**THE AMERICAN COLLEGE, MADURAI**

PROGRAM / COURSE FRAME ,P.G. DEPARTMENT OF CHEMISTRY (AIDED)

**Program for Choice Based Credit System - 2018 – 2019 onwards**

| S.N. | Sem | Course Code | Course Title | Hours | Credits | Marks |
|---|---|---|---|---|---|---|
| 1 | 1 | PGC 4431 | Organic Chemistry – I | 6 | 4 | 80 |
| 2 | 1 | PGC 4433 | Inorganic Chemistry – I | 5 | 4 | 80 |
| 3 | 1 | PGC 4435 | Physical Chemistry – I | 5 | 4 | 80 |
| 4 | 1 | PGC 4301 | Chemistry and Health | 4 | 3 | 60 |
| 5 | 1 | PGC 4303 | Organic Qualitative Lab | 5 | 3 | 60 |
| 6 | 1 | PGC 4305 | Physical Chemistry Lab – I | 5 | 3 | 60 |
| | | | **Total** | **30** | **21** | **420** |
| 7 | 2 | PGC 4432 | Organic Chemistry – II | 6 | 4 | 80 |
| 8 | 2 | PGC 4434 | Inorganic Chemistry – II | 5 | 4 | 80 |
| 9 | 2 | PGC 4436 | Physical Chemistry – II | 5 | 4 | 80 |
| 10 | 2 | PGC 4302 | Chemistry in Beauty and Health | 4 | 3 | 60 |
| 11 | 2 | PGC 4304 | Organic Quantitative Lab | 5 | 3 | 60 |
| 12 | 2 | PGC 4306 | Physical Chemistry Lab – II | 5 | 3 | 60 |
| | | | **Total** | **30** | **21** | **420** |
| 13 | 3 | PGC 5531 | Organic Chemistry – III | 5 | 5 | 100 |
| 14 | 3 | PGC 5533 | Inorganic Chemistry – III | 5 | 5 | 100 |
| 15 | 3 | PGC 5535 | Physical Chemistry – III | 5 | 5 | 100 |
| 16 | 3 | PGC 5301 | Inorganic Qualitative Lab | 5 | 3 | 60 |
| 17 | 3 | PGC 5601 | Research Methodology Lab | 10 | 6 | 120 |
| | | | **Total** | **30** | **24** | **480** |
| 18 | 4 | PGC 5532 | Organic Chemistry – IV | 5 | 5 | 100 |
| 19 | 4 | PGC 5534 | Inorganic Chemistry – IV | 5 | 5 | 100 |
| 20 | 4 | PGC 5536 | Physical Chemistry – IV | 5 | 5 | 100 |
| 21 | 4 | PGC 5302 | Inorganic Quantitative Lab | 5 | 3 | 60 |
| 22 | 4 | PGC 5602 | Project | 10 | 6 | 120 |
| | | | **Total** | **30** | **24** | **480** |
| | | | **Grand Total** | **120** | **90** | **1800** |

## PG CHEMISTRY –PSO

At the end of the degree/programme, students will be able to:

**PSO-1**: Gain advanced knowledge in major areas of physical, organic, inorganic, analytical environmental and biological chemistry.

**PSO-2**: Isolate, identify and estimate organic/inorganic compounds using classical laboratory and modern analytical methods.

**PSO-3**: Develop skills in literature survey, designing synthetic methodologies and characterizing the ventured compounds.

**PSO-4**: Use ideas, and techniques of chemistry and other fields of science to acquire knowledge in the emerging areas of science.

**PSO-5**: Utilize graphical/virtual communications to interact productively with people from diverse background, employ online search engines and software's tools.

**PSO-6**: Effectively communicate themes relating to chemistry.

**PSO-7**: Develop skills in the handling chemical compounds by identifying their chemical and physical properties including any specific hazards associated with their usage.

**PSO-8**: Actively participate with government agencies in monitoring equity, and supporting nations sustainable development.

**PSO-9**: Pursue research & development in all disciplines of Chemical sciences, succeed in competitive examinations, and emerge as successful entrepreneurs.

**PSO-10**: Develop skills to work with international research and development team, contribute to research collaboration and to be familiar with intellectual property rights both national and globally.

**Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)**

## DEPARTMENT OF CHEMISTRY (PG)

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 | PSO8 | PSO9 | PSO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| PGC 5531 | ✓ | | | ✓ | | ✓ | ✓ | | ✓ | |
| PGC 5533 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| PGC 5535 | ✓ | | ✓ | ✓ | | ✓ | ✓ | | ✓ | |
| PGC 5301 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ |
| PGC 5601 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | | | | | | | | |
| PGC 5532 | ✓ | | | ✓ | | ✓ | ✓ | | ✓ | |
| PGC 5534 | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| PGC 5536 | ✓ | | ✓ | ✓ | | ✓ | ✓ | | ✓ | |
| PGC 5302 | | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ |
| PGC 5602 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## Mapping of PO and PSO – DEPARTMENT OF CHEMISTRY (PG)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **PSO1** | ✓ | | | | | | | | | |
| **PSO2** | ✓ | ✓ | | | | | | | | |
| **PSO3** | | ✓ | | | | | | | | |
| **PSO4** | | | | ✓ | | | | | ✓ | |
| **PSO5** | | ✓ | | ✓ | ✓ | | | | | |
| **PSO6** | | | ✓ | | | ✓ | | | | |
| **PSO7** | ✓ | | ✓ | | | | | | | |
| **PSO8** | | | ✓ | | | ✓ | ✓ | ✓ | | |
| **PSO9** | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| **PSO10** | | | ✓ | ✓ | | | ✓ | | | ✓ |

# Curriculum

**for**

## Second Year M.Sc Chemistry (AIDED) Programme

**(For those who were admitted from the academic year 2018-2019 onwards)**

**SEMESTER III**


## Postgraduate Department of Chemistry

## The American College

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

**Madurai, Tamilnadu, INDIA**

**SEMESTER –III**

**PGC 5531 ORGANIC CHEMISTRY – III 5hrs/ 5 Cr**

**Course Objectives:**

This is the third of the four semester sequential course in organic chemistry. This course deals with oxidation and reduction reactions, photochemical and pericyclic reactions in addition to organometallic reagents.

**Course Outcome:**

At the end of the course, students will be able to:

1. Analyze the various oxidizing reagents to effect organic transformations.
2. Use the various reducing reagents and synthesize organic compounds.
3. Predict the product along with stereochemical nature of the reactions under photochemical conditions.
4. Compare various rules in pericyclic reactions to predict product and their stereochemistry.
5. Identify the potential use of various organometallic reagents and apply them to synthesize compounds

**UNIT-I : Oxidation Reactions**

DMSO -Swern oxidation, $HIO_4$, $Pb(OAC)_4$ , $Hg(OAC)_2$, $I_2$ / AgOAc (dry and wet)- Woodward and Prevost, Peroxides- Sharpless asymmetric epoxidation and dihydroxlation, Peroxyacids, PCC (Corey's reagent), PDC, Etards reagent, Jones reagent, $MnO_2$, $OsO_4$, DDQ, $SeO_2$, $N_2O_4$ and Wacker reagent ($PdCl_2$), Oxidation with Ruthenium tetraoxide, Iodobenzene diacetate , Thallium (III) nitrate.

**UNIT-II : Reduction Reactions**

Complex metal hydrides such as $LiAlH_4$, $NaBH_4$, $Na(CN)BH_3$, $Zn(BH_4)_2$ and trialkyl tin hydrides-Dissolving metals such as alkali metals, tin and zinc-$H_2$/various metal catalysts (hydrogenation)-$SnCl_2$, Lawessonn reagent – $TiCl_4$ / Zn-Cu (Mac Murrays reagent) – $TiCl_4$ / Mg-Hg-Wilkinson's catalyst, Lindlar catalyst-$BH_3$/THF, 9-BBN, optically active boranes-Baker's yeast

**UNIT-III : Photochemistry**

Introduction - Jablonski diagram - geometry of excited states - quenching - sensitisation - quantum efficiency - introduction to photo chemical reaction - photo sensitized reaction - reactivity of electronically excited ketones - Norrish-I and Norrish-II reactions - photo reductions - Paterno Buchi reaction – Barton's reaction – photo addition – photo oxidations (di-pi methane or Zimmerman rearrangement) - photo Fries rearrangement - photo chemistry of α , β unsaturated compounds – photo chemistry of arenes – photo chemistry of vision.

**UNIT-IV : Pericyclic reactions**

Atomic and molecular orbitals - Electro cyclic reaction - concepts of con and dis rotation - stereo chemical course of electro cyclic reaction in terms of conservation of orbital symmetry - cyclization of butadienes and 1,3,5- hexatriene - Frontier-Molecular orbital approach - orbital correlation diagram - state correlation diagram - theory of cyclo additions [4+2] and [2+2] additions - suprafacial and antrafacial additions - Diels alder reactions - endoselectivity regioselectivity - catalysis of Lewis acid theory of sigma tropic reactions - sigma tropic migrations of hydrogens and carbons - Claisen, Cope and Aza–Cope rearrangements - Fluxional tautomerism.

**UNIT-V : Organometallic reagents**

Organometallic reagents- principle, preparation, properties and applications of the following in organic synthesis with mechanistic details Cu, Li (Shapiro reaction), Mg, Pd, B, Rh, Si, Ti, Hg, Cd, Zn, P, Cr.

**References:**


1. S.M. Mukergi, Pericyclic reactions, Mac millan, India.
2. R.B. Woodward, R. Hofmann Verlag, The conservation of orbital symmetry, Chemie Academic Press, 1970.
3. A.J. Bellamy, An introduction to conservation of orbital symmetry, Longman group Ltd., 1974.
4. C.H, Depuy and O.L. Chapman, Molecular reactions and Photo Chemistry, Eastern and Economic edition, Tata Mac Graw Hill, 1975.
5. Organic Photo chemistry, J.M. Coxon, B.Halton Camb, Univ Prem 2nd edition, 1987.
6. K.K. Rohatgi Mukerji, Fundamentals of photochemistry, Wiley Eastern India Ltd.
7. A. Gilbert, Essentials of molecular photochemistry, Baggott Blackwell Scientific publication.
8. A. Cox and T.Camp, Introductory photochemistry, M.C. Graw Hill.
9. Jerrymarch, Advanced organic chemistry, John Wiley and Sons INC 4th Edn 1992.
10. Carey and Sundberg, Advanced Organic ChemistryPart – A Structure and mechanism, Part – B Reactions and synthesis, Plenum press, 3rd Edition 1990.
11. E.S. Gould Henry, Mechanism and structure in organic chemistry, Holtco INC1963.
12. Graham Solomons, Organic chemistry, John Wiley and Sons INC 5th Edn 1992.
13. Norman and J.M. Coxon, Principles of organic synthesis, ELBS 3rd Edition, 1993.
14. R.K. Mackie and D.M. Smith, Guide Book to organic synthesis, ELBS, 1982.
15. Michael B. Smith, Organic synthesis, M.C. Graw Hill, International Edn, 1994.
16. H.O. House, Modern synthetic reactions, Cambridge university press 3rd Edn, 1972.
17. W. Caruthers, Some modern methods of organic synthesis, Cambridge University.
18. Paul Jenkins, Organic metallic reagents in synthesis, Oxford university press, 1990.
19. R.C. Mehrotra and A. Singh, Organometallic chemistry, New age int. edition.
20. A.J. Pearson, Metallo organic chemistry, Wiley India Ltd.
21. Clayden, Greeves, Warren and Wothers, Organic Chemistry, OXFORD University Press, 2007.


| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | **X** | **X** | | **X** | |
| K5: Evaluating | | **X** | | **X** | |
| K6: Creating | | **X** | | | |

**Semester-III** **Core Theory**
**PGC 5533** **INORGANIC CHEMISTRY-III** **5 hrs/ 5 cr**

**Course Objective:**

This course exposes students to a detailed discussion on organometallics, some aspects of bioinorganic and f-block elements.

**Course Outcome:**

After completion of the course the students will be able to:

1. Describe the bonding and deduce the structure & stability of sigma and pi complexes
2. Illustrate the catalytic property of organo-metallic compound
3. Explain and highlight the properties of f-block elements
4. Discuss the structure and functions of metalloenzymes
5. Reason the role of metals in redox proteins, diagnosis and medicine

**UNIT – I: ORGANOMETALLIC CHEMISTRY - I**

Stability of organometallic compounds – effective atomic number rule – theoretical basis – metal carbonyls – preparation, properties and structures – carbonylate anions – carbonyl hydrides – synthetic utility – metal nitrosyls - preparation-bonding - stereochemical control of valence – dihydrogen complexes – carbocyclic systems – benzene, cp, cht, cot, cyclobutadiene – synthesis of ferrocene – reactions – MO diagram – alkene, alkyne, carbene and carbyne metal complexes – synthesis, structure and bonding – fluxional behavior

**UNIT – II: ORGANOMETALLIC CHEMISTRY- II**

Coordinative unsaturation – oxidative addition – reductive elimination – agostic interaction – activation of small molecules – insertion and elimination – nucleophilic attack on coordinated ligands – catalysis by organometallic compounds – hydrogenation cycle – hydroformylation – Monsanto acetic acid process – Wacker process – isomerisation reaction – WGS reaction - synthesis of gasoline – Fischer Tropsch process – Mobil process – olefin metathesis- Zeigler – Natta catalysis.

**UNIT – III: THE f-BLOCK ELEMENTS**

General features – occurrence –variable valencies - lanthanide and actinide contraction – separation of lanthanides – absorption spectra of Ln – magnetic properties– coordination chemistry – applications - shift reagents – transactinide elements – chemistry of uranium –uranyl complexes – extraction cycles of U and Np.

**UNIT – IV: BIOINORGANIC CHEMISTRY- I**

Essential and trace elements in biological systems – biological significance of metals – alkali & alkaline earth metals – Na/K pump – transition metal storage and transport of Fe, Cu, Zn – biological oxygen transport systems - structure and function of heme and non- heme proteins (Mb, Hb, Hc, Hr) – non-redox metalloenzymes - carboxy peptidase - carbonic anhydrase.

**UNIT –V: BIOINORGANIC CHEMISTRY- II**

Metalloproteins in electron transport processes – Functions of Fe, Cu proteins- cytochrome C – cytochrome P-450 – iron - sulphur proteins – blue copper proteins- superoxide dismutase – nitrogen fixation – coenzyme $B_{12}$- metal-nucleic acid interactions- fundamental reactions of metals with nucleic acids – metals in diagnosis and medicine –chelate therapy.

**References:**


1. Huheey J.E., Inorganic Chemistry IV Edn. Principles of Structure and Reactivity, Collins College Publishers, New York 1993.
2. Cotton, F.A. and Wilkinson, G.I., Advanced Inorganic Chemistry VI Edn. John Wiley and Sons, New York, 2004.
3. Purcell, K.F. and Kotz, J.C., Inorganic Chemistry, Saunders, Philadelphia, 1977.
4. Powell, P., Principles of Organometallic Chemistry II Edn. Chapman and Hall, New York, 1988.
5. Meissler G.L &Tarr T.A, Inorganic Chemistry, III Edn, Pearson Academy, Inc, New Delhi 2004.
6. Porterfield W.W, Inorganic Chemistry, Academy press, Elsevier, California 2005.

7. Shriver D.F. and Atkins P.W. Inorganic Chemistry III Edn. Oxford Univ. Press 1999.
8. Hay.R.W., Bio-Inorganic Chemistry, Ellis Horwood 1984.
9. Bertini I Gray and others, Bioinorganic Chemistry – Viva Books Pvt. Ltd., 1998.
10. Lippard S.T. Berg T.M., Principles of Bioinorganic Chemistry, Panima publishing Co. New York 1997.
11. Simon Cotton, Lanthanide and Actinide Chemistry, John Wiley & Sons, Ltd. 2006.
12. Joseph.J. Katz, Glenn. T. Seaborg, The Chemistry of the Actinide elements, Methurn& Co, Ltd, London 1957.

| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** | **Unit 4** | **Unit 5** |
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | **X** | | **X** | | **X** |
| K5: Evaluating | **X** | | | | |
| K6: Creating | | | | | |

**SEMESTER –III** ***CORE/ THEORY***

**PGC 5535 PHYSICAL CHEMISTRY – III 5 hrs/ 5cr**

**Course objectives**: The learners should be able to apply chemical thermodynamic concepts in understanding the physical behaviour of solution mixtures, utilize elementary laws of chemical kinetics in chemical reactions, acquire analytical skills in the field of photochemistry & radiation, apply theories of electrochemistry to understand electrode kinetics and theoretical aspects of electrochemical application.

**Course outcome:**

At the end of the course, students will be able to

1. Relate the effect of solute on thermodynamic properties of solution.
2. Deduce the rate of chemical reactions to understand mechanism involved in reactions.
3. Examine the changes on molecules using radiation.
4. Determine thermodynamic properties of electrochemical cells.
5. Explain redox process at the electrode and determine the kinetics of such process.

**UNIT – I: CHEMICAL THERMODYNAMICS**

A general review of enthalpy, entropy and free energy concepts, Genesis of third law and its limitations – Thermodynamics of systems of variable compositions – partial molar quantities and their determination – chemical potential – Gibbs-Duhem equation – Duhem-Margules equation – Fugacity and its determinations – choice of state- Activity and activity coefficients – electrolytes and non-electrolytes – equilibrium thermodynamics - Gibbs phase rule and its application to three component systems – Introduction to non-equilibrium thermodynamics – transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations.

**UNIT – II: CHEMICAL KINETICS – I**

Simple collision theory, absolute reaction rate theory, thermodynamics treatment, potential energy surfaces, application of ARRT to simple bimolecular processes – steady state approximation, principle of microscopic reversibility & detailed balancing – chain reactions – general characteristics, study of kinetics of chain reactions like – decomposition of acetaldehyde and $N_2O_4$; study of $H_2$-$O_2$ explosive reactions. Theory of unimolecular reactions – Lindemann, Hinshelwood, RRKM and Slater treatments. Reactions in solutions – factors influencing reaction rate in solution, significance of dielectric constant, salt effect, and kinetic isotope effect. Oscillatory reactions.

**UNIT – III: PHOTOCHEMISTRY AND RADIATION CHEMISTRY**

Physical properties of the electronically excited molecules – excited state dipole moments excited state pKa, excited state redox potential. Fluorescence, phosphorescence and other deactivation process – Stern-Volmer equation and its applications. Photosensitisation and chemiluminescence. Experimental techniques in photochemistry – flash photolysis technique.

Radiation chemistry – source of high energy – interaction of high energy radiation with matter, radiolysis of water – definition of G value.Primary and secondary process, linear energy transfer – the hydrated electron and its reactions.

**UNIT – IV: ELECTROCHEMISTRY – I**

The nature of electrolytes –ion-ion and ion-solvent interactions. Mean ion activity-The Debye-Huckel equation – Bjerrum equation- Conductivity - transport numbers – Nernst Einstein equation - Stork Einstein equation- Debye-Huckel Onsager equation - Conductivity at high frequency and at high field strength. Determination of transport number.

Double layer-polarized and non-polarized electrodes – Lippmann equation – Models for double layer – Helmholtz, Guoy&Chapmann – Stern models – Zeta potential – Elctro-kinetic phenomena – Electro-osmosis. Streaming potential – electrophoresis.

**UNIT – V: ELECTROCHEMISTRY – II**

Electrode potential – Types of potential generation – Nernst equation – Hydrogen scale – other reference electrodes – concentration cells – Liquid junction potential – membrane equilibria. Butler-Volmerequation -Tafel equation – electrolysis & overvoltage – Theories of hydrogen overvoltage – Application of EMF measurements & conductivity. Batteries – fuel cells – corrosion. Zero current potentiometry - constant current potentiometry. Polarography – pulse polarography – Differential pulse polarography – stripping voltammetry. Cyclic voltammetry – electrogravimetry – colorimetric methods

**REFERENCES**


1. Klotz and R.M. Rosenberg, Chemical Thermodynamics, 4th edition, Benjamin, 1986.
2. Kuriacose and Rajaram, Thermodynamics, 3rd edition, S.N. Chand, 1999.
3. W.J. Morre, Physical Chemistry 5th edition, Orient Longman, 1976.
4. Castellan, Physical Chemistry, 3rd edition, Addison Wesley, 1983.
5. Lee, Sears and Turcotte, Statistical Thermodynamics, 2nd edition, Addison Wesley, 1973.
6. Glasstone, Introduction to Electrochemistry, Von Nostrand
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8. Rock, Chemical Thermodynamics, Oxford University press, 1983.
9. Crow, Principles and applications of electrochemistry, Chapman and Hall, 1988.
10. Laidler, Chemical kinetics, 3rd edition, Harper & Row, 1987.
11. Rajaram & Kuriacose, Kinetics and mechanism of chemical transormation, Macmillan, India, 1993.
12. Rohatagi-Mukherjee, K.K., Fundamentals of Photochemistry, New-Age International, 1982.
13. Spinds, T.W.T., An introduction to Radiation Chemistry, John Wily & sons, 1964.


| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **Unit-I** | **Unit-II** | **Unit-III** | **Unit-IV** | **Unit-V** |
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | | **X** | **X** | **X** | **X** |
| K5: Evaluating | | **X** | | | |
| K6: Creating | | | | | |

**SEMESTER –III** **Core/ Lab**
**PGC 5301 INORGANIC QUALITATIVE ANALYSIS 5 hrs/ 3 cr**

**Course Objective:**
This is a laboratory course that deals with the principles and methods of qualitative analysis of common and less common cations present in a mixture.

**Course Outcome:**
After completion of the course the students will be able to:

1. Summarise the principle of distribution of common and less common cations in different groups
2. Demonstrate reactions for identification of cations
3. Develop analytical skill in the field of separation of cations from mixture.
4. List the cations present in a mixture
5. Design methods to analyze industrial effluents, antique pieces, environmental samples etc.,

**Component 1**: Theoretical principles

1. Classification of cations into analytical groups and classification with in each analytical group.
2. Confirmatory and spot test for cations – Chemistry of reactions

**Component 2:**

1. Semimicro qualitative analysis mixtures of four simple salts containing two common cations and two less common cations with non-interfering anions.

   Common cations of:

   Group I: Pb and Hg;
   Group II: Hg, Cu, Cd, Bi, Sb, As, and Sn;
   Group III: Al, Fe, and Cr;
   Group IV: Mn, Zn, Co, and Ni
   Group V: Ca, Sr, and Ba
   Group VI: Mg, K, and $NH_4^+$

   Less common cations of:

   Group I: W and Tl;
   Group IA: Se and Te;
   Group II: Mo;
   Group III: Be, Tl, Ce, Ti, Th, Zr, V, and U;
   Group VI: Li

   Systematic separation of cations into analytical groups followed by identification of individual cations.

2. Determination of chemical constituents in ore samples like nichrome, bronze,

**References**


1. V.V.Ramanujam, Inorganic Semimicro qualitative analysis, National Publishing company, Madras, 1974
2. A. I. Vogel, "Quantitative Inorganic Analysis", ELBS, 3rd Edition, 1971.
3. Vogel's Text book of Inorganic Qualitative Analysis, 4th Ed, ELBS, London, 1974


| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | | | | **X** | **X** |
| K5: Evaluating | | | | | **X** |
| K6: Creating | | | | | **X** |

**SEMESTER –III**

**PGC 5601 Research Methodology Lab 10 hr/ 6 cr**

**Course Objectives:**

This course will consider the application of a number of principles as applied to chemical research. This will be achieved by placing students in active research groups in the discipline of chemistry and providing them with the opportunity to carry out research activities.

**Course Outcome:**

Upon completion of this course, the students will be able to:

1. Assess the sources of information related to research
2. Utilize OHP and Power point presentation
3. Acquire the wide knowledge of instrumental analysis
4. Perform computer assisted analysis of data
5. Apply search engine and software tools in research

Students will do the experiments and project work on a title approved by the respective project supervisor. Students will maintain daily records and present oral reports while doing project preparation. All the above process will be duly assessed by the project supervisor. They will submit the collection of research article at the end of the semester.

**Component I - Practical**

1. Multistage organic synthesis
2. Purification &recrystallization techniques
3. Characterisation of compounds using UV-Vis, IR, fluorescence
4. Electrochemical study of inorganic compounds
5. Determination of the formula of a complex by spectrometry
6. Preparation and study of a super conductor
7. Thermodynamics of denaturation of bovine serum albumin (Fluorescence spectra)
8. Intermolecular H-bonding in benzyl alcohol using IR spectroscopy
9. Determination of the formation constant of iron(III)salicylate complex

**Component II- Project**

**Evaluation**

Presentation – seminar 25 marks (collective evaluation from all guides)

Project progress (includes 9 experiments) 75 marks from guide

| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | | **X** | **X** |
| K4: Analyzing | **X** | | | **X** | |
| K5: Evaluating | **X** | | | **X** | |
| K6: Creating | | | | **X** | |

# Curriculum

**for**

## Second Year M.Sc Chemistry (AIDED) Programme

**(For those who were admitted from the academic year 2018-2019 onwards)**

**SEMESTER IV**

Since 1881

## Postgraduate Department of Chemistry

# The American College

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

**Madurai, Tamilnadu, INDIA**

**SEMESTER –IV**

**PGC 5532 ORGANIC CHEMISTRY – IV 5 hrs/ 5 Cr**

**Course Objectives:**

This is the fourth of the four semester sequential course in organic chemistry. This course deals with retrosynthesis, biologically important steroids and proteins, medicinal chemistry and supramolecular chemistry.

**Course Outcome:**

At the end of the course, students will be able to:

1. Identify various synthons, synthetic equivalents and design a probable synthetic strategy in disconnection of a target molecule.
2. Apply the concepts of retrosynthesis to identify selectivity in synthesis and assess various synthons for effective retrosynthetic approach.
3. Elucidate the structure of steroidal molecules and analyze the structures and functions of proteins and nucleic acids.
4. Explain the various concepts of medicinal chemistry in designing a drug.
5. Analyze the potential applications of various supramolecules and apply green chemistry to organic synthesis.

**UNIT-I : Retrosynthesis-I**

Synthesis – types of synthesis – rational, irrational, linear, convergent, partial, total and biosynthesis - Synthons and types – synthetic equivalent – principles of disconnections in aromatic Target molecule – Functional group interconversion – order of events – guidelines to a good disconnection -– one group and two group C – X disconnection and synthetic strategies – one group C-C disconnections in carbonyl compounds – two group disconnections I – Diels-Alder reaction – two group disconnections II : 1,2-, 1,3-, 1,4-, 1,5- and 1,6- difunctional disconnections and strategies.

**UNIT-II : Retrosynthesis-II**

Chemoselectivity – Stereoselectivity – Regioselectivity — Use of aliphatic nitro compounds in organic synthesis – a high light on the use of acetylenes in the synthetic chemistry – amine synthesis – alkene synthesis – Protection and deprotection of groups: alcohols, diols, amine, acids, aldehydes and ketones – Strategy of ring synthesis – small rings such as 3 and 4 membered rings - Retrosynthetic analysis of simple and complex organic molecules – Ferruginol, α-Bisabolene, Trisporic acid and multistriatin.

**UNIT-III : Steroids, Proteins and Nucleic acids**

Steroids – Basic skeleton – Isolation – Structure determination – Structure of cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone.

Amino acids – Peptides – Proteins, Structure and function conformations of polypeptides – Ramachandran Plot -Peptide synthesis

Nucleotides and Nucleosides – laboratory synthesis of nucleotides and nucleosides – RNA and protein synthesis – Replication-Genetic code – DNA and determining the base sequence of DNA

**UNIT-IV : Medicinal Chemistry**

Drug design – Introduction – Analoges and Prodrugs – Concept of Lead – Factors governing Drug design – Rational approach to drug design– Isosterism and Bio-isosterism – Biopharmaceutical properties of drug substances –Functional groups as binding groups – pharmacophore – Quantitative Structure Activity Relationships –Computer aided drug design – A broad outline of different types of drugs based on pharmacology and their representative examples Host-guest chemistry – Biomimetic chemistry– Proximity effect – molecular adaptation – Transition state analogs – antibodies as enzymes – Suicide enzyme inactivators Molecular recognition and drug design.

**UNIT-V : Supramolecular and Green Chemistry**

Introduction to supramolecular chemistry – physical and chemical characteristics of supramolecules - self assembly into mono and multilayers – Structure, reactions and applications- Crown ethers, β - cyclodextrin, Clays, Zeolites, Dentrimers & Fullerenes.

Green chemistry-12 principles-solvent free reactions-microwave assisted reactions-role of ionic liquids ([bmim][$BF_4$])- super critical fluids ($ScCO_2$)

**References:**


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| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | | **X** |
| K4: Analyzing | **X** | **X** | **X** | | **X** |
| K5: Evaluating | **X** | **X** | | | |
| K6: Creating | **X** | | | | |

**Semester-IV** **Core Theory**

**PGC 5534** **INORGANIC CHEMISTRY-IV** **5 hrs/ 5 cr**

**Course Objectives:**

This course attempts to present an overall view of various heteroatom ring systems, their synthesis and reactivity will be discussed. Polymers of such systems and their technological application will also be introduced. It also includes the metal clusters and inorganic photochemistry. Principles and applications of various analytical techniques will also be discussed.

**Course Outcome:**

After completion of the course the students will be able to:

1. Formulate synthetic routes and infer the structure of boron compounds
2. Classify Si-O, P-O & P-S systems and relate the structure with properties
3. Explain the synthesis, reactions and bonding properties of P-N and S-N heterocycles and polymers
4. Establish the structural implications of metal clusters and describe the photochemistry of coordination compounds
5. Analyze the thermal data and evaluate the analytical data

**UNIT – I: CHEMISTRY OF BORON HETEROSYSTEMS**

Boron and multicentered bonds – types of bonds – diborane – tetraborane – synthesis – chemical reactions – structure and bonding – higher boranes – $B_{10}H_{14}$ – bonding –classification by Wade's rule – topological structure – styx number – structural studies by IR and NMR – carboranes – preparation, properties – metallacarboranes – monocarboranes – carboranes with more than two cage carbon atoms.

**B-N systems:** borazines – comparison with benzene – N and B substituted borazines-hydrolytic stability – B-O systems – borates.

**UNIT – II: Si-O, P-O, P-S SYSTEMS**

**Silicates:** classification – asbestos minerals – Zeolites – organosilicon compounds – silicone polymer – types – preparation – uses – siloxanes – reactions – polymerisation of cyclicsiloxane – mechanism – factors influencing polymerization.

**P-S rings and cages:** synthesis and reactions – P-O heterocyclic compounds – preparation – reactions – linear & cyclic phosphates ($Na_2HPO_4$, $NaH_2PO_4$, $Na_3P_3O_9$)- inter conversions of various phosphates – applications – P-O compounds – preparation and reactions.

**UNIT – III: P-N and S-N HETEROSYSTEMS**

**P-N system:** $N_3P_3Cl_6$, $N_4P_4Cl_8$, $(NPCl_2)_x$ – Synthesis, uses, theories of bonding, electronic structure and aromaticity – reactions: hydrolysis, aminolysis, metathetical reactions, organometallic reagents, Friedel-Crafts substitutions, rearrangements

**S-N heteroatom systems:** bonding – Huckel's rule – $S_4N_4$: preparation, structure (Banister and Mingos mdels), properties – $S_4N_3Cl$, $S_3N_2Cl_2$, $S_4N_4O_4$: preparation, structure, properties – $S_4N_2$: preparation, structure determination – $(SN)_x$: preparation, structure, properties

**UNIT–IV: METAL CLUSTER COMPOUNDS AND INORGANIC PHOTOCHEMISTRY**

Metal atom clusters – high nuclearity carbonyl clusters – lower halide clusters – isoelectronic and isolobal analogy – structure implications – their synthetic utility – electron counting schemes – capping rule – compounds with M-M multiple bonds

Basic photochemical process – Photosubstitution – Adamson's rule – photoredox – ligand photo reaction – photo induced cleavage of M-M bonds-evidences– ligand field photochemistry of $d^3$, $d^6$ complexes – photochemical cleavage of water - solar energy conversion

**UNIT–V: ANALYTICAL TECHNIQUES**

**Thermal analysis:** TGA, DTA, DSC – principle, instrumentation, factors affecting - applications.

**Evaluation of data:** Significant figures – accuracy – precision – Gaussian distribution – Poisson distribution – confidence levels – tests of significance - F test, student t test – least square analysis – correlation coefficient – criteria for rejection of data- Q test.

**References:**


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| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** | **Unit 4** | **Unit 5** |
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | **X** | | | **X** | **X** |
| K5: Evaluating | **X** | | | | |
| K6: Creating | | | | | |

**SEMESTER –IV** ***CORE/ THEORY***

**PGC 5536 PHYSICAL CHEMISTRY - IV 5 hrs/5 Cr**

**Course objectives**:
The learners should be able to link microscopic properties of matter and its bulk properties, predict the population of states in systems at thermal equilibrium, acquire skills in understanding catalysis and adsorption phenomena, acquire analytical skills in understanding polymerization using latest techniques and explore the frontiers of nanoscience.

**Course outcome:**
At the end of the course, students will be able to

1. Assess partition functions and relate them with thermodynamic functions.
2. Compare the various statistics and their implication to different state of molecules.
3. Examine the kinetics and catalysis of reactions in solution.
4. Deduce the parameters involved in different types of polymerization and explainthe techniques for molecular weight determination.
5. Compare the types of sensors and the accesses physical effects involved in signal transduction.

**UNIT – I: STATISTICAL THERMODYNAMICS – I**

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging, Canonical, Grand canonical and microcanonical ensembles, corresponding distribution laws. Maxwell-Boltzmann statistics – Partition functions – thermodynamic properties from partition function – translational, rotational, vibrational and electronic partition functions. Partition function and equilibrium constant.

**UNIT – II: STATISTICAL THERMODYNAMICS – II**

Quantum statistics – Fermi-Dirac and Bose-Einstein statistics – photon gas, Bose-Einstein condensation, degeneracy and Bose-einstein condensation, application to liquid He.Electron gas, degeneracy and electron gas.Heat capacities of diatomic gases. Einstein and Debye's theory of heat capacity of solids – paramagnetism - population inversion – negative Kelvin temperature.

**UNIT – III: CHEMICAL KINETICS – II AND SURFACE CHEMISTRY**

Homogeneous catalysis – acid-base catalysis, acidity function – Michaelis-Menten kinetics. Fast reaction techniques – chemical relaxation methods, T-jump and P-jump methods, ultrasonic absorption techniques, reaction in a flow system, continuous and stopped flow, shock wave tube method. Micelles – surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration, factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization – reverse micelles.

Physisorption and Chemisorption – Langmuir and BET adsorption – Gibbs adsorption isotherm – insoluble surface films – electrokinetic phenomena – zeta potential – Heterogeneous catalysis – reactions and their kinetics.

**UNIT – IV: POLYMER CHEMISTRY**

Introduction – Classification of polymers – chemistry of polymerization – chain – - Free-Radical Polymerisation – Ionic polymerization – Coordination polymerization - Step polymerization – Polycondensation – Polyaddition polymerization – Ring-opening polymerization - polymerization techniques. Copolymerisation – Ionic – free radical – copolycondensation.

Kinetics of polymerization – Free-Radical chain polymerization – cationic polymerization – Anionic polymerization – polycondensation.Measurement of molecular weight and size.End-group analysis – colligative property measurement – light scattering – ultracentrifugation – solution viscosity and molecular size – gel permeation chromatography – polyelectrolysis.

**UNIT – V: NANOSENSORS**

Micro &nanosensors, Active and Passive sensors – Static characteristic - Accuracy, offset and linearity – Dynamic characteristics - First and second order sensors-Physical effects involved in signal transduction- Photoelectric effect – Photo dielectric effect – Photoluminescence effect – Electroluminescence effect – Hal effect – Thermoelectric effect – Peizoresistive effect – Piezoelectric effect – Pyroelectric effect –Magnetomechanical effect (magnetostriction).

Selectivity of Potentiometric Sensor - MeasurementwithPotentiometricSensors-SelectivityofAmperometric Sensors – MeasurementwithAmperometric Sensors - Classes of Electrochemical Biosensors. Sensors with Thermistors and Pellistors - Pyroelectric Sensors-Fibre Sensors Without Chemical Receptors& with chemical receptors.

**References:**


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| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **Unit-I** | **Unit-II** | **Unit-III** | **Unit-IV** | **Unit-V** |
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | **X** | **X** | **X** | **X** | **X** |
| K5: Evaluating | **X** | **X** | | **X** | **X** |
| K6: Creating | | | | | |

**SEMESTER –IV** **Core/ Lab**
**PGC 5302 INORGANIC QUANTITATIVE ANALYSIS 5 hr/ 3 cr**

**Course Objectives:**
This is a laboratory course that deals with the principles and various analytical methods of quantitative analysis of cations present in a mixture.
**Course Outcome:**

After completion of the course, the students will be able to:

1. Summarize the principle of calibration and standards
2. Perform calibration of apparatus
3. Develop analytical skill in the field of estimation of cations in mixture
4. Highlight the principle of methods of cation estimation
5. Design methods to analyze industrial effluents, antique pieces and environmental samples

**Component 1:**

Calibration of apparatus – Burette, Pipette, Volumetric flasks

Assessment of errors in apparatus and distribution

**Component 2:**

1. Estimation of Cu(II) – Iodometry & Gravimetric method
2. Estimation of Cu(II) and Ni(II) – Iodometry & Gravimetric
3. Estimation of Cu(II) and Ni(II) – Spectrophotometric
4. Estimation of Fe(II) and Fe(III) – Reduction & Redox titration
5. Estimation of Cu(II) and Zn(II) – Acidimetry with glass pH electrode/potentiometry
6. Estimation of Ca(II) and Mg(II) – Complexometric with pH control
7. Estimation of Ni(II) and Zn(II) – Complexometric/kinetic control/potentiometric
8. Estimation of Cu(II) and Ca(II) – Iodometry / reduction/ Complexometry

**Component 3:**

1. Determination of total hardness of water
2. Determination of Mn content in steel
3. Determination of Cu content in brass

**REFERENCES**

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| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | | **X** | **X** | **X** | **X** |
| K5: Evaluating | | | | | **X** |
| K6: Creating | | | | | |

**SEMESTER –IV**

**PGC 5602 PROJECT 10 hr/ 6 cr**

**Course objectives:**

This course is designed to reinforce the concepts with analytical techniques. It will provide a platform for students to have a hands-on experience with instruments and present a report on a research topic.

**Course outcome:**

Upon completion of this course, the students will be able to:

1. Design, conduct, analyze and interpret results of an experiment, and effectively communicate these in written reports
2. Develop interdisciplinary solutions to a variety of chemical problems.
3. Communicate effectively in a variety of forms.
4. Use terminology appropriate to the field of study correctly and contextually.
5. Extend knowledge and understanding of a variety of chemical concepts in a range of contexts.

Students will do the project work on a title approved by the respective project supervisor. Students will maintain daily records and present oral reports while doing the project. All the above process will be duly assessed by the project supervisor. They will submit the thesis at the end of the semester.

**Evaluation**

| | |
|---|---|
| Project presentation | 25 marks (collective evaluation from all guides) |
| Project progress | 50 marks from guide |
| Thesis | 25 marks from guide |

| **Mapping of Bloom's Taxonomy with Course Outcome** | | | | | |
|---|---|---|---|---|---|
| | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| K1: Remembering | **X** | **X** | **X** | **X** | **X** |
| K2: Understanding | **X** | **X** | **X** | **X** | **X** |
| K3: Applying | **X** | **X** | **X** | **X** | **X** |
| K4: Analyzing | **X** | **X** | | | **X** |
| K5: Evaluating | **X** | **X** | | | **X** |
| K6: Creating | **X** | **X** | | | **X** |