

**H.H. THE RAJAH'S COLLEGE (AUTONOMOUS)**

**PUDUKKOTTAI-622 001**

**PG & RESEARCH DEPARTMENT OF CHEMISTRY**

**M.Phil. CHEMISTRY COURSE STRUCTURE UNDER CBCS**

**FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR**

**2015 – 2016**

**ONWARDS**



**M.Phil. CHEMISTRY - SYLLABUS**

## COURSE STRUCTURE

CODE	COURSE	TITLE	MARKS		TOTAL	CREDIT
			Int.	Ext.		
	COURSE –I	Research Methodology	40	60	100	4
	COURSE –II	Some Advanced Topics in Chemistry	40	60	100	4
	COURSE –III	Environmental Chemistry and Molecular Spectroscopy (Guide paper)	40	60	100	4
	COURSE –IV	Teaching and Learning skills(Common Paper)	40	60	100	4
		Dissertation(150 marks) and Viva-Voce(50 marks)			200	8
		<b>TOTAL</b>			<b>600</b>	<b>24</b>

## **COURSE-I - RESEARCH METHODOLOGY**

### **UNIT –I - Literature Survey**

**Print:** Sources of information – Primary, Secondary, Tertiary sources – Journals – Journal abbreviations – Abstracts – Current titles – Reviews – Monographs – Dictionaries – Textbooks – Current contents – Introduction to Chemical Abstracts and Beilstein – Subject Index, Substance Index, Author Index, Formula Index and other Indices with examples.

**Digital:** Web resources – E-Journal – Journal access – TOC alerts – Hot articles – Citation index – Impact factor – H-Index – E-Consortium – UGC infonet – E-Books – Internet discussion groups and communities – Blogs – Preprint server – Search engines, Scirus, Google Scholar, ChemIndustry, Wiki – Databases, ChemSpider, ScienceDirect, SciFinder, Scopus.

### **UNIT –II - Methods of scientific research and writing scientific papers:**

a) General principles of research, inculcation of scientific temper, avoidance of prejudices and lax judgments, undue admiration of authority (i.e. excessive admiration of the work of great minds), false distinction between theoretical and applied research, impulses of a strong will to do research, persistent hard work and concentration, developing high-minded independence of judgment and taste for scientific originality, various stages of scientific research, observation, experimentation, working hypotheses, proof etc.,

b) On writing scientific papers – justification for scientific contributions, bibliography, justice and courtesy in decisions, description of methods, conclusions, the need for illustration, style, publications of scientific works, c) Writing methods - Writing the first draft, revising the first draft on content and structure, revising the second draft on style, writing a thesis, writing review article and book reviews, preparing research proposals for grants.

### **UNIT –III - Chemical Safety and Ethical Handling of Chemicals**

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 - Data Analysis**

Types of Error – Accuracy, precision, significant figures, use of calculus in the estimation of errors – Frequency distributions, the binomial distribution, the Poisson distribution and normal distribution – describing Data, population and sample, mean, variance, standard deviation, way of quoting uncertainty, robust estimators, repeatability and reproducibility of measurements – Hypothesis testing, levels of confidence and significance, test for an outlier, testing variances, means t-Test, paired t-Test – Analysis – of variance (ANOVA) – Correlation and Regression – Curve fitting, Fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals – General polynomial fitting, linearizing transformations, exponential function fit –  $r$  and its abuse – Basic aspects of multiple linear regression analysis.

## **UNIT – V - Electronics and Computer Packages**

Basic fundamentals of electronic circuits and their components used in circuits common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Applications of some computer packages like MS-Excel, Origin, Chem draw, Sciplot, ISIS draw, Chems sketch.

### **References**

1. D. B. Hibbert and J. J. Gooding, „Data Analysis for Chemistry“, Oxford University press, 2006.
2. J. Topping, „Errors of Observation and Their Treatment“, Fourth Edn., Chapman Hall, London, 1984
3. S. C. Gupta, „Fundamentals of Statistics“, Sixth Edn., Himalaya publ. House“, Delhi, 2006
4. H. E. Solbers, „Inaccuracies in Computer Calculation in Standard Deviation“, Anal. Chem. 55, 1611 (1983)
5. P. M. Wanek et al., „Inaccuracies in the Calculation of Standard Deviation with Electronic Calculators“, Anal. Chem. 54, 1877 (1982)
6. R. L. Tokheim, „Digital Electronics-Principles and Applications“, 5th Edn., Tata Mc Graw-Hill, New Delhi, 1999.
7. Alan Jhonson, „Electronics, A Systems Approach“ Hodder and Stoughton, London, 1987.
8. Robert Boylested, Louis Nashelsky, „Electronic Devices and Circuit Theory“, Prentice Hall, 9th Edn., May 2005.
9. Thomas L Floyd, „Principles of Electric Circuits: Conventional Current Version“, Prentice Hall, 7th Edn., Jan 2006.
10. For computer applications any commonly available books as well as common materials available in the web.

## **COURSE-II – SOME ADVANCED TOPICS IN CHEMISTRY**

### **UNIT I - Microscopy Techniques**

Electron Microscopy, Transmission electron microscope (TEM), general design, resolution, electron source, TEM grids, electron lenses , electron – sample interactions- Scanning transmission electron microscope (STEM)

Scanning probe microscopy - Atomic and molecular force microscopes (AFM and MFM), Scanning tunneling Microscope (STM); Scanning near-field and far-field optical microscope (SNOM and SFOM) - Fluorescence microscopy, single-molecule fluorescence imaging, single molecule FRET (Fluorescence energy transfer) techniques, Confocal microscopy.

### **Unit-II - RESONANCE SPECTROSCOPY**

<sup>1</sup>H NMR: Long-range coupling – Homotopic, enantiotopic and diastereotopic systems - Conformationally mobile, open-chain systems, Virtual coupling – Coupling of proton to fluorine, phosphorus - Nuclear Overhauser effect. <sup>13</sup>C NMR: Off resonance decoupling – Coupling of carbon to deuterium, fluorine, phosphorus – DEPT – Application of proton and carbon data in identifying small organic compounds. 2D NMR: Principles of 2D NMR spectroscopy - <sup>1</sup>H-<sup>1</sup>H COSY, <sup>1</sup>H-<sup>13</sup>C COSY, HMBC and HSQC.

Basic concepts of ESR spectroscopy – g tensor- 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 systems like methyl radical, p-benzoquinone and naphthalene anion, Cu(II), Fe(II), Mn(II) and Ni(II) complexes – Spin-trapping.

Basic principles of ENDOR spectroscopy and its applications in inorganic chemistry

### **UNIT III - Electroanalytical Techniques**

Potentiometric sensors- criteria for choosing these sensors, selective electrodes- primary ion-selective electrodes encompassing crystalline and non-crystalline electrodes- membrane ion-selective electrodes including gas-sensing and enzyme substrate electrodes- all solid state ion-selective electrodes – Voltammetric sensors, chronoamperometry- potential sweep techniques (cyclic voltammetry including study of reaction mechanisms)- step and pulse techniques- Normal pulse and differential pulse voltammetry- square wave voltammetry- AC techniques- stripping voltammetry (anodic and cathodic)- stripping analysis.

## **Unit IV**

### **Applications of Mass Spectrometry to Biomolecules and Fluorescence Spectroscopy**

Basic Instrumentation - Resolution, EI, CI and APCI methods - base peak, isotopic peaks, metastable peak, parent peak - determination of molecular formula Techniques in Instrumentation - Soft Ionization Methods - Fast Atom-Ion Bombardment-Electrospray Ionization - Matrix-Assisted Laser Desorption/Ionization - Mass Analyzers – Detectors- Hyphenated techniques, GC-MS, LC-MS and tandem Mass spectrometry- Applications to Biomolecules - Molecular weight Determination - Protein Identification - Protein-Peptide Sequencing - Nucleic Acid Applications.

Emission spectra and excitation spectra, 2D – emission spectra, frequency-domain spectra and time-domain spectra- definition of lifetime of an excited state- multiexponential decays- time-correlated single-photon counting technique to obtain time-domain spectra- micro- nano- pico and femto second transient recordings using laser flash photolysis techniques- various laser sources and light-emitting diodes- Fluorescence quenching and its applications in some biological systems like proteins. membranes, DNA etc.

## **UNIT V - Biological Chemistry**

Chemistry in biosystems (distinct from non-living systems) – Weak non-covalent interactions - Molecular recognition – Enzyme chemistry – Mechanism of enzyme action – Chymotrypsin – Antibodies as enzymes-Enzymes in synthetic organic chemistry –Coenzyme chemistry - NADH – NADPH and FADH(2) as electron carriers – Pyridoxal phosphate - Thiamine pyrophosphate – suicide enzyme inactivators and affinity labels – Bioenergetics & metabolism –Biological energy – ATP – Carbohydrate metabolism – Lipid metabolism – Citric acid cycle – Enzyme models – utility of cyclodextrins, Crown ethers and calixarenes as enzyme models – Molecular recognition and drug design – Supramolecular chemistry – Supramolecular reactivity and catalysis.

### **Reference:**

#### **Unit I**

1. Acc. Chem. Res. July 2005
2. Bengt Nolfing, „Methods in Modern Biophysics“, Springer, 2004.
3. T. Pradeep, Nano: The Essentials, Mc Graw-Hill Edn, New Delhi, 2007.

#### **Unit II**

1. P.M. Silverstein, F.X. Wester, Spectroscopic Identification of Organic Compounds, 6th Ed., Wiley 1998.
2. J. Mohan, Organic Spectroscopy Principles and Applications, CRC; 2nd Ed., 2004.

3. W. Kemp, Organic Spectroscopy, 3rd Ed., MacMillon, 1994.
4. D.L. Pavia, G.M. Lampman and G.S. Kriz, Introduction to Spectroscopy, Brooks Cole, 3rd Ed., 2000.
5. H. Gunther, NMR spectroscopy, basic principles, concepts and application in chemistry, John Wiley & Sons, 2nd Ed., 1995.
6. R. S. Drago, Physical Methods in Chemistry, Saunders, 1977.
7. J. A. Weil, J. R. Bolton and J. E. Wertz, Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, John Wiley and sons, 1994.

### **Unit III**

1. Christopher M.A Brett and Ana Maria Oliveira Brett, "Electroanalysis" Oxford University Press, Oxford, 1998.
2. Daniel C. Harris, "Quantitative Chemical Analysis", Third Edn., W.H. Freeman and Company New York, 1996.
3. A.J. Bard L.F. Faulkner, Electrochemical methods – Fundamentals and Applications, Second Edn., Wiley-VCH, 1998.
4. Journal of Chemical Education, "State of Art Symposium:Electrochemistry" Vol.60, issue No.4, 1983.
5. J. Janata, "Principles of Chemical Sensor", Plenum Press, New York, 1989.
6. Joseph Wang, "Analytical Electrochemistry", Second Edn., Wiley-VCH, 2001

### **Unit IV**

1. Spectrometric Identification of Organic Compounds, 6th Edition, Robert M. Silverstein and Francis X. Webster, Publisher: John Wiley & Sons, Inc, 1998
2. Theme issue on "Frontiers in Mass Spectrometry", Chemical Reviews 2001, Vol. 101, Issue 2.
3. Bioanalytical Chemistry, S. K. Mikkelsen and Eduardo Corton, Publisher: Wiley-Interscience - John Wiley & Sons, Inc., 2004
4. Joseph R.Lakowicz "Principle of Fluorescence Spectroscopy" Third Edn. Springer,USA,2006

### **Unit V**

1. Biochemistry, 3rd edition, C. K. Mathews, K. E. van Holde, K. G. Ahern, Publisher: Pearson Education 2000
2. Principles of Biochemistry, 2nd edition, A. L. Lehninger, D. L. Nelson, M. M. Cox, Publisher: CBS Publishers & Distributors (India) 1993
3. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, 3rd edition, Hermann Dugas, Springer International Edition 2003

## **COURSE-III**

### **ENVIRONMENTAL CHEMISTRY AND MOLECULAR SPECTROSCOPY UNIT I**

#### **Surface Chemistry & Water Treatment**

Definitions- Classifications of Adsorption-Characteristics of Adsorption- Adsorption of Gases on solids- Adsorption Isotherms- Freundlich's Adsorption Isotherms-Langmuir's Adsorption Isotherms-Applications of Adsorption, Introduction- Various impurities in water- hard and soft water- Hardness of water- estimation of hardness – softening methods – potable water – (water for domestic supply) – treatment – desalination – Reverse Osmosis.

#### **UNIT II**

#### **Polymer Technology**

Introduction – polymer and monomers - Functionality – Nomenclature of polymers – polymerisation and its types – mechanism of polymerisation – properties of polymer – plastics – rubbers – synthetic rubbers – biodegradable plastics – Application of plastics.

#### **UNIT III**

#### **Pollution and its control**

Introduction – Air pollution – Green house effect – Ozone layer depletion – Acid rain – water pollution – sewage treatment – Biological Oxygen Demand (BOD) – Chemical Oxygen Demand (COD) – Eutrophication – Soil pollution – Radioactive pollution – Noise pollution – Marine pollution.

#### **UNIT IV**

#### **Electronic Absorption Spectroscopy**

Microstates – Term symbols and energy levels for  $d^1 - d^9$  ions in Octahedral, tetrahedral cubic and square square fields – Intensity of bands – Group theoretical approach to selection rules – Jahn Teller distortion — Charge transfer spectra.

#### **Infrared Spectroscopy**



Group vibrations and the limitations— Effect of coordination on ligand vibrations – Uses of group vibrations in the structural elucidation of metal complexes of urea, thiourea, cyanide, thiocyanate, nitrate, sulphate and dimethyl sulfoxide.

## UNIT V

### **NMR Spectroscopy**

$^{13}\text{C}$  NMR,  $^{31}\text{P}$  NMR, P-NMR, FT-NMR. Spectrum of paramagnetic molecules – Isotropic shift—lanthanide shift reagents – fluxional behaviour of molecules.

### **ESR Spectroscopy**

ESR- Zeeman effect, hyperfine splittings ( isotropic systems ) – coupling constants – .--Zero field splitting and Kramers degeneracy – esr of transition metal complexes. McConnell equation--g-value.

### **References**

1. Environmental science and Engineering – A.Koushik and P.Koushik
2. Environmental science working with earth – G.Tyler and Miller.
3. Applied Chemistry – N.Krishnamurthy, K.Jayasubramaniam, A.Vallinayagam.
4. Polymer Chemistry – Gowariker.
5. Modern spectroscopy, J.M.Hollas, John Wiley.
6. Physical methods in chemistry, R.S.Drago, Saunders College
7. Introduction to Molecular Spectroscopy, G.M.Barrow, Mc.Graw Hill.
8. Introduction to Magnetic Resonance, A.Carrington and A.D.Maclachalan.
9. Group theory and Application to Chemistry, K.V.Raman, New Delhi, Tata. Mc Graw Hill.

## **COURSE –IV – TEACHING AND LEARNING SKILLS**

### **Unit I – Computer Application 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 – 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 – 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 applications on the Internet, interpersonal communication through the web.

### **Unit IV – 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 – Models of teaching: CAI, CMI and WBI

## **Unit V – Teaching Skills**

Teaching skill: 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

### **References:**

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 and programme of Teacher development, Jonathan Anderson and Tom Van Weert, UNESCO, 2002
4. Kumar K.I (2008) Educational Technology, New Age International Publishers, New Delhi
5. Mangal, S.K. (2002) Essential of Teaching – Learning and Information Technology, Tandon Publications, Ludhiana
6. Michael D. and William (2000), Integrating Technology into Teaching and Learning: Concepts and Applications, Prentice Hall, New York
7. Pandey S.K. (2005) Teaching Communication, Commonwealth Publishers, New Delhi
8. Ram Babu A. and Dandapani S (2006) Microteaching (Vol.1&2) Neelakamal Publications, Hyderabad
9. Singh V.K. and Sudarshan K.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.