cholesterol, Prostaglandins, and cell membranes. Glycolysis, citric acid cycle, electron transport chain, oxidative phosphorylation.

**Module-III: Pericyclic Reaction** **14L**

Introduction, phase and symmetry of orbitals, types of pericyclic reactions; Cycloaddition reactions: FMO-approach, co-relation diagram, Woodward-Hoffmann selection rules, regioselectivity, secondary orbital interaction, Lewis acid catalysis, site selectivity, Electrocyclic reactions: FMO-approach, electroreversion, stereochemical effects, Woodward-Hoffmann rules, Sigmatropic rearrangement:

definition, types of sigmatropic reactions, FMO-approach, selection rules, Ene reaction: FMO-approach for ene reactions.

**Text/Reference Books**

1. S.M. Mukherjee and S.P. Singh, Pericyclic Reactions &Photochemistry, MacMillan India, New Delhi.
2. I. Fleming, Pericyclic Reactions, Oxford University Press, Oxford (1999).
3.Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
4. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
5. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
6. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd Edition (1994), Wiley Eastern Ltd., New Delhi.
7.L. Stryer, Biochemistry, 5$^{th}$ edition (2002), Freeman & Co., New York.

8. D. L. Nelson and M. M. Cox, Lehninger, Principles of Biochemistry, 3$^{rd}$ edition (2002) McMillan North Publication.

**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | - | - | 3 | 2 | 3 | 3 | - | - | 2 | 2 |
| CO2 | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | - | - | - | 2 |
| CO3 | 2 | 3 | - | - | 3 | 2 | 1 | 2 | - | - | 2 | 1 |

| | |
|---|---|
| **Course Code** | PCH3007 |
| **Course Title** | Solid State Chemistry |
| **Category** | Science |
| **LTP & Credits** | L / T / P / Credits: 4 / 0 / 0 / 4 |
| **Total Contact Hours** | 48 |
| **Pre-requisites** | Fundamental knowledge of solid state chemistry |

**COURSE OBJECTIVES**

- To develop theoretical foundation of solid state chemistry
- To learn about solid state reactions and its growth kinetics
- To exhibit the correlation among properties of solids with respect to electric, thermal and magnetic behavior

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Recognize and categorize the crystal structure based on X-ray diffraction
**CO2:** Fabricate the synthetic method to grow phase pure single crystals and study their growth kinetics
**CO3:** Explain the conduction behaviour of solids in terms of Band theory
**CO4:** Correlating the structure-property relationship in terms of thermal and magnetic properties of the solids

**COURSE CONTENT**

**Module-I: Crystal structure and X-ray Diffraction** **8L**

Definitions related to crystal structure, reciprocal lattice, Brillouin Zones, structure factor, Laue equations and Bragg's law, X-ray diffraction experiments: powder method and single crystal method.

**Module-II: Solid State Reactions & Phase transitions** **10L**

General principles and experimental procedure of solid state reactions, growth of single crystals: Czochralski method, Bridgman and Stockbarger methods. Thermodynamic and Burger's classification of phase transition, kinetics of phase transition, nucleation and growth.

**Module-III: Free electron & Band Theory of Solids** **15L**

Free electron gas model of metals, free electron gas in a one-dimensional and three dimensional box, Bloch theorem, Kronig-Penny model, tight binding approximation, Band theory of insulators and semiconductors, intrinsic semiconductors, extrinsic semiconductors, doped semiconductors, rectifiers, transistors, p-n junctions and their applications, Schottky and Frenkel defects, stoichimetric imbalance, origin of colours.

**Module-IV: Thermal & Magnetic Properties of Solids** **15L**

Electronic specific heat, lattice heat capacity, Hall effect, Einstein theory, Debye theory, Born's modification of the Debye theory. Origin and classifications of magnetic substance, magnetic moment, ferromagnetic, antiferromagentic and ferromagnetic ordering, magnetic susceptibility, Curie and Cuire-Weiss law, super exchange, magnetic domains, and hysteresis.

**Text/Reference Books**

1. C. Kittel, Introduction to Solid State Physics, John Wiley & Sons, Inc., New York, Chichester.
2. O. Madelung, Introduction to Solid State Theory
3. A. R. West, Solid State Chemistry and its Applications, (1984) John Wiley and Sons, Singapore.
4. L.V. Azaroff, Introduction to Solids, (1977) Tata McGraw-Hill, New Delhi.
5. A. J. Dekker, Solid State Physics, Prentice Hall

**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | - | - | 2 | - | - | - | - | - | 2 |
| CO2 | 2 | 2 | - | 3 | 2 | 2 | - | - | - | - | - | 2 |
| CO3 | 3 | 2 | - | - | 2 | - | - | - | - | - | - | 1 |
| CO4 | 2 | 2 | 2 | - | 3 | 2 | - | - | - | - | - | 2 |

**ELECTIVE 1**

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3008 | | | |
| **Course Title** | Supramolecular Chemistry And Drug Design | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 2 | 0 | 0 | 2 |
| **Total Contact Hours** | 24 | | | |
| **Pre-requisites** | NIL | | | |

**COURSE OBJECTIVES**

- To learn the fundamental knowledge of supramolecular chemistry and its applications in different fields
- To provide students with an understanding of the process of drug discovery and development from the identification of novel drug targets to the introduction of new drugs into clinical practice

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Interpret a combined approach of supramolecular chemistry with electrochemistry that has produced a wealth of interesting functions and devices and their practical applications in energy conversion technology, advanced materials and diagnostics

**CO2:** Understand basic principles of how new drugs are discovered with emphasis on lead identification, lead optimization, classification and kinetics of molecules targeting enzymes and receptors, prodrug design and applications, as well as structure-based drug design methods

**COURSE CONTENT**

**Module-I: Supramolecular Chemistry** **8L**

*Fundamentals:* definitions of supramolecular chemistry, host-guest chemistry, chelate and macrocyclic effects, preorganisation, thermodynamic and kinetic selectivity, supramolecular interactions (i.e. cation –π, π-π etc.), cation, anion and neutral molecule binding: crown ethers, podands/ lariat ethers, spherands, cryptands, complexation of organic cations, calixarenes, cation host to anion host, shape selectivity, guanidinium receptors, coordination interactions, cavitands: cyclodextrins and molecular tweezers. molecular switches.

**Module-II: Drug Design and Antineoplastic Agent** **16L**

Concept of pharmacodynamics, d*rug targets:* enzymes, receptors, nucleic acids; c*oncept on pharmacokinetics:* drug absorption, distribution, metabolism and excretion, concept on lead compound and lead modification, pharmacophore, concept of prodrug and soft drug, structure activity relationship

(SAR), factors affecting bioactivity; *Antineoplastic agents*: synthesis and mode of action of mechlorethamine, cyclophosphamide, melphalan, and 6-mercaptopurine. *Cardiovascular drugs:* introduction to cardiovascular diseases, synthesis and mode of action of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyl dopa; *local antiinfective drugs and antibiotics:* synthesis and mode of action of sulphonamides, nalidixic acid, norfloxacin, aminosalicyclic acid, ethinamide, fluconazole, chloroquin and premaquin; *Antibiotics*: cell wall biosynthesis, inhibit-lactam rings, i**mmunosuppressants** .

**Text/Reference Books**


1. J. M. Lehn, Supramolecular Chemistry- Concepts and Perspectives
2. S chneider, H. J., Yatsimirski, Principles and Methods in Supramolecular Chemistry
3. Advanced Organic Chemistry, Part-A, F.A. Carey and R.J. Sundburg
4. Advanced Organic Chemistry, Part-B, F.A. Carey and R.J. Sundburg
5. I. L. Finar, Organic Chemistry (Volume 1 & 2)


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **3** | **-** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **-** |
| **CO2** | **2** | **2** | **2** | **3** | **1** | **2** | **-** | **-** | **-** | **-** | **-** | **-** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3009 | | | |
| **Course Title** | Nuclear Chemistry | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 2 | 0 | 0 | 2 |
| **Total Contact Hours** | 24 | | | |
| **Pre-requisites** | Fundamental knowledge of chemistry | | | |

**COURSE OBJECTIVES**

- To develop strong theoretical foundation in nuclear chemistry
- To learn about the nuclear forces, design of the nuclear reactor and different aspects of nuclear reactions within it

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Explain the radioactive disintegration quantum mechanically
**CO2:** Interpret nuclear forces and its importance in predicting the magnetic dipole moment and electric quadruple moment
**CO3:** Understand nuclear fission and fusion reaction and will be able to calculate the fission probability of a radioactive element
**CO4:** Justify the generation of nuclear energy as clean energy by appropriate integration of reactor/ detector design and safety measurements

**COURSE CONTENT**

**Module-I: Theory of radioactive decay** **4L**

Quantum mechanical aspects of radioactive disintegration, alpha decay paradox and its explanation in terms of tunnel effect, Geiger-Muller relationship, time-dependant perturbation theory, Golden rule and its application in explaining beta and gamma transition, selection rules.

**Module-II: Nuclear force and structures** **5L**

Two body problem - properties of deuteron and derivation of depth-range relationship, its applications in explaining nature of nuclear force, elementary particles; nuclear models - strong and weak interaction, nuclear magnetic dipole moment and electric quadruple moment in terms of shell model, collective model, Fermi gas model.

**Module-III: Nuclear reactions general features** **6L**

Types of nuclear reaction, conservation laws, nuclear reaction dynamics, mechanism of nuclear reaction, use of uncertainty principle, resonance and non-resonance reaction, optical model and calculation of mean free path, nuclear fission and fusion reaction, calculation of fission probability from Bohr-Wheeler's theory Centre of mass system and laboratory co-ordinate.

**Module-IV: Nuclear detectors** **9L**

Classification of nuclear detectors, G. M. detector-operational principle, dead time, proportional detectors: proportional counter performance, flow-type proportional counter, gas multiplication factor, scintillation detectors: different types with examples, pulse shape analysis, resolution and detection efficiency, liquid scintillation detectors, detection of neutrons, semiconductor detector: general characterization, depletion depth, reverse bias, requirement of cryogenic condition, resolution and efficiency, pulse rise time, with a brief account of n-type and p-type semiconductor, Si lattice, Ge-Li, Si-Li - a comparison intrinsic and doped-semiconductor-fabrication surface barrier detector; some basic ideas of pulse processing and shaping, single- and multi-channel analysers, digital and analogue systems, applications in space research, development of detector assembly with requirement of newer space and defense technology viz., nuclear missile, Coincidence counting, determination of absolute disintegration rates, decay scheme studies.

**Text/Reference Books**


1. B. Harvey, Introduction to Nuclear Physics and Chemistry, Prentice Hall, New York, 1965.
2. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn Reprint, New Age International (P) Ltd Publications, New Delhi, 2001.
3. G. R. Choppin and J. Rydberg, Nuclear Chemistry: Theory and Applications, Pergamon, Oxford, 1980.
4. D. D. Sood, A.V. R Reddy and N. Ramamoorty, Fundumentals of Radiochemistry, Yancas, Mumbai, 2004.


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 2 | 2 | - | 2 | - | - | - | - | - | 1 |
| **CO2** | 3 | - | 2 | - | 2 | 2 | - | - | - | - | - | - |
| **CO3** | 2 | 2 | 3 | - | 1 | 2 | - | - | - | - | - | - |
| **CO4** | 2 | 2 | - | 2 | 3 | 2 | - | 3 | - | - | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3101 | | | |
| **Course Title** | Inorganic Special Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 6 | 2 |
| **Total Contact Hours** | 72 | | | |
| **Pre-requisites** | Fundamental knowledge of Inorganic chemistry | | | |

**COURSE OBJECTIVES**

- To learn the kinetics of conductometric, colorimetric and spectrophotometric method
- To learn about the gravimetric estimation of selected ores, minerals and alloys
- To learn about the nuclear forces, design of the nuclear reactor and different aspects of nuclear reactions within it

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Understand the principle and working of different instruments like colorimeter, conductometer, spectrophotometer, etc.

**CO2:** Apply the knowledge of quantitative analysis for the determination of metals from ores/alloys

**CO3:** Synthesize and characterize different inorganic complexes

**COURSE CONTENT**

- To study the kinetics of different inorganic reactions by conductometric, colorimetric, and spectrophotometric method
- Estimation of selected ores/minerals/ alloys
- Synthesis and characterization of different coordination complexes

**Text/Reference Books**


1. A.I. Vogel, Qualitative Inorganic Analysis
2. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
3. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
4. G. N. Mukherjee, Handbook of Practical Chemistry


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | 2 | 2 | - | 2 | - | - | - | 2 |
| **CO2** | 2 | 2 | 2 | 3 | - | 3 | - | - | - | - | 1 | 2 |
| **CO3** | 2 | 2 | 2 | - | 3 | 2 | - | 2 | - | - | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3102 | | | |
| **Course Title** | Organic Special Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 6 | 2 |
| **Total Contact Hours** | 72 | | | |
| **Pre-requisites** | Fundamental knowledge of organic chemistry | | | |

## COURSE OBJECTIVES

- To learn separation method of organic mixture using thin layer chromatography
- To learn about the column packing and separate the organic mixture using column layer chromatography
- To learn process of isolation of natural products
- To learn about the spectral data analysis of unknown organic compounds

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Separate complex mixture using thin layer chromatography
**CO2:** Purify crude reaction mixture to desired products using column chromatography
**CO3:** Spectral data analysis of organic compounds

## COURSE CONTENT

- Thin Layer Chromatography (TLC, preparation of TLC plates, analysis), identification
- Column Chromatography (packing, running), separation
- Spectral Data Analysis (UV-Vis/FT-IR/NMR/MS etc.) of Unknown Organic Compounds

## Text/Reference Books


1. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
2. G. N. Mukherjee, Handbook of Practical Chemistry
3. A.I. Vogel, A Textbook of Practical Organic Chemistry


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | 3 | 2 | - | 2 | - | - | - | - | 2 |
| CO2 | 3 | - | 2 | 2 | 3 | 2 | - | - | - | - | 2 | 3 |
| CO3 | 2 | 1 | - | 1 | 2 | 2 | 2 | - | - | - | - | 1 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH3103 | | | |
| **Course Title** | Physical Special Practical | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 6 | 2 |
| **Total Contact Hours** | 72 | | | |
| **Pre-requisites** | Fundamental knowledge of physical chemistry | | | |

## COURSE OBJECTIVES

- Provide essential background of computational chemistry through nurture programming skills
- Expose towards modern computational tools in respect to chemical and interdisciplinary research
- To enable problem solving ability and to correlate the theoretical data with experiments

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Apply appropriate computational methods to solve the chemical problems
**CO2:** Utilize the advanced computational chemistry software's to solve problems
**CO3:** Provide the theoretical foundation of possible mechanistic pathways of a reactions

## COURSE CONTENT

- Computer programming
- Energy minimization techniques by utilization of software
- Utilization of molecular geometry optimisation software for modelling of small molecules

## Text/Reference Books


1. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
2. G. N. Mukherjee, Handbook of Practical Chemistry
3. A. M. James, F. F. Prichard, Practical Physical Chemistry
4. Shoermaker, Garland, Experimental Physical Chemistry
5. F. Jensen, Introduction to Computational Chemistry, 3rd Edition, John Wiley & Sons Ltd, UK, 2017
6. Norman S. Clerman and Walter Spector, Modern Fortran: Style and Usage, Cambridge University Press, New York, USA, 2012


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **2** | **-** | **3** | **2** | **-** | **2** | **-** | **-** | **1** | **2** |
| **CO2** | **2** | **2** | **-** | **-** | **2** | **3** | **-** | **-** | **-** | **-** | **2** | **2** |
| **CO3** | **-** | **3** | **2** | **-** | **3** | **2** | **-** | **2** | **-** | **-** | **-** | **2** |

# Detailed Syllabus of Fourth semester

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4001 | | | |
| **Course Title** | Spectroscopy For Structure Elucidation | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Basic knowledge of spectroscopy | | | |

**COURSE OBJECTIVES**

- To learn basic principles of NMR, IR, UV-Vis spectroscopy and mass spectrometry and to use these spectroscopic methods for organic structure elucidation
- The course focuses the magnetic resonance methods and its application to the structural characterization of organic and inorganic compounds supplemented by techniques like mass spectroscopy, IR spectroscopy, EPR spectroscopy and Mössbauer spectroscopy
- To learn about the optical effect of organic complexes

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Describe the applications of UV-Visible spectroscopy in the identification of conjugation in organic compounds and apply IR spectroscopy to identify the various functional groups in organic molecules

**CO2:** Evaluate the structure of organic compounds using $^{1}$H, $^{13}$C, and 2D-NMR spectroscopy

**CO3:** Describe the basic principles and applications of organic-mass spectrometry and apply UV-Visible, IR, NMR, and mass spectrometry in structure elucidation of organic compounds.

**CO4:** Understand the applications of EPR spectroscopy, Mossbauer spectroscopy and mass spectroscopy for the structural characterization

**CO5:** Understand the fundamentals of ORD and CD

**COURSE CONTENT**

**Module-I: UV-vis-NIR & Infrared Spectroscopy** **10L**

Absorption of dienes, polyenes, carbonyl compounds and α,β-unsaturated carbonyl compounds, Woodward rule and its applications. Different vibration modes, bond stretching, absorption region of functional groups, electrical and steric effects, effects of hydrogen bonding, Fingerprint region and interpretation of IR spectra.

**Module-II: NMR Spectroscopy** **14L**

Principles, relaxation phenomenon, chemical shifts, coupling constants, spin-spin interactions, simplification of complex spectrum, spin decoupling, nuclear Overhauser effect, detailed interpretation of $^{1}$H NMR, $^{13}$C NMR, DEPT, two dimensional NMR: COSY, NOESY.

NMR spectra of paramagnetic coordination compounds, dipolar and contact shifts, $^{11}$B, $^{19}$F, $^{27}$Al, and $^{31}$P – NMR spectroscopy with typical examples.

**Module-III: Mass Spectroscopy** **8L**

Principles, different techniques, fragmentation modes, factors influencing ion abundance, rearrangements, cleavage associated with common functional groups, molecular and metastable ion peak, Nitrogen rule and interpretation of mass spectra.

***Combined applications of different spectroscopic techniques (UV, IR, NMR, Mass) in elucidation of structure.***

**Module-IV: EPR & Mössbauer** **10L**

Origin, principle, hyperfine splitting, factors affecting the magnitude of g-value, anisotropy in hyperfine coupling constants, zero-field splitting, Kramers' degeneracy, nuclear quadrupole interactions, Mössbauer effect, isomer shift, quadrupole splitting, typical spectra of iron and tin compounds, NQR.

**Module-V: Optical Rotatory Dispersion & Circular Dichroism** **6L**

Principles of ORD and CD, different techniques, Cotton effect, Faraday and Kerr effects, applications in determining absolute configuration of metal complexes, amino acids and proteins.

**Text/Reference Books**


1. R. M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D. H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi.
3. P. Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice-Hall, New Delhi.
4. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1st Edition (1987), Blackwell Scientific Publications, Oxford, London.
5. R. S. Drago, Physical Methods in Chemistry, International Edition (1992), Affiliated East-West Press, New Delhi.
6. R. S. Drago, Physical Methods in Inorganic Chemistry, 1st Edition (1971), Affiliated East-West Press, New Delhi.


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | - | 3 |
| CO2 | 3 | 1 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | - | - | 3 |
| CO4 | 3 | 3 | 2 | - | - | 2 | - | - | - | 2 | - | 3 |
| CO5 | 3 | - | - | - | - | 2 | - | - | - | 2 | - | 1 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4002 | | | |
| **Course Title** | Advanced Topics In Inorganic Chemistry II | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of inorganic chemistry | | | |

**COURSE OBJECTIVES**

- To develop advanced foundation of magnetochemistry, crystallography and inorganic photochemistry
- To correlate the magnetic behavior of the synthesized materials by SQUID
- To determine the structure from single crystal XRD and composition & constituents of inorganic compounds from powder XRD
- To generate the concept about photocatalysis based on transition metal complexes

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Classify the compounds with respect to magnetic behavior and their dependence on temperature

**CO2:** Determine the magnetic behavior of Lanthanides and Actinides

**CO3:** Categorize the crystal structure based on X- ray diffraction and will explain the conduction behaviour of solids in terms of Band theory and BCS theory

**CO4:** Explain the photocatalytic behavior of Cr(III), Co(III), Ru(II) complexes, and transition metal carbonyls complexes

**COURSE CONTENT**

**Module-I: Magnetochemistry** **18L**

Vector atom model and relation between orbital angular momentum and dipole moment. Spectroscopic term determination. Splitting of term due to spin orbit coupling. Types of magnetic materials, magnetic susceptibility and its determination. diamagnetism in atoms and polyatomic systems, Pascal's constants, Lande interval rule, energies of J states, Curie equation, Curies law and Curie-Weiss law, First order and second order Zeeman effects, temperature independent para magnetism, simplification and application of Van Vleck susceptibility equation, Gouy, Faraday and Evans methods, vibrating sample magnetometer, SQUID and NMR methods. Magnetic anisotropy, quenching of magnetic moments of transition metal compounds in cubic and axially symmetric crystal fields, low spin- high spin crossover, magnetic behavior of Lanthanides and Actinides, magnetic exchange interactions, magnetic materials.

**Module-II: Solid State Chemistry and X-ray Crystallography** **18L**

The geometry of crystalline state; Nature and generation of X-rays, Production of monochromatic X-rays, Scattering of X-rays, Diffraction of X-rays by crystals, Bragg's law, 1, 2 and 3 dimensional Laue equations, atomic scattering factor, structure factor, systematic absences, Unit cell-primitive and non-primitive unit cells, unit cell parameters and crystal systems. Miller indices. Crystallographic symmetries. Crystallographic Point group. Space group-Hermann–Mauguin notations, Determination of space groups and crystal structures, Single crystal XRD.

Bonding in metal crystals: free electron theory, electrical conductivity, band theory, band gap, metal and semi-conductors – intrinsic and extrinsic semiconductors; semiconductor/metal transition, p-n junctions, superconductivity, Bardeen, Cooper and Schriefer (BCS) theory. Defects in solids.

**Module-III: Photochemistry of Transition Metal Complexes** **12L**

Photoreactions of complexes of Cr(III) and Co(III), photo-aquation, photo-substitution and photo-racemization, photochemistry of $Ru(bpy)_3^{2+}$ and its application as photocatalyst for photo-splitting of water, photochemistry of transition metal carbonyls complexes.

**Text/Reference Books**


1. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John-Wiley & Sons, New York.
2. N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd Edn. (1997), Butterworth Heinemann, London.
3. F. E. Mabbs and D. J. Machin, Magnetism and Transition Metal Complexes, Dover Publications, New York, 2008.
4. O. Kahn, Molecular Magnetism, VCH, New York, 1993.
5. P. Day and A. E. Underhill (Eds), Metal-organic and Organic Molecular Magnets, RSC, London, 2000.
6. J. S. Miller and M. Drillon (Eds), Magnetism: Molecules to Materials, V; Molecule-based Magnets, Wiley-VCH, Weinheim, 2005.
7. B. D. Cullity and C. D. Graham, Introduction to Magnetic Materials, 2nd Ed, John Wiley & Sons, New York, 2011.
8. D. M. Roundhill, Photochemistry and Photophysics of Metal Complexes, Plenum Press, New York and London (1994).
9. G. J. Ferraudi, Elements of Inorganic Photochemistry, John Wiley & Sons (1988).
10. V. Balzani and V. Carassiti, Photochemistry of Coordination Compounds, Academic Press, London (1970).
11. O. Horvath and K.L. Stevenson, Charge Transfer Photochemistry of Coordination Complexes, VCH Publishers Inc. (1993)


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | 2 | 2 | 2 | - | - | - | - | - | 1 |
| CO2 | 2 | - | 2 | 2 | | 2 | - | - | - | - | - | 2 |
| CO3 | 2 | 2 | - | - | 3 | 2 | - | - | - | - | - | 2 |
| CO4 | 2 | 3 | - | 2 | - | - | - | 2 | - | - | - | 1 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4003 | | | |
| **Course Title** | Advanced Organic Synthesis II | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of organic reactions | | | |

**COURSE OBJECTIVES**

- To learn the importance of minimizing waste, saving power and doing organic synthesis according to the principles of green chemistry
- To learn various asymmetric transformations and employ such reactions in asymmetric organic synthesis of important chiral molecules
- To gather about a good overview of the fundamental principles of organotransition-metal chemistry and know how chemical properties are affected by metals and ligand
- The course aims at giving a fundamental theoretical understanding of heterocyclic chemistry, including alternative general methods for ring synthesis and application of such methods for the preparation of specific groups of heterocyclic systems

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Create awareness for reducing waste, minimizing energy consumption in organic synthesis

**CO2:** Apply asymmetric transformations in a logical manner for the synthesis of chiral molecules

**CO3:** Understand the fundamental principles of organotransition-metal chemistry and apply in the synthesis of organic compounds

**CO4:** Synthesis of heterocyclic compounds with mono and di heteroatoms

**COURSE CONTENT**

**MODULE-I: Green Organic Synthesis** **8L**

The background of organic synthesis, The need of green chemistry, Principles of green chemistry, Concept of atom economy Tools of green Chemistry – microwave, ultra sound, ionic liquids, supercritical $H_2O$ and $CO_2$ as solvents, etc. Concept of organocatalyst, Green Chemistry in real world cases and planning green synthesis in chemical laboratory.

**Module-II: Asymmetric Synthesis** **20L**

Introduction, kinetic and thermodynamic principles to asymmetric synthesis, diastereoselective & enantioselective synthesis; *Methods of asymmetric synthesis:* Resolution, use of chiral pool, chiral auxiliaries, use of stoichiometric chiral reagents, asymmetric catalysis. Asymmetric hydrogenation with special reference to Ru-BINAP catalysts, asymmetric reduction of prochiral ketones with Baker's Yeast & CBS-catalyst, asymmetric epoxidation with special reference to Sharpless and Jacobsen epoxidation, asymmetric diethylzinc addition to carbonyl compounds, asymmetric aldol reactions, asymmetric Michael reaction; industrial applications of asymmetric synthesis. Asymmetric dihyroxylation, aminohydroxilation, asymmetric cyclopropanation, application of Sharpless asymmetric epoxidation.

**Module-III: Organometallic Chemistry** **12L**

Preparation, properties and reactions of Organomagnesium, Organolithium and Organozinc reagents in synthesis. The role of Boron, Silicon, Sulphur and Phosphorus in organic synthesis. Principle, preparation, properties and application of some transition metals in organic synthesis with special reference to Copper, Palladium, Cobalt, Titanium and Nickel.

**Module-IV: Heterocyclic Chemistry** **8L**

*1,2- and 1,3-azoles*: Synthesis/ reactions/ applications, Comparison of azoles (1,2- / 1,3-) with other related mono-heterocycles. *benzo-fused five and six-membered heterocycles:* synthesis and reactions including medicinal applications of benzopyrroles, benzofurans, benzothiophenes, quinolizinium and benzopyrylium salts, coumarins and chromones; heterocycles in pharmaceutical industry.

**Text/Reference Books**


1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. R. O. C. Norman and J. M. Coxon, Principle of organic synthesis
4. S. Warren, Organic synthesis: The disconnection approach
5. W. Carruthers, Modern methods of organic synthesis
6. Paul. T. Anantas and Tracy C. Williamson, Green Chemistry
7. Theory and Practice, Paul T. Anastas and John C. Warner, Green Chemistry
8. J. A. Joule and K. Mills: Heterocyclic Chemistry (4 th Edition)


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **-** | **3** | **2** | **-** | **2** | **-** | **-** | **-** | **1** | **2** |
| **CO2** | **2** | **-** | **-** | **2** | **3** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **3** | **2** | **-** | **3** | **2** | **-** | **2** | **-** | **-** | **-** | **1** | **2** |
| **CO4** | **2** | **-** | **1** | **-** | **2** | **-** | **-** | **-** | **2** | **-** | **-** | **2** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4004 | | | |
| **Course Title** | Electrochemistry And Statistical Mechanics | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of electrochemistry and statistical mechanics | | | |

**COURSE OBJECTIVES**

- To develop theoretical aspects of ion-solvent interaction, electrical double layer and electrode kinetics
- To understand the underlying principle of quantum statistics
- To expose student to real life problems

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Evaluate the enthalpy of ion-solvent interaction and solvation number
**CO2:** Apply the principles of electrochemistry to solve the real world problems
**CO3:** Interpret thermodynamic properties by statistical mechanics
**CO4:** Apply quantum statistics to explain electronic, magnetic and fluctuation of microscopic world

**COURSE CONTENT**

**Electrochemistry**

**MODULE-I: Ion-Solvent interaction** **6L**

Born model and Born equation, enthalpy of ion-solvent interaction and its evaluation, Eley-Evan model, solvation number and its determination.

**Module-II: Electrical double Layer** **14L**

OHP and IHP, potential profile across double layer region, potential difference across electrified interface, structure of the double layer**:** Helmholtz-Perrin, Gouy-Chapman, and Stern models, Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot, thermodynamics of double layer, electrocapillary equation, determination of surface excess and other electrical parameters.

**Module-III: Electrode Kinetics** **8L**

Polarizable and non-polarizable interfaces, multistep reactions: a near equilibrium relation between current density and over potential, concept of rate determining step, determination of reaction order, stochiometric number, transfer coefficient.

**Statistical Mechanics**

**Module-IV: Ensembles and Partition function** **10L**

Probability, Equal a priori probability, concept of ensemble, Micro/Macro/Grand-canonical ensemble, Ergodic hypothesis, phase space, quantization of phase space, Liouville theorem, review of rotational, vibrational and translational partition functions, entropy of a two level system, Gibbs paradox, equipartition of energy, applications of partition function to specific heat of solids, chemical equilibrium ideal and real gases.

**Module-V: Quantum statistics** **10L**

Bose-Einstein distribution law, Einstein condensation, thermodynamic properties of ideal BE gas, Fermi-Dirac distribution law, degenerate Fermi gas, electron in metals, magnetic susceptibility, fluctuation in ensembles, concentration fluctuation.

**Text/Reference Books**


1. J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1 & 2A and 2B, (1998) Plenum Press, New York.
2. A. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd edition, (2001) John Wiley &Sons, New York.
3. Samuel Glasstone, An Introduction to Electrochemistry: Edition 1st, East-West Press Pvt Ltd New Delhi, India.
4. S. R. Morrison, Electrochemistry in Semiconductor and Oxidised Metal Electrodes, Plenum Press, New York, 1980.
5. D. E. Kyriacou and D. A. Jannakoudis, Electrocatalysis for Organic Synthesis, Wiley, New York, 1986.
6. J. Goodisman, Electrochemistry: Theoretical Foundations, Wiley, New York, 1987.
7. J. O'M. Bockris and S. U. M. Khan, Surface Electrochemistry, Plenum Press, New York, 1993.
8. C. M. A. Brett and A. M. O. Brett, Electrochemistry: Principles, Methods and Applications, Oxford University Press, Oxford, 1993.
9. P. W. Atkins, Physical Chemistry, 5th Edn, Oxford University Press, Oxford, 1994.
10. K. V. Kordesch, Fuel Cells and Their Applications, VCH, Weinheim, 1994.
11. B. K. Agarwal and M. Eisner, Statistical Mechanics, (1988) Wiley Eastern, New Delhi
12. D. A. McQuarrie, Statistical mechanics, (1976) Harper and Row Publishers, New York
13. E. S. R. Gopal, Statistical Mechanics and Properties of Matter, Ellis Horwood, England, 1974
14. S. K. Ma, Statistical Mechanics, World Sci, Singapore, 1985
15. R. K. Pathria, Statistical Mechanics, Butterworth-Heinemann, 1996
16. B.B. Laud, Statistical Mechanics


## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **-** | **2** | **-** | **2** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CO2** | **2** | **3** | **2** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **2** |
| **CO3** | **3** | **2** | **-** | **-** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO4** | **2** | **2** | **-** | **-** | **3** | **2** | **2** | **-** | **-** | **-** | **2** | **2** |

**ELECTIVE-II**

| | |
|---|---|
| **Course Code** | PCH4005 |
| **Course Title** | Polymer Chemistry |
| **Category** | Science |
| **LTP & Credits** | L: 2, T: 0, P: 0, Credits: 4 |
| **Total Contact Hours** | 24 |
| **Pre-requisites** | Fundamental knowledge of chemistry |

**COURSE OBJECTIVES**

- To understand the fundamentals of polymer in terms of polymerization techniques, tacticity control, and speciality polymers
- To interpret the differentiate between the kinetics of step growth and chain growth polymerization
- To learn about different characterization techniques to characterize polymer and polymer based hybrid materials
- To expose student to real life problems related to development of polymeric materials

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Classify the polymers and able to determine the molecular weight of the polymer by viscosity, osmotic pressure, GPC, MALDI-TOF MS, and MALLS

**CO2:** Understand the importance of stoichiometric imbalance, Carothers equation and Mayo equation to predict the molecular weight of the synthesized polymer

**CO3:** Devise the synthetic method of dendrimers and polymers to control the livingness, copolymerization, branching, sequence and stereochemistry of polymer

**CO4:** Apply the gained knowledge to construct tailor made polymer and polymer based hybrid materials as per the requirement of the society

**COURSE CONTENT**

**Module-I: Introduction to polymer** **2L**

Introduction, classification, different molecular weights and their determination, glass transition temperature, crystallinity, mechanical properties

**Module-II: Step growth and Chain growth Polymerization** **13L**

Polymerization techniques, detailed kinetics study of condensation and addition polymerization, Carothers equation, chain transfer agents and their utility, Mayo equation, controlled/living polymerization techniques and their applications: criteria, classifications, anionic, cationic, group transfer, radical: NMP, RAFT, ATRP, degenerative transfer polymerization, TERP, metal free thermal and photo-polymerization, co-ordination polymerization, metallocene polymerization, concept of copolymerization, copolymer equation, Q-e scheme

Dendrimers: synthetic strategy, molecular weight and branching calculation, properties and applications, Hyperbranched polymers synthesis and importance, sequence and stereo-controlled polymer synthesis, properties of polymers in solutions, Flory-Huggins model, viscoelastic properties of polymers polymer modification and manufacturing of commodity polymers: grafting, cross-linking, blending, compounding.

**Module-III: Speciality polymers** **9L**

Liquid crystalline polymers, conducting polymers: synthesis, mechanism of conduction and applications, electroluminescent polymers, inorganic polymers, biomedical polymers, rubber chemistry, biodegradable polymers, and hybrid materials based on polymers.

**Text/Reference Books**


1. G. Odian, Principles of Polymerization, 3rd Edition (1991), John Wiley, Singapore
2. F. W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Willey-Interscience, NY
3. C. Tanford, Physical Chemistry of Macromolecules
4. P. Bahadur, N.V. Sastry, Principle of Polymer Sciences, Narosa Publishing House, New Delhi
5. V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar, Polymer Sciences, Wiley Eastern, New Delhi
6. P. W. Atkins, Physical Chemistry, 8th Edition, Oxford University Press, New York
7. P. J. Flory, Polymer Chemistry


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **2** | **-** | **2** | **3** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **3** | **2** | **-** | **2** | | **2** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO3** | **2** | **2** | **3** | **2** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO4** | **2** | **2** | **-** | **-** | **3** | **-** | **-** | **2** | **-** | **-** | **2** | **2** |

| Course Code | PCH4006 | | | |
|---|---|---|---|---|
| Course Title | Advanced Spectroscopy | | | |
| Category | Science | | | |
| LTP & Credits | L | T | P | Credits |
| | 2 | 0 | 0 | 4 |
| Total Contact Hours | 24 | | | |
| Pre-requisites | Fundamental knowledge of spectroscopy | | | |

## COURSE OBJECTIVES

- To learn about the advanced spectroscopic techniques and their utility to study the photophysical processes
- To understand the underlying principle and working methodology of time resolved spectroscopy
- To expose student to real life problems related to spectroscopy

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Classify the photochemical transitions and identify their origin
**CO2:** Apply in depth knowledge of laser in laser spectroscopy to understand time resolved spectroscopy
**CO3:** Interpret the kinetics of photophysical processes and flush photolysis
**CO4:** Solve the advanced spectroscopic problems

## COURSE CONTENT

**MODULE-I: Fundamentals** **6L**

Generation of singlet and triplet states, radiative and non-radiative transitions, fluorescence, phosphorescence, quantum yield and life-time measurements, fluorescence quenching, resonance energy transfer, solvation dynamics.

**Module-II: Laser Spectroscopy** **6L**

Brief review of laser action, application of lasers as excitation source, time resolved fluorimetry, transient absorption spectroscopy, surface plasmon spectroscopy, multiphoton spectroscopy, single molecule spectroscopy, fluorescence correlation spectroscopy, upconversion, microscopy (optical, phase contrast, confocal, FLIM), SERS, and CARS.

**Module-III: Photophysical Processes** **12L**

Unimolecular processes, delayed fluorescence, kinetics of bimolecular processes: collision quenching, Stern-Volmer equation, concentration dependence of quenching and excimer formation, excited state electron transfer processes: exciplex, twisted intramolecular charge transfer processes, proton couple electron transfer processes, special photochemical reactions, flash photolysis, laser flash photolysis.

**Text/Reference Books**

1. J. M. Hollas, Modern Spectroscopy, Wiley, New York, 1996.
2. D. N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques, University Press, 2001.
3. G. Aruldhas, Molecular Structure and Spectroscopy, 2nd Edn, Prentice-Hall of India, New Delhi, 2007.
4. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill International Book Company, Tokyo, 1982.
5. J. D. Graybeal, Molecular Spectroscopy, McGraw-Hill International Editions, Spectroscopy series, 1998.
6. J. R. Lakowicz, Principles of Fluorescence Spectroscopy
7. R. Schinke, Photodissociation dynamics
8. W. Demtroder, Laser spectroscopy
9. R. D. Levine, Molecular Reaction Dynamics
10. J. I. Steinfeld, J. S. Francisco, W. L. Hase, Chemical Kinetics and Dynamics

**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** |
| **CO2** | **3** | **2** | **-** | **2** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **-** | **2** | **-** | **-** | **3** | **-** | **2** | **-** | **-** | **-** | **-** |
| **CO4** | **2** | **2** | **2** | **2** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **2** |

| Course Code | PCH4007 | | | |
|---|---|---|---|---|
| Course Title | Medicinal Chemistry | | | |
| Category | Science | | | |
| LTP & Credits | L | T | P | Credits |
| | 2 | 0 | 0 | 2 |
| Total Contact Hours | 24 | | | |
| Pre-requisites | Fundamental knowledge of biochemistry | | | |

**COURSE OBJECTIVES**

- To understand the mode of action of different drugs
- Synthetic methodology of drugs

**COURSE OUTCOME**

Upon successful completion of the course, the student will be able to

**CO1:** Demonstrate principles of drug metabolism and mode of action of drugs
**CO2:** Identify the different kinds of drugs and their utility
**CO3:** Provide synthetic protocols of numerous drugs

**COURSE CONTENT**

**Module-I: Physicochemical properties in relation to biological action** **4L**

Introduction to medicinal chemistry, historical development, classification of drugs.

Ionization, solubility, partition coefficient, hydrogen bonding, protein binding, chelation, bioisosterism, optical and geometrical isomerism.

**Drug metabolism principles**: Phase I and Phase II, factors affecting drug metabolism including stereo chemical aspects

**Module-II: Antibiotics** **6L**

Introduction, β-lactam antibiotics, classification, SAR and chemical degradation of penicillin, cephalosporins-classification, ntetracycline antibiotics-SAR, Synthesis of ampicillin, and cephradine,

**Antimycobacterials**: p-Aminosalicyclic acid, Thiourea, Pyrazinamide

**Anti-Viral agents:** Introduction, viral diseases, viral replication, and transformation of cells, investigation of antiviral agents, Chemotherapy for HIV. Synthesis of Idoexuidine, and cytarabin

**Anti-malarial agents:** Introduction, malarial parasite, and its life cycle, development of antimalarials, chemotherapy of malaria. Synthesis of Chloroquin, proguanil, and Quinacrine

**Module-III: General and Local Anesthetics** **8L**

**Inhalation Anesthetics:** Halothane, Methoxyflurane, Enflurane

**Diuretics:** Introduction, mode of action, loop diuretics. Synthesis of Bumetanide, Frusemide

**Anti-hypertensive Agents**: Timolol, Captopril

**Antidiabetic Agents-** Type-I and Type-II diabetes, Insulin, thiazolidinediones, Synthesis of major antidiabetic drugs

**Anti-inflammatory drugs:** Introduction, etiology of inflammatory diseases. Synthesis of: Sodium salicylate, Aspirin, Mefenamic acid

**Antipyretics:** Indomethacin, Phenylbutazone, and Analgin

**Morphine and related drugs:** SAR of Morphine analogues, Morphine sulphate, Codeine, Meperidine hydrochloride

**Module-IV: CNS Active Drugs** **6L**

**Hypnotics and sedatives**: SAR of Benzodiazepines, Chlordiazepoxide, SAR of Barbiturates, Phenobarbital, Mephobarbital,Amobarbital, Butabarbital.

**Anticonvulsants**: Epilepsy introduction, Barbiturates, Hydanatoins, Oxazolidinediones, Succinimides

**CNS-stimulants**: CNS stimulants of natural origin and synthetic CNS stimulants : methylphenidate, atomoxetine.

**Antipsychotics**: Phenthiazines, Triflupromazine

**Antidepressants:** Tricyclic antidepressants, monoamine oxidase drugs

**Antianxiety drugs:** Meprobomote and related drugs

**Text/Reference Books**


1. Wilson and Gisvolds Textbook of Organic Medicinal and PharmaceuticalsChemistry, 8th edition, edited by R.F. Doerge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.C. Foye, Principles of Medicinal Chemistry, Lea &Febiger, Philadelphia, USA.
4. The Organic Chemistry of Drug Design and Drug Action, by R. B. Silverman, Academic Press, 1992.
5. Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. Ist edition, Vol. I, II, V, VIII & IX (only relevant chapters).
6. Reuben, B.G.; Wittcoff, H.A Pharmaceutical Chemicals in Perspective, John Wiley & Sons, New York, 1989.
7. An introduction to Medicinal chemistry, G. L. Patrick, Oxford Press
8. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1-5, Wiley
9. Medicinal Chemistry, Ashutoshkar, New Age International Ltd
10. Principles of Medicinal Chemistry, W. O. Foye, Varghese Pub. House
11. Essentials of Medical Pharmacology, K. D. Tripathi, Jaypee Brothers
12. A text book of medicinal chemistry, P. Primo, CBS Publishers & Distributors
13. Text book of pharmaceutical organic chemistry, Md. Ali, CBS Publishers
14. A Text book of pharmaceutical chemistry, Jayasree Ghosh
15. The organic chemistry of drug design and drug action, Silvermann R. Academic press

Medicinal Chemistry by Burger, Vol I –VI

## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | 3 | 2 | 2 | - | - | - | 2 | 2 |
| CO2 | 2 | 2 | - | - | 2 | 2 | - | - | 2 | - | - | 2 |
| CO3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | - | 2 | - | - | 2 |

**ELECTIVE-III**

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4008 | | | |
| **Course Title** | Materials Chemistry | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 2 | 0 | 0 | 2 |
| **Total Contact Hours** | 24 | | | |
| **Pre-requisites** | Fundamental knowledge of chemistry and physics | | | |

## COURSE OBJECTIVES

- To understand the fundamentals of materials chemistry and its importance in nanoregime
- To identify the controlling factor in terms of size, shape and dimension of the nanomaterials
- To learn about different characterization techniques to characterize the synthesized materials and hybrid materials
- To expose student to real life problems related to development in catalysis, electronics, nanobiotechnology, sensors, nanomedicines, nanophotonics and defense

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Apply top down-bottom up approach to synthesize required nanomaterials and their in depth characterization by X-ray diffraction, electron microscopies, TGA, XPS and spectroscopy

**CO2:** Understand the growth kinetics and growth mechanism to synthesize shape and dimension controlled nanomaterials

**CO3:** Correlate how size, shape and dimensionality of nanomaterials affects the opto-electronic, magnetic, organocatalytic, sensing, and biomedical properties

**CO4:** Design and deliver desired nanomaterials as per the requirement of the society

## COURSE CONTENT

**Module-I: Synthesis and Application of Nanomaterials 16L**

Introduction, importance, classifications and theoretical aspect of nanomaterials, top down-bottom up approach, different synthetic strategy of metal/metal oxide/semiconducting materials, template based synthesis, size, shape and dimension controlled synthesis, growth kinetics, composite nanostructures, properties and size effect of nanomaterials in optoelectronic, mechanical, magnetic, and catalytic properties, applications of nanomaterials in energy, electronics, automobiles, textiles, cosmetics, nanobiotechnology, nanosensors, nanomedicines, nanophotonics space and defense, etc.

**Module-II: Instrumental Techniques for Characterization 8L**

Basic principles and applications of X-ray diffraction, electron microscopies (SEM, TEM), scanning probe microscopies (STM), atomic force microscopy (AFM), optical microscopies [confocal microscopy, scanning near field optical microscopy, particle size analysis (DLS)], thermal (DSC, DTA), optical (IR, FTIR, Raman), ICP-MS and XPS.

**Text/Reference Books**


1. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, Wiley-VCH, Weinheim, 2004
2. C. Bréchignac, P. Houdy, M. Lahmani, Nanomaterials and Nanochemistry, Springer, London, 2006.
3. G. Cao, Nanostructures & Nanomaterials, Synthesis, Properties & Applications, Imperial College Press, London, 2004. L. Cademartiri and G. A. Ozin, Concepts of Nanochemistry, Wiley-VCH, Weinheim, 2009.
4. C. N. R. Rao, A. Muller and A. K. Cheetham, Nanomaterials Chemistry: Recent Developments and New Directions, Wiley-VCH, Weinheim, Germany, 2007.
5. G.A. Ozin, A. C. Arsenault and L. Cadematiri, Nanochemistry: A Chemical approach to Nanomaterials, Royal Society of Chemistry, London, 2009.


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **2** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **2** | **2** |
| **CO2** | **2** | **2** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO3** | **2** | **2** | **2** | **-** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO4** | **2** | **3** | **2** | **2** | **3** | **-** | **-** | **2** | **-** | **-** | **2** | **2** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4009 | | | |
| **Course Title** | Industrial Chemistry | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 2 | 0 | 0 | 2 |
| **Total Contact Hours** | 24 | | | |
| **Pre-requisites** | Fundamental knowledge of chemistry | | | |

## COURSE OBJECTIVES

- To familiarize about the need of the industry
- To provide in depth knowledge about the materials requirement are their genesis in electronic industry, fertilizer industry, utility chemicals, and glass-ceramics
- To expose the students in industrial environment

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Synthesize high purity electronic materials and glass-ceramic materials as per the requirement of the industry

**CO2:** Understand the importance and function of plant nutrient and thereby to develop essential fertilizers

**CO3:** Manufacture utility chemicals as per the requirement

**CO4:** Apply the gained knowledge to construct tailor made materials as per the requirement of the society

## COURSE CONTENT

**Module-I: Materials for Electronic Industry** **6L**

High purity Silicon, Germanium, Gallium Arsenide (GaAs) Indium phosphide (InP) etc. preparation using Zone refining, crystal growth and there use in electronic industry. High temperature materials, high alumina, alumina, sic, chromite, zirconia, magnesite etc. Ionic and superionic conductors, alumina oxide ion conductors, halide conductors superionic, fast ion conductors- RbbAg4I5, Arrhenious equation.

**Module-II: Fertilizer Industries** **8L**

General Principles of plant Nutrition: Essential plant nutrients, functions of the essential elements, classification of commercial nitrogenous fertilizers, manufacturing of ammonium sulphate, Urea, ammonia nitrate commercial phosphatic fertilizers. Manufacturing process and properties of phosphatic fertilizers, single super phosphate, triple super phosphate.

Commercial potassic fertilizers: Chemicals of potassium compounds, classification, manufacturing process and properties of potasium fertilizer, mariate of potassium, potassium sulphate, mixed fertilizer.

Biofertilizers: Classification, demands and production, Present status of fertilizer Industries in India.

**Module-III: Glass and Ceramics** **4L**

Physical and chemical properties of glasses, raw materials, manufacturing of special glasses, ceramics and their properties, raw materials, manufacturing of ceramics, applications of colors to pottery, use of ceramics.

**Module-IV: Utility Chemicals** **6L**

Manufacturing and industrial uses of $H_2$ $O_2$, $N_2$, $CO_2$, $Cl_2$ & acetylene gases. Liquefaction of gases, production of low temperature.

Inorganic fine chemicals, magnesia, alumina, $AlCl_3$, calcium carbonate, sodium silicate, $MnO_2$, $FeSO_4$, $PbO_2$ and NaOH etc.

**Text/Reference Books**


1. H. V. Keer, Principles of Solid state.
2. A. R. West, Solid State Chemistry and its applications, John Wiley & Sons, 2003.
3. B. K. Sharma, Engineering chemistry, Krishna Prakashan Media.
4. Industrial chemistry, B. K. Sharma.
5. Engineering chemistry, B. K. Sharma.
6. S. D. Shukla & G N Pandey: A text book of chemical technology Vol. 1
7. F A. Henglein: Chemical Technology (Pergamon)
8. D. Patranabis, Sensors and Transdusers, 2nd Edn, Prentice, Hall of India (2003).
9. Rajankumar Basak, Fertilizers, A text Book


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | **-** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **2** |
| **CO2** | **2** | **2** | **-** | **-** | **3** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CO3** | **3** | **2** | **-** | **3** | **2** | **2** | **-** | **2** | **-** | **-** | **2** | **-** |
| **CO4** | **2** | **2** | **2** | **-** | **3** | **-** | **-** | **2** | **-** | **-** | **2** | **-** |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4010 | | | |
| **Course Title** | Applied Electrochemistry | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 2 | 0 | 0 | 2 |
| **Total Contact Hours** | 24 | | | |
| **Pre-requisites** | Fundamental knowledge in electrochemistry | | | |

## COURSE OBJECTIVES

- To provide different industrial application of electrochemistry
- To expose student to real life problem related to electrochemistry

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Design electrochemical storage cell and fuel cell

**CO2:** Devise bioanalytical sensors for applications in biological environment

**CO3:** Identify and solve the problem related to industrial electrochemistry

**CO4:** Understand the reason and extent of corrosion and thereby provide the remedy to the corrosion

## COURSE CONTENT

**Module-I: Electrochemical Storage Cell** **6L**

Fundamentals and classification of batteries, primary battery (Laclanche-dry cell and Alkaline cell), secondary battery (acid and alkaline), reserve battery, construction, working and application of acid storage batteries, lithium-$MnO_2$ batteries, nickel- metal hydride batteries, and lithium based conducting polymer battery.

**Fuel cell:** Introduction, characteristics of fuel cell, classification, construction and working principle of: gaseous fuel cells, solid oxide fuel cells, cool fuel cells, phosphoric acid fuel cell, molten carbonate fuel cell, proton exchange membrane fuel cell, problems with fuel cells.

**Module-II: Bio-electrochemistry and Sensors** **6L**

Introduction, membrane potential, theoretical and modern approach of biochemical cells, electrical conduction in biological organism, electrochemical communication in biological organisms.

**Biosensors:** Introduction, electrochemical bio-sensors- characteristics, use as a transducer, types.

**Ion-Sensors**: Introduction, types, analytical and biological applications of sensors.

**Module-III: Industrial Electrochemistry** **6L**

Fundamentals, electro- organic synthesis (Kolbes synthesis, oxidation and reduction of hydrocarbons, reduction of nitro-compounds), electro inorganic synthesis of fluorine and ozone, synthesis of metal salts via anodic dissolution.

The chloro-alkalyl industry: Introduction, general concepts of brine elecrolysis, modern technological developments (electrode materials, membrane), chlorine cell technologies (diaphragm cells, membrane cell).

Electrochemistry applied to electrodeposition, electroplating, electroplating of metals chromium, cadmium, nickel, copper, silver, gold, purpose of metal electroplating composition and conditionof plating bath, applications waste treatment and metal recovery.

**Module-IV: Corrosion** **6L**

Definition, scope and economics of corrosion, factors affecting corrosion, theories of corrosion, kinetics of corrosion, Evan's diagram, Pourbaix diagram, electrochemical series, galvanic series, dry and wet corrosion, different types of corrosion-pit, soil, chemical and electrochemical, inter- granular, waterline, microbial corrosion, measurement of corrosion by different methods, passivity and its breakdown, protection against corrosion: design and material selection, modification of materials, corrosion inhibitors, protective coatings, cathodic and anodic protection.

Corrosion testing techniques: XRD, ESCA, FTIR and surface techniques, corrosion in industries with special reference to oil and mining industries.

**Text/Reference Books**


1. Modern Electrochemistry, 2nd Ed. Vol.1,2A &2B, Bockris & Reddy (Plenum, NY) 1998
2. Chemical &Electrochemical Energy Systems, R. Narayan & B. Viswanathan (University Press), 1998.
3. Industrial Electrochemistry, D. Peltcher & F. C. Walsh (Chapman & Hall)1990.
4. Biosensors-theory and Applications, Donald G. Burek, (Technomic), 1993.
5. Principles and Applications of Electrochemistry–Crow (Chapman hall, New York) 2014
6. Fundamentals of Electrochemistry, Fulkner and A. J. Bard, Wiley India, 2006.


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 3 | 2 | - | 2 | - | - | - | 2 |
| CO2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | - | - | - | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | - | - | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 | 2 | - | - | - | 3 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH4101 | | | |
| **Course Title** | Project | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 0 | 0 | 9 | 6 |
| **Total Contact Hours** | 72 | | | |
| **Pre-requisites** | Advanced knowledge in chemistry | | | |

## COURSE OBJECTIVES

- To provide opportunity to involve in scientific research and thereby inculcate innovative thinking and research culture
- To design research oriented project on particular context
- To perform literature review on selected project work
- To conduct experiment scientifically with all safety measures
- To characterize the prepared material by using modern instrumental tools such as microscopic, spectroscopic, diffraction, adsorption and thermal techniques

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Identify research problem and execute literature survey
**CO2:** Analyze the research gap and accordingly design the research problem
**CO3:** Interpret the acquired data and demonstrate research findings in form of a scientific reports / dissertation and presentations
**CO4:** Communicate the findings to the society through proper presentation

## COURSE CONTENT

- Recent research articles will be supplied to each student for study followed by critical discussion on the research paper
- Research problem has to be finalized in consultation with the supervisor. The work has to be carried out under the supervisor and Research Report of approximately 40-50 pages has to be submitted
- Seminar Lecture has to be delivered on research outcomes in Power Point Presentation

## MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | - | - | 3 | - | - | 2 | - | - | - | 2 |
| CO2 | 2 | 2 | 3 | 3 | 3 | - | 2 | 2 | - | - | - | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | - | - | 2 | 2 |
| CO4 | 2 | - | 2 | - | - | - | - | - | - | 3 | 2 | 3 |

# DETAIL SYLLABUS OF CBCS PAPER

## FOR OTHER DEPARTMENTAL PG STUDENTS

**(WILL BE OFFERED IN SECOND SEMESTER)**

| | | | | |
|---|---|---|---|---|
| **Course Code** | PCH2004 | | | |
| **Course Title** | CBCS Chemistry | | | |
| **Category** | Science | | | |
| **LTP & Credits** | L | T | P | Credits |
| | 4 | 0 | 0 | 4 |
| **Total Contact Hours** | 48 | | | |
| **Pre-requisites** | Fundamental knowledge of chemistry | | | |

## COURSE OBJECTIVES

- To provide an overview of analytical and spectroscopic determination of unknown small molecules
- To introduce polymer chemistry and materials chemistry

## COURSE OUTCOME

Upon successful completion of the course, the student will be able to

**CO1:** Separate pure compounds from crude reaction mixture and analyze the same with modern instrumental tools
**CO2:** Determine the oxidation state of metals in a complex
**CO3:** Apply the knowledge to interpret the structure elucidation of simple molecules by spectroscopy

**CO4:** Understand the importance of polymer and materials chemistry

## COURSE CONTENT

**Module-I: Separation Techniques** **12L**

Solvent extraction: principle, distribution ratio and partition coefficient, successive extraction and separation; Chromatography: general principle, classification, mathematical relations of capacity, selectivity factor, distribution constant and retention time, chromatogram, elution in column chromatography, band broadening and column efficiency, column resolution, numerical problems, ion chromatography, thin-layer chromatography, size-exclusion chromatography and gas chromatography.

**Module-II: Electroanalytical Methods** **4L**

Theory, instrumentation and applications of voltammetry and linear sweep voltammetry, amperometry.

**Module-III: Spectroscopy** **12L**

Theory, instrumentation and applications of X-rays, atomic absorption spectroscopy

Principle and applications of rotational, vibrational, Raman, electronic, NMR and mass spectroscopy.

Combined applications of different spectroscopic techniques (UV, IR, NMR, Mass) for structure elucidation of simple molecules.

**Module-IV: Polymer Chemistry** **10L**

Introduction, classification, different molecular weights and their determination, polymerization techniques, controlled polymerizations, glass transition temperature, crystallinity, mechanical properties, polymer modification and manufacturing of commodity polymers.

**Module-V: Nanoscience and Nanotechnology** **10L**

Introduction, importance, classifications and theoretical aspect of nanomaterials, top down-bottom up approach, different synthetic strategy of metal/metal oxide, size and shape controlled synthesis, properties and size effect of nanomaterials: optoelectronic, magnetic and catalytic properties.

*Different Instrumental Techniques for characterization:* Basic principles and applications of X-ray diffraction, electron microscopies (SEM, TEM), atomic force microscopy (AFM), size analysis (DLS), and thermal analysis (DSC, DTA).

**Text/Reference Books**


1. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
2. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
3. C. N. Banwell and E.M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th edition (1994), Tata McGraw Hill, New Delhi.
4. R. M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
5. G. Odian, Principles of Polymerization, 3rd Edition (1991), John Wiley, Singapore
6. F. W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Willey-Interscience, NY
7. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, Wiley-VCH, Weinheim, 2004.
8. C. N. R. Rao, A. Muller and A. K. Cheetham, Nanomaterials Chemistry: Recent Developments and New Directions, Wiley-VCH, Weinheim, Germany, 2007.


**MAPPING OF COURSE OUTCOME WITH PROGRAMME OUTCOMES**

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | 3 | 3 | - | 2 | - | - | 2 | 2 |
| CO2 | 2 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | - | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | 2 | 2 |
| CO4 | 2 | 2 | 2 | - | - | - | - | 2 | - | 3 | 2 | 2 |