# M.Phil. DEGREE COURSE (AUTONOMOUS) IN CHEMISTRY
# (SEMESTER PATTERN)

## REGULATIONS-5

(Effective from the academic year 2018 onwards)


**SCHOOL OF CHEMISTRY**

**BHARATHIDASAN UNIVERSITY**

**TIRUCHIRAPPALLI - 620 024**

## SCHOOL OF CHEMISTRY

## BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI 620 024

## M. Phil CHEMISTRY (Autonomous) COURSE (Full time)

## (SEMESTER PATTERN)

## REGULATIONS

(For the candidates admitted from the academic year 2018 onwards)

### 1. NAME OF THE COURSE

Bharathidasan University under choice based credit system (CBCS) is offering a one year M.Phil Degree Course (Semester Pattern) in Chemistry to be conducted in the School of Chemistry with provision for a research project in the second semester.

The term 'credit' is used to describe the quantum of syllabus for various programmes in terms of hours of study. Core courses are a set of compulsory courses required for each programme. Elective courses are suggested by the departmental committee to their students. The minimum credit requirement for one year M.Phil., programme in chemistry is 90.

### 2. ELIGIBILITY

A candidate, who is qualified for the MSc Degree in Chemistry through regular study / Distance Education mode / Open University system with not less than 55% of marks or 5.51 in a 10.00 grade point scale under CBCS, is eligible to register for the M.Phil degree programme in chemistry. A candidate who is qualified for the Master's Degree prior to 19.09.1991, with not less than 50% of marks, is also eligible to register for M.Phil. programme in this University. The SC/ST candidates are given 5% relaxation from the prescribed minimum marks.

A candidate who is qualified with not less than 55% marks in chemistry for the or B.Sc. (Hons.) under the old regulations of any other University recognized by this University as equivalent thereto may also be permitted to register for the M.Phil. degree.

### 3. DURATION

The duration of the M.Phil programme shall be one year consisting of two semesters for the Full – Time programme, and two years for the Part – time programme.

The full – time and part – time programmes shall commence from July and the August. Final Examination shall be conducted in January / February for the Full – time Candidates and in April / May for Part – time candidates. The second terms Examinations shall be conducted in August / September for the Full – time candidates and April / May for the Part – time candidates.

## 4. PROGRAMME OF STUDY

### Framing Course Work for M.Phil.

The M.Phil candidates shall write three Course (I) Research Methodology (II) the paper related to the research and (III) paper related to general skills required on teaching, learning process, such as (i) computer application skills (ii) Communicative skills and (iii) Educational skills (Pedagogical skill including practical training in teaching) and (IV) Topic of Research. (Guide Paper) to equip the candidate with skills in the Research area. For each Course. 25% of marks would be allotted for the continuous internal Assessment (CIA) and the remaining 75% would be allotted for the final Examination.

| Sem-ester | Course | Title of the Course | Exam Hours | Credits | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | IA | UE | Total |
| I | Course - I | Research Methodology | 3 | 4 | 25 | 75 | 100 |
| | Course - II | Related to the Research Work | 3 | 4 | 25 | 75 | 100 |
| | Course - III | Teaching and Learning skills (Common Paper) | 3 | 4 | 25 | 75 | 100 |
| | Course - IV | Paper on Topic of Research (The syllabus will be prepared by the Guide and the examination will be conducted the COE | 3 | 4 | 25 | 75 | 100 |
| II | --- | Dissertation and Viva-Voce<br>Viva Voce 50 marks<br>Dissertation 150 marks | --- | 8 | --- | --- | 200 |

The following components shall be adopted for continuous internal evaluation / assessment

| | | |
|---|---|---|
| 1 | Best 2 tests out of 3 | 10 Marks |
| 2 | Attendance | 05 Marks |
| 3 | Seminar | 05 Marks |
| 4 | Assignment | 05 Marks |
| | **Total** | **25 Marks** |

### Question Paper Pattern for M.Phil. Programme

Section A : 10 Questions x 2 Marks = 20 Marks (Two Questions from each unit)

Section B : 5 Questions x 5 Marks = 25 Marks (Internal Choice and on set of questions from each unit)

Section C : 3 Questions x 10 Marks = 30 Marks
(Answer any three out of 5 questions and one question from each unit)

The syllabi for Courses I, and II, shall be prescribed by the Board of Studies. The syllabus for Course III (Common Paper) shall be prescribed by the University. The syllabus for Course IV shall be formulated by the subject expert / guide. The Syllabi for all the 4 courses shall consist of five units. For the Full-Time candidate Course – I, II, III, and IV will be covered in the first semester and dissertation will be covered in the Second Semester. For the Part-Time candidate Course – I, II, III and IV will be covered in the first year and dissertation in the Second year.

## 5. SCHEME OF EXAMINATIONS

(Credits and workload for the Course shall be as per the P.G. norms)

| | Marks | | Credits |
|---|---|---|---|
| **Semester - I** | CIA | F.E. | |
| Course I | 25 | 75 | 4 |
| Course II | 25 | 75 | 4 |
| Course III | 25 | 75 | 4 |
| Course IV (Elective) | 25 | 75 | 4 |
| **Semester - II** | | | |
| Dissertation | - | 200<br>(Thesis 150 + Viva- voce 50) | 8 |

## 6. FINAL EXAMINATION

The final examination for courses – I, II, III, & course IV (Elective) shall be conducted at the end of the first semester (January / February) for full-time candidates and in the case of part-time candidates the final examination for course I,II,III and course IV shall be conducted in April /May completing a minimum of 10 months of class work.

Each course shall have 60 marks for the Final Examination and 40 marks for continuous Internal Assessment. The duration for each written examination shall be 3 hours. Question papers for the final examination of Courses – I to IV shall be set externally and valued by external examiners who will form the Board of Examiners to pass the results. A candidate shall be declared to have passed course I,II,III and IV, if he / she secures not less than 40% of the marks in the University Examination and 50% of the marks in the aggregate (i.e. continuous internal assessment and the written Examination taken together).Supplementary examinations for the theory courses shall be conducted depending upon the exigency.

### Part – II Dissertation

Candidates shall submit the dissertation to the University through the Supervisor and the Head of the Department / Principal not earlier than 5 months but within 6 months from the date of start of the second semester in the case of Full-time programme and not earlier than 10 months but within one year from the date of start of the second year, in the case of Part- time programme. If a candidate is not able to submit his / her dissertation within the period stated

above, he / she shall be given an extension time of 4 months in the first instance and another 4 months in the second instance with penalty fees. If a candidate does not submit his / her dissertation even after the two extensions, his / her registration shall be treated as cancelled and he / she has to re-register for the programme. However the candidate need not write the theory papers again, if he / she has already passed these courses.

The dissertation shall be valued by one external examiner, who is within the respective University area where the Supervisor is located and by the Research Supervisor for Maximum of 150 marks by each examiner and the average of the marks awarded by both the examiners shall be taken. The external examiner shall be selected from a panel of 3 experts suggested by the Research Supervisor and working within the respective University area of the Research Supervisor. However, the University may ask for another panel, if necessary. The viva-voce examination shall be conducted by both the external examiners and the supervisor and evaluated for the maximum of 50 marks. The valuation of M. Phil Dissertations and the viva-voce examination shall be carried outs on the same day at the place of the Research Supervisor (viva is to be conducted only if the student passes in the valuation of the dissertation). The mark should be sent to the Controller of examinations by the Research supervisor.

The dissertation shall ordinarily be written in English. However, the option of writing the dissertation in Tamil is given to the candidates at the time of assigning the candidates to the Supervisor, in mutual consultation with the Research Supervisor and the Scholar.

### Viva-voce Examination

There shall be a viva-voce examination which shall be conducted by two examiners, one being the supervisor and the other who evaluated the dissertation. The maximum marks for the viva-voce examination shall be 50 (joint evaluation). A candidate shall be declared to have passed part-II Examination if he secures not less than 50% of the marks prescribed for the dissertation and 50% of the marks prescribed for the viva-voce Examination.

If the examiner who values the dissertation makes a qualified recommendation such as revision of dissertation, the candidate shall be advised to revise the dissertation in the light of the suggestions made by the examiners and re-submit the dissertation, within a period of SIX months. A sum of Rs.1500/- shall be charged as fee for Re-submission of dissertation. The revised dissertation shall be sent to the same examiner who evaluated the dissertation in the first instance

## 7. CLASSIFICATION OF SUCCESSFUL CANDIDATES

1. The candidates who passed written papers and dissertation in their first attempt shall be Classified as follows.

| | |
|---|---|
| 1. 75% and above | I Class with Distinction |
| 2. Above 60% to below 75% | I Class |
| 3. Above 50% to below 60% | II Class |

2. Candidates who pass the programme in more than one attempt shall be declared to have completed the programme under II Class.

## 8. RESTRICTION IN NUMBER OF CHANCES

### Full – Time Candidates

No candidate shall be permitted to appear for the written Examination in any course morethan twice or to re-submit the dissertation or appear for the vivavoce examination more than twice. Resubmission of a dissertation shall be done with penalty fee, within 6 months from the first of the month which follows the month in which the result of the first attempt is announced. The permitted attempts of semester-I & II Examinations shall be completed within a maximum period of 36 months from the first of the month which follows the month in which the registration was done.

### Part – Time Candidates

No candidate shall be permitted to appear for the written Examination in any course more than twice or to re-submit the dissertation or appear for the vivavoce examination more than twice. Resubmission of a dissertation shall be done with penalty fee, within 6 months from the first of the month which follows the month in which the result of the first attempt is announced. The permitted attempts of Part-I & II Examinations shall be completed within a maximum period of 48 months from the first of the month which follows the month in which the registration was done.

## 9. CONFERMENT OF THE DEGREE

No candidate shall be eligible for the conferment of the M.Phil programme unless he/she is declared to have passed both written examinations and dissertation of the programme.

## 10. RE-REGISTRATION

The candidates shall be permitted for Re-Registration based on the merit of individual cases.

While **Re-registering** the candidates shall pay the following fees prescribed for Second semester / year.

| **Particulars** | **Science Subjects Rs.** |
|---|---|
| Tuition fee (per annum) | 1,500/- |
| Special fee | 400/- |
| Laboratory fee | 2,000/- |
| Special laboratory fee | 1,000/- |
| (For subjects of Microbiology &Biotechnology) | 750/- |
| Re-registration fee | |

The Re-registered candidates are required to submit the dissertation not earlier than three months and not later than one year after the date of re-registration. No further extension of time shall be given.

## CURRICULUM STRUCTURE FOR M.Phil. CHEMISTRY

| Semester | COURSE Code No | Title of the Course Paper | Credits | CIA | ESE | Total |
|---|---|---|---|---|---|---|
| 1st Semester | Core paper | | | | | |
| | MPC511CC | Research Methodology | 4 | 40 | 60 | 100 |
| | MPC512CC | Physical Methods in Chemistry | 4 | 40 | 60 | 100 |
| | MPC514CC | Teaching and learning Process | 4 | 40 | 60 | 100 |
| | Elective paper - Any one among the following seven papers | | | | | |
| | MPC513EC-I | Modern Trends in Organic Syntheses | 4 | 40 | 60 | 100 |
| | MPC513EC –II | Selected Topics in Organic Synthesis | 4 | 40 | 60 | 100 |
| | MPC513EC–III | Principles and Applications of Organotransition metal Chemistry | 4 | 40 | 60 | 100 |
| | MPC513EC–IV | Organic and Medicinal Chemistry | 4 | 40 | 60 | 100 |
| | MPC513EC-V | Chemical Biology | 4 | 40 | 60 | 100 |
| | MPC513EC–VI | Photophysics and Photochemistry | 4 | 40 | 60 | 100 |
| | MPC513EC–VII | Essentials of Inorganic Chemistry | 4 | 40 | 60 | 100 |
| 2nd Semester | MPC521CC | Project work and viva voce | 8 | 50 | 150 | 200 |

**QUESTION PAPER PATTERN (**Paper I – IV**)**

Part A: Two questions from each unit (without choice). Each question carries 2 marks (2 x 2 = 4)

Part B: One "EITHER OR" questions from each unit. Each question carries 3 marks ( 1 x 3 = 3)

Part C: One "EITHER OR" question from each unit. Each question carries 5 marks(1 x 5 = 5)

## PROGRAMME OUTCOMES

- General terminology including various methods for the research shall be the outcome of the course. An understanding of major concepts, theoretical principles and experimental findings in chemistry.

- An ability to work effectively in diverse teams in both classroom and laboratory.

- An ability to employ critical thinking and efficient problem-solving skills in the four basic areas of chemistry (analytical, inorganic, organic, and physical).

- An ability to conduct experiments, analyze data, and interpret results, while observing responsible and ethical scientific conduct.

- Effective written and oral communication skills, especially the ability to transmit complex technical information in a clear and concise manner.

- The ability to use modern instrumentation for chemical analysis and separation.

- The ability to use computers for chemical simulation and computation.

- The ability to employ modern library search tools (e.g. SciFinder) to locate, retrieve, and evaluate scientific information.

- A familiarity with, and application of safety and chemical hygiene regulations and practices.

- shown abilities in the critical evaluation of current research, research techniques and methodologies;

- Excellent opportunity for Ph.D. programe in India or Abroad

## PROGRAMME SPECIFIC OUTCOMES

- To provide a specialization in M.Phil. degree with advanced understanding in the concepts of organic, inorganic and physical chemistry.

- To accumulate introductory and basic knowledge of research and its methodology to impact quality and comparative study of the literature for investigation of new area of research

- To impart the necessity of literature survey for research, document writing, laboratory practices, safety, project management and filing patents

- To understand the principles and applications of various characterization techniques and apply those to structural elucidation of unknown compounds

- To gain knowledge in old and advanced modern organic synthesis
- To understand the principles and applications or organo-transition metal chemistry and catalysis

- To demonstrate the influence of organic chemistry to medicinal industry

- To get broad understanding of chemical biology, photophysics and photochemistry

# Course Details

**MPC511CC**

## PAPER-I: RESEARCH METHODOLOGY

**OBJECTIVES**

- **To understand the basic principles and different stages of scientific research**
- **To expertise in document, dissertation and patent writing**
- **To develop an understanding of various research designs and techniques**
- **To learn project management, good laboratory practices and safety**

### UNIT-I

**1. Basics of Research and Literature survey**

Basic principles and different stages of scientific research: observation, problem identification, hypothesis formulation, experimentation and conclusion. Characteristics of researchers: knowledge, curiosity, creativity, commitment, interpersonal skills, open-mindedness and integrity.

Sources of information–Primary, secondary and tertiary sources (journals, reviews, monographs, books and dictionaries)–Types of journal articles (communication, full papers, notes and reviews)–Journal abbreviations–Science Citation Index–Journal Impact factors–H-index–Chemical abstracts–Beilstein–E-Journals and books–UGC infonet–Search engines: Google Scholar, Scopus, Current Contents Connect, SciFinder and Reaxys–ToC alerts.

### UNIT-II

**2. Methodology of Chemistry Document Writing**

Purpose of writing chemistry documents–Audience to chemistry documents–Importance of content, conciseness, grammar and formatting in chemistry writing–Tools for writing chemistry documents (ChemDraw, Origin and EndNote)–Lab notebooks–Different sections of chemistry documents (IMRD format)–Details of writing abstract, introduction, results and discussion, conclusion and reference sections (ACS and RSC styles) of journal articles (read-analyze-write strategy)–Writing review articles, conference abstracts, posters, dissertations/theses–Preparing research proposals for grants – Power Point presentation – Ethics in publication.

### UNIT-III

**3.Good laboratory Practices and safety**

Introduction: History, definition, principles, Good laboratory practices (GLP) and its application. GLP training: Resources, Rules, Characterization, Documentation, quality assurance, Resources, Facilities: building and equipment, Personnel, GLP and FDA, European Union, non-member courntires. Stepwise implementation of GLP and compliance monitoring.

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation, Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals , recovery , recycling and reuse of laboratory chemicals, procedure

for laboratory disposal of explosives, identification , verification and segregation of laboratory waste , disposal of chemicals in the sanitary sewer system , in incineration and transportation of hazardous chemicals.

## UNIT-IV

### 4.Project Management

Need for project management, project management approaches, project development stages, work breakdown structure.

Time, cost, quality and risk management, tools and techniques for project management, cost estimation and budgeting, monitoring controlling and closure, continual improvement.

## UNIT-V

### 5. Patents and patenting

Definitions and interpretation, criteria for patenting, types of inventions not patentable, patent application procedure, types of patent documents : provisional and complete specifications, publication and examination of patents, opposition proceeding to grant of patent, grant of patent, patent office and its establishment, patent agents, international arrangements while patenting. Exclusive Marketing Right (EMR) – Paris convention and its advantages – Patent Cooperation Treaty(PCT) and its applications - Non English patents.

## UNIT-VI

### 6. Statistical Analysis of Data

Various types of errors – precision and accuracy – significant figures, various statistical tests on the accuracy of results, positive and negative deviation from accurate results - the Gaussian distribution – the normal distribution of random errors, mean value, variance and standard deviation, reliability interval, deviations from the Gaussian law of error distribution, t-tests-comparison of the mean with the expected value, comparison of the results of two different methods, comparison of the precision of two methods by F-test, Gross errors and elimination of outlying results, graphical methods – Linear regression, regression line, standard deviation, correlation coefficient – Multiple Linear regression (one variable with two other variables)

### Text and Reference Books


1. P. B. Medawar, “Advice to a young scientist”, The Perseus Books Group (New York), 1981.
2. J. March, “Advanced organic chemistry; Reactions, Mechanism and Structure” 6$^{th}$ Ed., Wiley-Interscience, 2007.
3. www.google.com and www.wikipedia.org.
4. A. M. Coghill and L. R. Gardson, “The ACS Style Guide – Effective Communication of Scientific information”, 3$^{rd}$Edn, Oxford University Press, 2006.

5. H. Beall and J. Trimbur, “A short Guide to Writing about Chemistry”, 2nd Edn, Longman, 2001.
6. A.I. Vogel, “Quantitative Inorganic Analysis”, 3rd Ed., ELBS Longman London.
7. M. S. Robinson, F. L. Stoller, M. S. Constanza-Robinson and J. K. Jones, “Write Like a Chemist”, Oxford University Press, 2008.
8. Handbook Good Laboratory Practice (GLP) Quality Practices for Regulated Non-ClinicalResearch and Development
9. Good Laboratory Practice Standards: Applications for Field and Laboratory Studies (ACS Professional Reference Book) by Willa Y. Garner, Maureen S. Barge, and James. P
10. Chemical safety matters-IUPAC –IPCS, Cambridge Univ. Press, 1992.
11. James P Lewis, Fundamentals of Project Management. 3rd Edition, AMACOM, 2006
12. K. Arora, Ed., The Patents act, 1970 as amended by the patents Act 2005, Professional book publishers, 2005.
13. Manual of patent practice and procedure, Patent office, India, 2008; http: www. Patent office.nic.in/ipr/patent.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to**

- Understand the basic principles and different stages of scientific research
- Gain of knowledge and expertise for impacting quality research.
- Identify appropriate research topics and select and define appropriate research problem and parameters
- Expertise in surveying literature, document, dissertation writing
- Learn good laboratory practices, rules and safety
- Know safe storage and disposal of waste chemicals , recovery , recycling and reuse of laboratory chemicals
- Manage project with quality and improvement in a more appropriate manner
- Expertise in patents and patenting.

**MPC512CC**

## PAPER-II: PHYSICAL METHODS IN CHEMISTRY

**OBJECTIVES**

- To enable students know about the molecular spectroscopy for qualitative and quantitative analysis and also advanced spectroscopy.

### UNIT I

**1. Fluorescence and microscopy Techniques**

Fluorescence anisotropy- Fluorescence lifetime (single and multiexponential decay), Time correlated single photon counting - Fluorescence quenching, static and dynamic quenching- Fluorescence and confocal microscopy, Fluorescence Imaging, FRET and its applications to some biological systems like proteins, membranes and DNA. Principle,instrumentation and applications of SEM, TEM and AFM.

### UNIT-II

**2. Proton NMR**

Chemical Shift –Spin-spin splitting – Coupling constants – Vicinal, geminal and aromatic ring coupling constants –Karplus equation – Long range coupling constants – Homotopic, Enantiotopic and Diastereotopic systems – First and Second order spectra – Heteronuclear Coupling with $^{19}F$ and $^{31}P$ – Chemical spin decoupling of rapidly exchangeable protons (OH, SH, COOH, NH, $NH_2$) – Solvent Effects – Simplification of complex spectra – Double resonance techniques, shifts reagents – NOE phenomenon.

### UNIT-III

**3. Carbon NMR**

Relaxation – Chemical shifts of common functional groups – Broad band decoupling – Off resonance decoupling – DEPT experiment – Non-equivalent carbons – Heteronuclear coupling with deuterium, fluorine-19, phosphorous-31 – Identification of small compounds based on proton and carbon NMR data.

Two dimensional spectroscopic methods: COSY technique; $^{1}H$-$^{1}H$ correlations – Hetcor technique; $^{1}H$-$^{13}C$ correlations – HSQC – HMQC – NOESY – MRI.

### UNIT-IV

**4. Mass Spectrometry**

Ionization techniques - Chemical Ionisation, Electronspray Ionization (ESI), Field desorption Matrix-Assisted Laser Desorption/Ionization (MALDI), Fast Atom-Ion Bombardment (FAB).Resolution: Mass Analyzers magnetic field only, Double focusing, quadrupole ion storage, time of flight (TOF). Hyphenated techniques: GC-MS and tandem Mass spectrometry MS/MS. Methods used in determination of molecular ion and molecular formula. Applications to different class of compounds.

## 5. IR spectroscopy

Sampling techniques – Factors influencing group frequencies – Both internal and external – Quantitative studies – Hydrogen bonding (intermolecular and intramolecular).

## UNIT-V

## 6. Diffraction Methods

Diffraction of X-rays- Bragg's condition, Geometry of crystals, 32 crystal classes (centrosymmetric and non-centrosymmetric), 14 bravais lattice, seven crystal systems. Crystal as lattice concept-lattice and reciprocal lattice, lattice planes and directions (Miller indices), stereographic projection, scattering by a unit cell, space groups – screw axis and glide planes, symmetry elements and its graphic symbols, systematic absences. Instrumentation of X-ray diffractometer, Structure factor and its calculation, structure determination-deduction of space groups from systematic absences,Fourier synthesis, heavy atom method, Phase problem in structure analysis, refinement of structure.A brief account of the use of synchrotron radiation in diffraction studies.

## UNIT-VI

## 7. Electron Spin Resonance

ESR spectroscopy: Basic concepts – Factors affecting the magnitude of g and A tensors in metal complexes – Anisotropy in g and A values -Zero-field splitting and Kramers degeneracy - Applications of EPR to some simple inorganic systems like methyl radical,p-benzosemiquinone and naphthalene anion, Cu(II), Fe(II), Mn(II) and Ni(II) complexes.

## 8. Electroanalytical Techniques

Principle, working and applications of Voltammetric techniques- Normal pulse and differential pulse voltammetry - cyclic voltammetry – stripping voltammetry - chronoamperometry

## Text and Reference Books


1. Special Issue on Nanoscience, Ace. Chem. Res., 41, (12), Dec 2008.
2. Bengt Nolfing, 'Methods in Modern Biophysics', Springer, 2004.
3. T. Pradeep, Nano: The Essentials, Tata Mc Graw-Hill, New Delhi, 2007.
4. N.J. Turro Modern Molecular Photochemistry, University Science Books, 1991.
5. J.R. Lakowicz Principles of Fluorescence Spectroscopy,3rdedn Kluwer, 2006.

6. P.M. Silverstein, F.X. Wester, Spectroscopic Identification of Organic Compounds, 8th Ed., Wiley 2014.
7. W. Kemp, Organic Spectroscopy, 3rd Ed., Mac Publications, 2011.
8. P. S. Kalsi, Spectroscopy of Organic Compounds; 6th Ed., New Age International Publishers, New Delhi, 2006.
9. D.L. Pavia, G.M. Lampman and G.S. Kriz, Introduction to Spectroscopy, 5th Ed., Cengage Learning, 2015.
10. H. Gunther, NMR spectroscopy, basic principles, concepts and application in chemistry, John Wiley & Sons, 2nd Ed., 1995.
11. J. Mohan, Organic Spectroscopy Principles and Applications, CRC; 2nd Ed., 2004.
12. Spectrometric Identification of Organic Compounds, 6th Edition, Robert M. Silverstein and
13. Francis X. Webster, Publisher: John Wiley & Sons, Inc, 1998
14. 2. Theme issue on "Frontiers in Mass Spectrometry", Chem Rev 2001, Vol. 101, px-xx, Bioanalytical Chemistry, S. K. Mikkelsen and Eduardo Corton, Publisher: Wiley-
15. Interscience- John Wiley & Sons, Inc., 2004
16. 4. Joseph R.Lakowicz "Principle of Fluorescence Spectroscopy" Third Edn.Springer,USA,2006
17. F. A. Cotton, Chemical Applications of Group Theory, John Wiley & Sons 3rd Ed. 1990 (for the basic of symmetry elements, character table and their various applications)
18. W-K. Li, G-D. Zhou, T. C. W. Mak, IUCR Text on Crystallography: Advanced Structural Inorganic Chemistry, Oxford University Press, 2008
19. IUCR Text on Crystallography: The Basics of Crystallography and Diffraction C. Hammond, Oxford University Press, 3rd Ed., 2009.
20. Y. Waseda, E. Matsubara, K. Shinoda, X-ray Diffraction Crystallography, Springer, 2011.
21. R. S. Drago, Physical Methods in Chemistry, Saunders, 1977.
22. R. S. Drago, Physical Methods in Inorganic Chemistry, Third Edition, Wilely Eastern
23. J. A. Weil, J. R. Boldton and J. E. Wertz, Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, John Wiley and sons, 1994. H. Willard, L. Merritt, A. Dean, A. Settle, 'Instrumental Methods of Analysis', First Edn., Wordswoth, USA.
24. Daniel C. Harris, "Quantitative Chemical Analysis", Third Edn., W.H. Freeman and Company New york, 1996.
25. A.J. Bard L.F. Faulkner, Electrochemical methods – Fundamentals and Applications, Second Edn., Wiley-VCH, 1998.
26. Joseph Wang, "Analytical Electrochemistry", Second Edn., Wiley-VCH, 2001

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to**

- Demonstrate the background theory of variety of spectroscopic techniques
- Understand instrumentation methods of analytical and spectroscopic techniques
- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- Investigate and solve qualitative and quantitative problems in the chemical sciences, both individually and in teams, by synthesizing and evaluating information from a range of sources
- Analyze the analytical and spectroscopic data of experiments and elucidate the structure of unknown compounds
- Understand the principle and applications of IR, NMR, EPR, mass and electroanalytical techniques
- Understand the principle and applications of SEM, TEM, AFM and X-ray diffraction studies.

**MPC513EC - I**

## PAPER III

## 1. MODERN TRENDS IN ORGANIC SYNTHESES

**OBJECTIVES:**

- **To learn the modern trends in organic synthesis**
- **To synthesize efficiently the targeted organic compounds by using metals**
- **To know the importance of asymmetric synthesis**

### UNIT I

**1. Transition metal in organic synthesis**

Formation of C-C single bonds: Organolithium reagents, Organomagnesium reagents, Organozinc reagents, Application of Organocopper, Organocobalt and Organopalladiumchemistry.Formation of C-C double bonds: Alkene metathesis reactions using ruthenium complexes

### UNIT II

**2. Organometallic reactions**

Organometallic reaction mechanisms: Ligand substitution processes, Oxidative Addition/ Reductive elimination, Migratory Insertion/ beta-Hydride Elimination, Transmetallation, Nucleophilic and electrophilic attack. Transition Metal Carbene complexes: Fischer, Non-stabilized, Schrock carbene complex, Rhodium-catalyzed Asymmetric hydrogenation – Rhodium(I) catalyzed Cycloisomerisation, Cyclotrimerization, [2+2+1] and [4+1]-cycloadditions.

### UNIT III

**3. Chemistry of 1,3-Dipoles - I**

1,3-Dipolar cycloaddition reactions: Types of dipoles – Reactivity of rhodium(II) carbenoids: Rhodium(II) catalyzed cycloaddition, Cyclopropanation, Insertion reactions – Inter- and intramolecular reactions – Carbonyl ylides: Generation – Stereoselectivity, Chemoselectivity, Regioselectivity, Asymmetric synthesis, Applications to natural products: alkaloids, sesquiterpenes, squalastatins, tropolone systems – Oxidopyrylium ions: Generation, Cycloaddition reaction.

### UNIT IV

**4. Chemistry of 1,3-Dipoles II**

Thiocarbonylylides: Generation, 1,4 hydrogen shift, 3+2 cycloaddition, Dimerization reaction – Diazoalkanes: Cycloaddition with C=C, C=N, C=S, C≡C groups – Mesoionic ring systems: Synthesis and cycloaddition of münchnones, isomünchnones, thiomünchnones,

sydnones – Generation, Cycloaddition reactions of Oxonium, ammonium ylides and Azomethineylides with suitable examples.

## UNIT V

### Synthons and Synthetic Equivalents

Introduction to disconnections – Synthons and synthetic equivalents – Electron donors (nucleophiles) – electron synthon approach – Electron acceptors – (electrophiles) – Introduction of functional groups – Rregioselective and stereoselective alkylation of cyclic ketones, cyclic enones. C-alkylation versus O-alkylation: Enamines and selection alkylation (Mono and di) via enamine reactions. Olefination of carbonyl compounds – Wittig reactions, McMurry method- Retrosynthetic analysis of Simple organic compounds- Antithesis of mono and difunctional open chain target molecules.Retrosynthetic analysis of monocyclic and bicyclic target molecules.

## UNIT VI

### 5. Asymmetric Synthesis

Basic principles of asymmetric synthesis – Enantioselective and diastereoselective – Analytical methods for determining enantiomeric excess. Asymmetric synthesis on chiral substrate: Nucleophilic addition to α-chiral carbonyl compounds; Prediction of stereochemistry – Cram's rule and related modifications. Asymmetric synthesis using chiral reagents: Chiral modification of lithium aluminum hydride – BINAL-H – Application in reduction of prochiral ketones; oxazaborolidines. T.S model. Asymmetric Michael addition to α,β-unsaturated carbonyl compounds – T.S model. Chiral lithium amides, enantioselective deprotonation. Asymmetric synthesis using chiral auxiliary: Chiral auxiliaries derived from proline, champhor and menthol. Asymmetric synthesis using chiral catalysts: Asymmetric alkylation and allylation of carbonyl compounds – Noyori's BINAP – Jacobson catalyst – Evans catalyst.

### Text and Reference Books


1. A.W. Darkins, R.C. Poller, An Introduction to Organometallic Chemistry, Macmillan Publishers, 1986.
2. L. Brandsma, S.F. Vasileusky, H.D. Verkruijesse, Applications of Transition Metal Catalysts in Organic Synthesis, Springer, Desktop Edition, 1999.
3. J. Clayden, N. Greeves, S. Warren, P. Wothers, OrganicChemistry, Oxford university press, 2001.
4. L.S. Hegedus, Transition Metal in the Synthesis of Complex Organic Molecules; University Science Books, California, 1994.
5. P. A. Evans, Ed., Modern Rhodium Catalyzed Organic Reactions, Wiley-VCH, 2005.

6. A. Padwa, W.H. Pearson, Eds., Synthetic Applications of 1,3-Dipolar CycloadditionChemistry Toward Heterocycles and Natural Products, John Wiley & Sons, 2003.
7. J. D. Morrison, Asymmetric Synthesis; Vols 1-5, Academic press, 1983.
8. R. Noyori, Asymmetric Catalysis in Organic synthesis, Wiley, New York, 1994.
9. I. Ojima, Catalytic Asymmetric Synthesis, VCH-New York, Pergamon, 1998.
10. H.B. Kagan, Asymmetric Synthesis, Thieme Medical Publishers, 1st Ed., 2003.
11. S. Waver, Organic Synthesis, The disconnection approach, John Wiley & Sons, 1982.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- Transition meal mediated organic synthesis
- Key functions and mechanism of organometallic reactions involved in organic synthesis
- The chemistry of 1,3-idipoles
- Rh(II) catalyzed reactions and mechanisms
- Chemistry of cycloaddition reactions and mechanisms
- Basic principles and applications of asymmetric synthesis
- Role of asymmetric synthesis in natural products preparation
- Asymmetric synthesis using chiral reagents and catalysts

**MPC513EC - II**

## 2. SELECTED TOPICS IN ORGANIC SYNTHESIS

**OBJECTIVES**

- **To learn the importance of retrosynthetic analysis**
- **To know drug discovery, design and development**
- **To demonstrate the use of lanthanide reagents in organic synthesis**

### UNIT I

### 1. Synthons and Synthetic Equivalents

Introduction to disconnections – Synthons and synthetic equivalents – Electron donors (nucleophiles) – electron synthon approach – Electron acceptors – (electrophiles) – Introduction of functional groups – Rregioselective and stereoselective alkylation of cyclic ketones, cyclic enones. C-alkylation versus O-alkylation: Enamines and selection alkylation (Mono and di) via enamine reactions. Olefination of carbonyl compounds – Wittig reactions, McMurry method.

### 2. Retrosynthetic Analysis of Simple Organic Compounds

Antithesis of mono and difunctional open chain target molecules.Retrosynthetic analysis of monocyclic and bicyclic target molecules.

### UNIT II

### 3. Asymmetric Synthesis

Basic principles of asymmetric synthesis – Enantioselective and diastereoselective – Analytical methods for determining enantiomeric excess. Asymmetric synthesis on chiral substrate: Nucleophilic addition to α-chiral carbonyl compounds; Prediction of stereochemistry – Cram's rule and related modifications. Asymmetric synthesis using chiral reagents: Chiral modification of lithium aluminum hydride – BINAL-H – Application in reduction of prochiral ketones; oxazaborolidines. T.S model. Asymmetric Michael addition to α,β-unsaturated carbonyl compounds – T.S model. Chiral lithium amides, enantioselective deprotonation. Asymmetric synthesis using chiral auxiliary: Chiral auxiliaries derived from proline, champhor and menthol. Asymmetric synthesis using chiral catalysts: Asymmetric alkylation and allylation of carbonyl compounds – Noyori's BINAP – Jacobson catalyst – Evans catalyst.

### UNIT III

### 4. Nomenclature and Mechanism of Drugs

Introduction – Study of drugs – Important terminologies in pharmaceutical chemistry – Classification and nomenclature of drugs – Nomenclature of some heterocyclic systems – Mechanism of action of drugs – metabolism of drugs – Absorption of drugs – Assay of drugs.

## UNIT IV

### 5. Drug Discovery and Development

Introduction – Choosing a drug target – Identifying a bioassay – Finding a lead compound – Structure-activity relationship(SAR) – Identification of a pharmacophore – Drug metabolism – Manufacture-synthetic issues – Toxicity – Clinical trials – Patents.

## UNIT V

### 6. Drug Design and Pharmacokinetics

Drug design: Variation of substituents, chain extension, ring expansions/contractions, ring variations, ring fusions, isosteres, rigidification of the structure, conformational blockers.

Pharmacokinetics: Pharmacokinetics issues in drug design – Solubility and membrane permeability – Resistant to hydrolysis and metabolism – Targeting drugs – Reducing toxicity – Prodrugs – Methods of administration – Formulation.

## UNIT VI

### 7. Lanthanide Regents in Organic Synthesis

**Divalent Lanthanides**: Common and uncommon divalent Lanthanides, Methods for generation of divalent Lanthanides, Stability and reactivity patterns, Application in Organic Synthesis and Polymerization reactions.

**Trivalent Lanthanides:** Classification of Trivalent Lanthanide reagents. Methods for preparation, types of reactions.Application to Natural product synthesis.

### Text and Reference Books:


1. R. K. Mackie and D. M. Smith, Guide Book to Organic Synthesis ELBS, 1982.
2. S. Waver, Organic Synthesis, The disconnection approach, John Wiley & Sons, 1982.
3. J. March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 5th ed., Wiley, 1996.
4. S. H. Pine, J.B. Hendrickson, D. J. Cram and G. S. Hammond, Organic Chemistry, McGraw Hill, 4th ed., 1980.
5. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, Cambridge University , Press, 4th edition, 2004.
6. G. L. Patrick, an Introduction to Medicinal Chemistry, Oxford University Press, 2nd Edition, 2001.
7. J. Ghosh, Fundamental Concepts of Applied Chemistry, S. Chand and Co., New Delhi, 2006.
8. A. Kar, Medicinal Chemistry, New Age International (P) Ltd, Delhi, 1997.
9. Shu Kobayashi, MasaharuSugiura, Hidetoshi Kitagawa, and William W.-L. Lam, Rare-Earth Metal Triflates in Organic Synthesis**,** *Chem. Rev.***2002**, 102, 2227-2302.
10. Shu Kobayashi, Rare Earth Metal Trifluoromethanesulfonates as Water-Tolerant Lewis Acid Catalysts in Organic Synthesis.*Synlet*., December 1994, 689-700.

11. Mikhail N. Bochkarev,Molecular Compounds of "new" divalent lanthanides, *Coordination Chemistry Review* 248, (2004) 835-851.
12. William J. Evans, Perspectives in reductive lanthanide chemistry,*Coordination Chemistry Reviews*, 206-207 (2000) 263-283.
13. Henri B. Kagan, Twenty-five years of organic chemistry with diiodo- samarium: An overview, *Tetrahedron* 59 (2003) 10351-10372.
14. S. Kobayashi, Volume Editor, Lanthanides: Chemistry and Use in Organic Synthesis,*Springer-Verlag*, Berlin Heidelberg 1999.
15. David J. Edmonds, Derek Johnston, and David J. Procter, Samarium (II)-Iodide-Mediated Cyclizations in Natural Product Synthesis, *American Chemical Society Chem. Rev.* 2004, 104, 3371-3403.
16. Tsuneo Imamoto, Lanthanides in Organic Synthesis,*Academic Press Limited***1994.**
17. WenhuaXie, YafeiJin, Peng George Wang, Lanthanide triflates as unique Lewis acids, *Chemtech., (*Feb. 1999), 23-31.
18. . H.B. Kagan, Asymmetric Synthesis, Thieme Medical Publishers, 1st Ed., 2003.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- The chemistry of disconnections, Synthons and synthetic equivalents
- Retrosynthetic analysis of organic compounds
- Discovery and development of drugs
- Nomenclature and mechanistic action of drugs
- Design and pharmacokinetic action of drugs
- Drugs undergoing clinical trials and patent rights
- Divalent and trivalent lanthanide reagents used in organic synthesis
- Role of lanthanide reagents in asymmetric synthesis

**MPC513EC – III**

## 3. PRINCIPLES AND APPLICATIONS OF ORGANOTRANSITION METAL CHEMISTRY

**OBJECTIVES**

- **To understand the principles and applications of Organometallic chemistry**
- **To learn the structure and bonding in transition metals and complexes**
- **To learn homogeneous transition metal mediated catalysis**

### UNIT I

**1. Structure and Bonding: Electronic Book Keeping**

Electronic configuration of the transition metals – Oxidation state formalism – d-electron configuration and the 18 electron rule – Spatial orientation of d-orbitals - Molecular orbital description of octahedral complexes – Ligand field orbital splitting for various coordination geometries – Simplified electron counting scheme.

### UNIT II

**2. Survey of Organotransition Metal Complexes According to Ligand**

Classic Lewis Base donors – Phosphine and other group VB donors – Hydrides - carbon bonded ligands –- End bound π-acid ligands – Side-bound π-acid carbon ligands – Unsaturated nitrogen ligands – dioxygen and its derivatives – Sulphur dioxide.

### UNIT III

**3. Oxidative Addition and Reductive Elimination Reactions**

Oxidative addition reactions with an overall two electron change – reactions with protons – Reactions forming metal-carbon bonds – Planar Ir(I) complexes – $d^{10}$ complexes – Macrocyclic Rh(I) complexes - Organo copper reagents – Alkylation of coorinatively saturated complexes – Acylation – Oxidative addition of $H_2$ – Oxidative addition with an overall one electron change – Mononuclear Reactions forming carbon-carbon bonds and carbon-Hydrogen bonds .

### UNIT IV

**4. Insertion Reactions**

Migratory insertions – Migrations to CO-migrations to other longitudinal ligands – Thiocarbonyls – isonitriles – carbenes – Migrations to olefins and acetylenes – Migratory insertions involving hydrides and olefins-migratory insertions involving metal alkyls and olefins or acetylenes – Nucleophillic attack on coordinated olefin, acetylene, arene, $\eta^3$-allyl, $\eta^5$-$C_5H_5$, carbyne.

## UNIT V

### 5. Homogeneous Catalytic Hydrogenation and Hydrosilation

Overview – Mechanism – General features of Wilkinson's catalyst – Mechanism of hydrogenation of Rh(I) catalyst – Asymmetric homogeneous hydrogenation – Other hydrogenation catalysts – Supported transition metal complex hydrogenation catalysts – Relative advantages of homogeneous versus heterogeneous hydrogenation catalysts – Homogeneously catalyzed hydrosilation.

## UNIT VI

### 6. Formation and Fragmentation of Metallacycles

Isolobal analogy – Structural implications of isolobal analogy – metallacyclobutanes – Metallacyclopentanes – Metallacyclopentadiene – Metallacyclopentenes.

### Text and Reference Books:


1. J. P. Collman and L. S. Hegedus, Principles and Applications of Organotransition Metal Chemistry,Oxford University Press, 1980.
2. R. Hoffman, Angew Chem., Int. Ed.(Eng) 21, 711 (1982)
3. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley & Sons, New York.
4. I.Haiduc and J. J. Zuckermann, Basic Organometallic Chemistry.
5. P. Powell, Principles of Orgnanometallic Chemistry, 2nd Ed. Chapman &Hall, London.
6. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Interscience, 1980.
7. J. E. Huheey, Inorganic Chemistry, Harper and Row, 1978.


## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- The principles and applications of organotransition metal chemistry
- Structure and bonding in transition metals and complexes
- Organotransition metal complexes with different ligands
- Key steps involved in catalysis\
- The chemistry of Cu, Ir and Rh mediated catalytic reactions
- Various types of insertion reactions
- Homogeneous transition metal mediated hydrogenation and hydrosilation
- Formation and fragmentation of metallacycles

**MPC513EC – IV**

## 4. ORGANIC AND MEDICINAL CHEMISTRY

**OBJECTIVES**

- **To understand the role of organic chemistry in medicinal industry**
- **To learn the chemistry of organic syntheses**
- **Detailed study of drugs and their mechanism of action**

### UNIT I

**1. Organic Synthesis-1**

Stereochemical features of substitutions, additions (including cycloadditions), eliminations and rearrangements – A survey on reagents for routine functional group transformations – Retrosynthetic analysis and synthesis of simple organic molecules

### UNIT II

**2. Organic Synthesis-2**

Total synthesis of medicinally important natural products: Woodward's synthesis of Reserpine (1958) – Johnson's synthesis of Progesterone (1971) – Curran's synthesis of Hirsutene (1986) – Nicolau's synthesis of Taxol (1994) – Stork's synthesis of Quinine (2001) – Corey's asymmetric synthesis of Oseltamivir (Tamiflu) (2006) and Caryophyllene (2008)

### UNIT III

**3. Drugs and Their Action-An Overview**

Drugs: Historical background-sources and classification of drugs-important terminologies in medicinal chemistry. Drug Action: role of intermolecular forces-drug targets: lipids, carbohydrates, proteins (enzymes, receptor) and nucleic acids as drug targets. Pharmacokinetics and pharmacodynamics: administration, absorption, distribution, metabolism, elimination of drugs-bioavailability of drugs-side effects.

### UNIT IV

**4. Molecular modeling and Computer aided drug design.**

Basic features of molecular modeling, Molecular mechanics, *Ab initio*, DFT and semi-empirical methods-Energy minimization; Local and global energy minima, saddle point-Force fields, Monto Carlo simulation; Molecular docking- Molecular Dynamics; Introduction, basic principles, Mechanics and dynamics of Bio-macromolecules.

Stages in drug development-conventional approach-Rational drug design-Target identification-Sequence to structure - Protein structure prediction - Homology modeling-Active sites-Lead structure identification, Target – Substrate Docking - Scoring-molecular descriptors -

High throughout screening and combinatorial chemistry-Structure-activity relationship (SAR)–Toxicity, Patents

## UNIT V

### 5. Selected Examples of Drugs and Their Mechanism of Action

Antibacterial agents-mechanism of action-antibacterial agents that act against cell metabolism (sulfonamides), inhibit cell wall synthesis (penicillins, cephalosporins), interact with plasma membrane (valinomycin and gramicidin A), impair protein synthesis (tetracyclines, chloramphenicol) and act on nucleic acids (quinolones and fluoroquinolones, rifamycins). Antiviral agents-general principles-nucleic acid synthesis inhibitors (HIV), host cell penetration inhibitors, inhibitors of viral protein synthesis.Antifungal agents-azoles, allyamines and phenols.Anticancer drugs and their mechanism of action- role of antimetabolites, antisense drugs, alkylating agents and interchelating agents in cancer chemotherapy. Cardiovascular drugs: antiarrhythemic and antihypertension drugs.

## UNIT VI

### 6. Drug Discovery, Design and Development

Identification of diseases and corresponding targets, bioassays and leads. Stereochemistry and solubility issues in drug design. Structure activity relationships (SARs): changing size and shape-introduction of new substituents. Quantitative structure activity relationships (QSARs): lipophilicity-electronic and steric effects-Hansch Analysis-Topliss decision tree. Chemical and process development of drugs. Preclinical trials: pharmacology, toxicology, metabolism and stability studies-formulation. Clinical trials: phase I-IV studies-ethical issues. Patent protection.Regulation.

### Text and Reference Books


1) Fundamentals of Medicinal Chemistry by Gareth Thomas, John Wiley & Sons: Chichester, **2003**.
2) Medicinal Chemistry: An Introduction by Gareth Thomas, Wiley-Interscience, 2nd edition, **2008**.
3) An introduction to Medicinal Chemistry by Graham L. Patric, Oxford University Press, USA, 3rd edition, **2005**.
4) Wilson and Giswald's Textbook of Organic Medicinal and Pharmaceutical Chemistry by John Block and John M Beale (Eds), Lippincott Williams & Wilkins, 11th edition, **2003**.
5) The Organic Chemistry of Drug Design and Drug Action by Richard B. Silverman, Academic press, 2nd edition, **2004**.
6) Designing Organic Synthesis: The Disconnection Approach by Stuart Warren, Wiley, 2nd edition, **1984**.
7) Asymmetric Synthesis by H. B. Kagan, Thieme Medical Publishers, **2003**.

8) Advanced Organic Chemistry: Part-A and Part-B by Francis A. Carey and Richard B. Sundberg, Springer, 5th edition, **2007**.
9) Classics in Total Synthesis by K. C. Nicolaou and E. J. Sorensen, Wiley-VCH, **1996**.
10) **Journals:** Quinine: *J. Am. Chem. Soc.***2001**, *123*, 3239; Oseltamivir: *J. Am. Chem. Soc.***2006**, *128*, 6310; Caryophyllene: *J. Am. Chem. Soc.* **2008**, *130*, 2954.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- The role of organic chemistry in medicinal industry
- Chemistry of retro synthetic analysis of simple organic molecules
- Total synthesis of medicinally important natural products
- Fundamentals of drugs, sources and classification
- Drug action and its pharmacokinetics and pharmacodynamics
- Mechanistic action of anti-bacterial, anti-fungal and anti-cancer drugs
- Discovery, design and development of drugs
- Drugs under clinical trails, ethical issues and patenting

**MPC513EC–V**

## 5. CHEMICAL BIOLOGY

**OBJECTIVES**

- **To understand the role chemistry in biology**
- **To learn the fundamentals of proteins, enzymes, lipids and ucleic acids and vitamins**
- **Detailed study of cell structure**

### UNIT I

**1. Protein chemistry**

Structure of amino acids, peptides and polypeptide, fibrous and globular proteins.Primary, secondary, tertiary and quaternary structure of proteins - alpha helix, beta sheet, collagen structure; protein conformation angle, Ramachandran plot, bonds stabilizing protein structure, helix-coil transition.

### UNIT II

**2. Enzymes**

Enzymes and coenzymes, Metalloenzymes: properties of enzymes- catalytic power, specificity and regulation. Active site, inhibitors,enzyme kinetics – Michaelis-Menten equation. Enzyme action – mechanism. Enzyme catalysed reactions. Coenzyme: cofactors, prosthetic group. Oxygen transport: Heme proteins, oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin and cooperative effect.

### UNITIII

**3. Nucleic acids**

Chemistry and properties of bases, nucleoside, nucleotide and nucleic acids; Watson and Crick model of DNA, sugar puckering, base stacking A, B, C and left handed Z form of DNA, denaturation of DNA. Lipids-classification, phosphoglycerides, prostaglandin, lipoprotein. Carbohydrates – mono,di and polysaccharides - storage, structure and function of carbohydrates.

### UNIT IV

**4. Vitamins**

Fat soluble vitamins: Occurrence, properties, structure and functions of vitamin A, D, E and K. Water soluble vitamins: Occurrence, properties, structure and functions of Thiamine, Riboflavin, pyridoxine, niacin, Biotin, Folic acid, B12, ascorbic acid.

## UNIT V

### 5. Lipids

Lipids: fatty acids, bilayer, lipidation of proteins and peptides, farnesylation of the Ras protein. Insertion of lipidated peptides into model membrane: biological membranes, transport across membranes, model membrane, biophysical properties of lipidated peptides in model membranes, basic concepts of fluorescence and fluorescence markers, synthesis of vesicles containing fluorescence quencher and lipidated peptides.

## UNIT VI

### 6. Cell structure

Cell cycle and stages of growth, continuous and synchronous culture, cell fractionation.Information flow, archae and eubacteria, eukaryotes.Single cell to multicellular organisms. Molecular organization of cell: plasma membrane, membrane structure, lipid bilayer, membrane proteins, carbohydrates, transport of small and macro molecules-ecocytosis, endocytosis, cytosol, ribosomes rough and smooth endoplasmic reticulum. Mitochondria-origin, evolution, structure.chemosmotic theory: Bioenergetics:respiratory chain, production of ATP in mitochondria. Chloroplast; origin and evolution, structure, light absorption, production of ATP and conversion of $CO_2$ to carbohydrate Glucose storage, Golgi apparatus metal complexes in transmission of energy, chlorophylls, photosystem I and photosystem II.

### Text and Reference Books:


1. Bio-Chemistry, L. Stryer, 5th edition, Freeman, Newyork, 2003.
2. A.L. Lehninger, Principles of biochemistry, Worth Publishers, 4th edition, 2005
3. Cell and Molecular Biology, Edn. 8, E. D. P. Robertis and E.M.F.D. RobertisJr International Ed. Inst. Med. Ltd. 1988.
4. Molecular biology of the Cell – Edn. 3., Bruce Alberts, Dennis Bray, Julian Lewis,Martin Raff, James D. Watson, 1994.
5. The cell: A molecular approach. G. M. Cooper, 2nd Edn. ASM press, Washington,2000.
6. F. Wold, Macromolecules: Structure and Function, Prentice – Hall, 1971.
7. S.J. Lippard, and J.M. Berg, Principles of Bioinorganic Chemistry, University Science Books, 1994.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- The role of chemistry in biology
- Structural study of amino acids and proteins
- Properties, function and mechanistic action of enzymes
- Structure and function of heme proteins
- Chemistry of nucleic acids and lipids
- Watson and Crick model of DNA
- Classification, properties, structure and functions of vitamins
- Fundamentals of cell structure

**MPC513EC–VI**

## 6. PHOTOPHYSICS AND PHOTOCHEMISTRY

**OBJECTIVES:**

- **To understand the basic concepts and laws of photophysics and photochemistry**
- **To know the various techniques used in photophysics and photochemistry**
- **To understand photochemical reactions and applications**

### UNIT - I

**1. Basics:**

Basic laws, Einstein Laws – absorption, Jablonski diagram, fluorescence, intersystem crossing, phosphorescence, lifetime and quantum yield. Rate Laws, Energy gap law.Kasha'sprinciple.Stokes's shift, Fluorescence anisotropy.

### UNIT – II

**2.Techniques:**Absorption CW photolysis, photoreactors, light Sources, filters, photochemical quantum yield and intensity measurements, detectors-PMT, Diode array, CCD, ICCD.Study using time resolved techniques – pump-probe methods and instrumentation: Lasers-nanosecond, picosecond and femtosecond. Measurement of Triplet quantum yield and Time resolved absorption spectrum. Fluorescence techniques: Steady-state fluorimeter- Time-resolved fluorimeter-TCSPC and Frequency domain, ultrafast fluorescence, femto- upconversion. – confocal and multiphoton. Fluorescence standards – lifetime and quantum yield.

### UNIT – III

**3. Fluorescence spectroscopy:** Quenching of fluorescence, fluorescence lifetime, fluorescence quantum yield-method of determination, Rotation diffusion, Time resolved anisotropy, environmental influence on fluorescence properties and photobleaching.

Solvent effect-Lippert equation, excited state acidity constants, Fluorescence analysis of excited state reactions. Ultrafast solvation dynamics.Two photon fluorescence.

### UNIT-IV

**4. Fluorescence Applications:** Fluorophores-intrinsic, extrinsic- DNA, membrane and protein. Bimolecular quenching and Stern-Volmer analysis- application to proteins and membranes.FRET-.Photoinduced electron transfer, Fluorescence signaling of metal ions, anions. Luminescence - Metal complexes.

### UNIT-V

**5. Photochemical reactions and applications:** Electron transfer, proton transfer, addition reactions, elimination reactions, photoisomerisation, photosensitisation, Norrish type reactions. Photochromism, singlet oxygen. Photoionization – Single photon and Multiphoton. Triplet Energy Transfer. Reactions of Transition metal complexes- Ruthenium and Iron complexes. Solar Energy Conversion- Photo electrochemical cells- Honda's cell, Dye sensitized solar cells.

## UNIT-VI

**6. Some Current Topics in Photochemistry:** Origin of life- mutagenic effect of radiation-photodynamic therapy– photosynthesisphotoelectrochemistry of excited state redox reations-solar energy conversion and storage.

### Text and Reference Books


1. Rohatgi-Mukherjee Fundamentals of Photochemistry, Wiley-Interscience, 1992.
2. N.J. Turro Modern Molecular Photochemistry, University Science Books, 1991.
3. J.R. Lakowicz Principles of Fluorescence Spectroscopy,3rdedn Kluwer, 2006.
4. B. Valeur.Molecular Fluorescence: Principles and applications, Wiley-VCH, 2001.
5. A. Sharma and S.G. Schulman, Introduction to Fluorescence Spectroscopy, Wiley-interscience, 1999.


### LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- The basic concepts and laws of photophysics and photochemistry
- The various techniques used in photophysics and photochemistry
- Fundamentals of fluorescence spectroscopy
- Determination of quantum yield
- Application of fluorescence spectroscopy
- Fluorescence signaling and luminescence of metal ions and complexes
- Photochemical reactions and applications
- Photochemical cells, solar energy and dye sensitized solar cells

**PC513EC–VII**

## 7. ESSENTIALS OF INORGANIC CHEMISTRY

**OBJECTIVES**

- **To understand the basic concepts of organometallics**
- **Detailed study of organometallic compounds and reagents**
- **To apply NMR spectroscopy to metal complexes**
- **To learn inorganic photochemistry and inorganic biochemistry**

### UNIT I

**1. Organometallic Basic Concepts**

Valence electron count (16/18 electron rules); Types of M-C bonds, structure and bonding in mono and polynuclear metal carbonyls, nitrosyls, metal olefins, acetylenes, metallocenes and arene complexes - isolobal analogy and its usefulness – synthesis and reactivity of metal carbonyls; vibrational spectra of metal carbonyls; CO releasing molecules and NO releasing molecule.

### UNIT II

**2. Synthesis of organometallic compounds and Reagents**

Cyclometallation: cyclometalating ligands –Examples of complexes of iridium, palladium, platinum and gold (synthesis, properties and applications). Pincer ligand complexes, Piano – stool complexes, Carbenes (Fisher carbenes, Schrock carbenes, N-heterocyclic carbenes) metathesis reactions and Grubb's catalyst – applications in small molecule activation.

### UNIT-III

**3. NMR spectroscopy for organometallic compounds.**

Examples for different spin systems – chemical shifts and coupling constants (spin-spin coupling) involving different nuclei ($^{1}H$, $^{19}F$, $^{31}P$, $^{13}C$) interpretation and applications to inorganic compounds – Effect of quadrupolar nuclei ($^{2}H$, $^{10}B$, $^{11}B$) on the $^{1}H$ NMR spectra, Satellite spectra. Systems with chemical exchange - study of fluxional behavior of molecules with examples – NMR of paramagnetic molecules –Lanthanide shift reagents.

### UNIT-IV

**4. EPR Spectroscopy**

Theory of EPR spectroscopy - Spin densities and McConnell relationship –presentation of the spectrum-hyperfine splitting, Applications of ESR to some simple systems such as $CH_3$, *p*-benzosemiquinone, $Xe_2^+$ - Factors affecting the magnitude of g and A tensors in metal species - Zero-field splitting and Kramers degeneracy – Spectra of VO(II), Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) complexes

## UNIT-V

### 5. Inorganic Photochemistry

Unique features of photochemical reactions-comparison with thermal reactions-prompt and delayed reaction.Photochemistry of $d^3$ and $d^6$ complexes (Cr(III), Co(III), Rh(III) and Ru(II) complexes with illustrations of photo-substitution, photo-rearrangement, photo-redox reaction, photosensitizer, photo-aquation and photo-anation) application in water photolysis. Manganese in photosynthesis and $O_2$evolution-importance of photosystem I and II and oxygen evolving complex (OEC).

## UNIT-VI

### 6. Selected Topics in Bioinorganic Chemistry and Reactions and Catalysis by Organometallics

Organometallic reactions-Ligand association and dissociation, oxidative addition and reductive elimination, Insertion reactions, reactions of coordinated ligands in organometallics. Reaction mechanism for hydrogenation, hydroformylation (oxo process), olefin oxidation (Wacker process) and carbonylation of methanol, epoxidation, alkene metathesis, Ziegler-Natta catalyst.

Heme and Non-heme proteins: structure and function of hemoglobin, myoglobin, hemerythrin, hemocyanin), blue copper proteins, cytochromes, iron-sulfur proteins, electron transport chain (ETC) in respiration, nitrogen-fixation using nitrogenase, hydrogenase, urease-platinum complexes in cancer therapy, cis-platin and its mode of action –cytotoxic compounds of other metals-gold containing drugs as anti-rhematic agents and its mode of action.

### Text and Reference Books


1. R.H.Crabtree, The Organometallic Chemistry of the Transition Metals, 6th Ed, Wiley-Interscience,2014
2. F.A. Cotton and G. Wilkinson, C. A. Murillo and M. Bochmann,Advanced Inorganic Chemistry;6thEd., A Wiley - Interscience Publication, John –Wiley & Sons, USA, 1999.
3. J. E. Huheey, E. A. Keiter, R. L. KeiterO. K. Medhi, Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Pearson Education Publishers India, 2006.
4. P.Powell, Principles of Organometallic Chemistry,2nd Ed.Springer,1998.
5. A.Elias, B.D.Gupta, Basic Organometallic Chemistry-Concepts Synthesis and Applications,2ndEd.University Press, 2013.
6. R. B. Jordon, Reaction Mechanisms of Inorganic and Organometallic Systems, Chapter 73rd Ed., Oxford University Press, 2008.
7. A. S. Negi, Introduction to Inorganic Photochemistry, 1st Ed. Cyber Tech Publications 2011

8. S. J. Lippard, J. M. Berg, Principles of Bioinorganic Chemistry, University Science Books, 1994.
1. 9I. Bertini, H. B. Gray, S. J. Lippard, J S Valentine, Bioinorganic Chemistry, 1st Ed., University Science Books, 1998.
9. W. Kaim, B.Schewederski, Bioinorganic chemistry: Inorganic Elements in the chemistry of Life 2nd Ed., Wiley-Blackwell publishers, 2013.
10. A. K. Das, Bioinorganic Chemistry, Books and Allied (P) Ltd. 2007.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to understand**

- Fundamentals of organometallic chemistry
- Synthesis of organometallic compounds and reagents
- Pincer ligand, heterocyclic carbene and piano-stool complexes
- Meta thesis reactions and Grubb's catalyst
- Applications of $^{1}H$, $^{19}F$, $^{31}P$, $^{13}C$ NMR spectroscopy to organometallic compounds
- Principles and applications of inorganic photochemistry and photosynthesis
- Structure and functions of heme proteins
- Metal based drugs and their mechanistic action towards various diseases

**MPC514CC**

## PAPER IV
## TEACHING AND LEARNING PROCESS

**OBJECTIVES**

- **To develop computer, communication and Teaching skills**
- **To learn bases, trends and developments of communication Technology**
- **To understand all aspects in pedagogy**

### UNIT I

**1. Computer Applications Skills**

Computer system: characteristics, parts and their functions – Different generations of computer – Operation of computer: switching on/off/restart, Mouse control,Use of key board and some functions of key – Information and Communication technology (ICT): Definition, Meaning, Features, Trends – Integration of ICT in teaching and learning - ICT applications: Using word processors, Spread sheets, Power point slides in the classroom- ICT for Research: On-line journals, e-books, Courseware, Tutorials, Technical reports, Theses and Dissertations.

### UNIT II

**2. Communication skills**

Communication: Definitions – Elements of communication: Sender, Message, Channel, Receiver, Feedback and Noise – Types of communication: Spoken and Written;Non-verbal communication – Intrapersonal, interpersonal, Group and Mass communication – Barriers to communication: Mechanical, Physical, Linguistic & Cultural – Skills of communication: Listening, Speaking, Reading and writing – Methods of developing fluency in oral and written communication – Style , Diction and vocabulary – Classroom communication and dynamics.

### UNIT III

**3. Communication Technology**

Communication Technology: Bases, Trends and Developments – Skills of using communication Technology – Computer Mediated Teaching: Multimedia, E- content – Satellite-based communication: EDUSAT and ETV channels. Communication through web: Audio and Video application on the internet, Interpersonal communication through the web.

### UNIT IV

**4. Pedagogy**

Instructional Technology: Definition, Objectives and Types – Difference between Teaching and Instruction – Lecture Technique: Steps, planning of a lecture, Delivery of a lecture – Narration in tune with the nature of different disciplines – Lecture with power point presentation – Versatility of lecture technique – Demonstration : Characteristics, Principles, Planning Implementation and Evaluation –Teaching-learning Techniques: Team Teaching, Group

discussion, Seminar, Workshop, Symposium and panel Discussion- Modes of teaching: CAI, CMI and WBI.

## UNIT V

### 5. Teaching skills-I

Teaching skills: Definition, Meaning and Nature –Types of Teaching skills: skill of set Induction, Skill of Stimulus Variation, Skill of Explaining, Skill of Probing Questions, Skill of Black Board Writing and Skill of Closure – Integration of Teaching Skills – Evaluation of Teaching Skills.

## UNIT VI

### 6. Teaching skills-II

Instructional Design Plan - Collaborative Learning Case Study - Inquiry-based Teaching Event - PowerPoint presentation of the project - Video demonstration - Self-directed Learning Event - Teaching Using Simulation Event - Bedside Teaching Scenario.

### Text and Reference Books


1. Bela Rani Sharma (2007),Curriculum Reforms and Teaching Methods, Sarup and sons, New Delhi.
2. Don Skinner(2005), Teacher Training, Edinburgh University Press Ltd., Edinburgh.
3. Information and Communication Technology in Education: A Curriculum for schools andprogramme of Teacher development, Jonathan Anderson and Tom Van Weart, UNESCO,2002.
4. Kumar, K.L (2008) Educational Technology, New Age International Publishers, New Delhi.
5. Mangal, S.K (2002) Essential of Teaching – Learning and Information Technology, TandonPublications, Ludhiana.
6. Micheal,D and William (2000), Integrating Technology into Teaching and Learning:Concepts and Applications, Prentice Hall, New York.
7. Pandaey,S.K (2005) Teaching Communication, Commonwealth Publishers, New Delhi.
8. Ram Babum, A and Dandapani, S (2006). Microteaching (Vol. 1&2), NeelkammalPublications, Hyderabad.
9. Singh V.K and SudarshanK.N(1996). Computer Education, Discovery Publishing Company, New York.
10. Sharma ,R.A (2006). Fundamentals of Educational Technology, Surya Publications, Meerut.
11. Vanaja,M and Rajasekar.S (2006), Computer Education, Neelkamal Publications, Hyderabad.

## LEARNING OUTCOMES

**After the completion of the course, the scholars will be able to**

- Develop computer applications skills
- Demonstrate features, Trends and applications of ICT in teaching and learning
- Learn the fundamentals of communication and promote communication skills
- Understand classroom communication and dynamics
- Know the bases, Trends and Developments
- Expertise in all aspects in pedagogy
- Develop teaching skills
- Integrate and evaluate teaching skills