SAIVA BHANU KSHATRIYA COLLEGE

(Aruppukottai Nadargal Uravinmurai Pothu Abiviruthi Trustukku Pathiyapattathu)
(Affiliated to Madurai Kamaraj university)
(Re-accredited with B+ Grade (3rd Cycle) by NAAC)

ARUPPUKOTTAI - 626 101
VIRUDHUNAGAR DISTRICT, TAMIL NADU
DEPARTMENT OF CHEMISTRY

M.Sc., Chemistry
REVISED SYLLABUS
(With effect from the academic year 2018-2019 onwards)

Year	Semester	Paper	Credit	Hr / week	Internal	External	Total	External Duration	External Total
II	IV	Biomolecules, Rearrangements and Synthetic methods	4	5	25	75	100	3 Hrs.	75
		Nuclear Chemistry, Electroanalytical and Thermal Methods	4	5	25	75	100	3 Hrs.	75
		Chemical Kinetics, Surface, Biophysical and Photochemistry	4	5	25	75	100	3 Hrs.	75
		Major Elective:	5	5	25	75	100	3 Hrs.	75
		1 Polymer Chemistry							
		2 Introduction to Nanoscience							
		Conductometric and Potentiometric Titrations and, Kinetic, Adsorption and Spectral Measurements-Practical	5	5	40	60	100	6 Hrs.	60
		Project/Review of recent aspects of chemistry Project Viva-voce	4	5	40	40 20	80 20	3 Hrs.	80 20
		Total	**90**				**2000**		

Semester IV
Paper I - Biomolecules, Rearrangements and Synthetic Methods

Unit I : Carbohydrates, Amino acids, proteins and Nucleic acids :

Classification of proteins – peptides – structure of peptides - synthesis of peptides – Chemisty of gluthathione and oxytocin – an elementary treatment of enzymes, coenzyme and nucleic acids – biosynthesis of amino acids – RNA and protein synthesis – Genetic code – DNA and determining the base sequence of DNA.

Pyronose and furanose, forms of aldohexoses and keto hexoses – methods used for determination of ring size – conformations of aldohexopyranoses – structure and synthesis of maltose, lactose, sucrose and cellobiose. A brief study of starch and cellulose.

Unit II : Photochemistry & Free radicals :

Conservation of orbital symmetry – electrocyclic reactions – cyclo addition reactions and sigmatropic rearrangements – applications of correlatioin diagram approach frontier molecular orbital approach, Huckel Mobius approach and Perturbation molecules orbital approach to the above reactions.

Photochemical reactions of ketones – photosensitization – Norrish I and Norrish type reactions – paterno – Buchi reaction – photooxidation – photoreduction – photochemistry of arenes.

Free radicals : Formation, detection and stability of free radicals – free radical reactions halogenations, addition, oxidation, reduction and rearrangement reactions – BartoSandmeye, Gomberg, Bachmann, Ultmann, Pschorr and Hundsdiecker reactions.

Unit III Molecular rearrangements

Mechanism of the following rearrangemetns reactions : Wagner - Meerwein, Pinacol, Demzanov. Beckmann, HOffmann, Curtius , Wolff, Baeyer - Villeger, Stevans, Sommelet – Hauser , Favorskii, Banzil – benzilic acid, Claisen, Cope, Fries, Dienone – phenol, di-pimethane, hydroxioamino – p=aminophenol and Benzidine rearrangement - Photochemical arrangements.

Unit IV Green Chemistry – I

Principles of green chemistry – planning a green synthesis in a laboratory - general interest for solvent free processes – solvent free techniques – Microwave synthesis : Introduction and characteristics of microwave heating – interaction of microwave radiation with the material – difference between conventional heating and microwave heating. Dielectric polarization – dipolar polarization - applications and advantages of microwave heating over conventional heating.

Unit – V Synthetic methods

Planning a synthesis - Relay approach and convergent approach to total synthesis Retrosynthetic analysis of simple organic compounds – functional group interconversions - use of activating and blocking groups in synthesis – stereoselective problems of geometrical and optical isomerism – steric crowding – Transition metal complexes in organic chemistry – Homogeneous hydrogenation – Regioselectivity – Disastereoselectivity – Enantioselectivity – Umpolung synthesis – Robinson annelation – A schematic analysis of the total synthesis of the following compounds; 2,4, dimethyl 1-2 –hydroxypentanoic acid, trans – 9 –methyl – 1- decalone and isonootkatone.

References:

1. A.L. Lehninger, Biochemistry, Nath Publishers.
2. C.H.Depuy and O.L.Chapman, Molecular Reactions and Photochemistry Prentice Hall, 1972.
3. S.M.Mukherji and S.P.Singh, Reaction Mechanism in Organic Chemistry, McMillan India Ltd., 1978.
4. R.B. Woodward andR.Hoffmann,The Conservation of Orbital Symmetry VerlogChemie GMBH and Academic Press, 1971.
5. Hung, The Chemistry of Free Radicals.
6. I.L.Finar, organic Chemistry, Vol. II, ELBS, 1975.
7. P.De., Mayo, Molecular arrangements.
8. Jerry march, Advanced Organic chemistry, John Wiley & Sons, 4thedn., 2000.
9. K.R.Desai, Green Chemistry (Microwave Synthesis) Himalaya Publishing House, Mumbari 2005.
10. R.Sanghi and M.M.Srivastava, Green Chemistry (Environmental Friendly Alternatives), Narosa Publishing House, New Delhi 2003.
11. A..K.Ahluwallia, Green Chemistry (Environmentally Benign Reactions), Aru Books

India, New Delhi 2006.
12. R.E. Ireland, Organic synthesis, Prentice Hall of India Pvt Ltd., 1975.
13. R.T.Morrison, and R.N.Boyd, Organic Chemistry, Prentice Hall 6thedn., 2001.

Paper II - Nuclear Chemistry, Electroanalytical and Thermal Methods

Specific Objectives: To introduce the nuclear and analytical chemistry concepts, data analysis and computers in chemistry.

Learning Outcomes: Ensures the students to understand the structure of nucleus, nuclear fission and fusion, radioactivity of isotopes, electroanalytical, thermoanalytical, spectroanalytical methods. In addition the students must have knowledge of computers in chemistry, internet, browsing and searching a website.

Unit I: Structure of Nucleus and Radioactive Decay

Composition of the nucleus – nuclear size, shape and density – principal, radial and magnetic quantum numbers – magnetic and electric properties of nucleus – elementary treatment of shell (independent particle) model – nuclear configuration – parity and its conservation – mass defect and binding energy – nuclear forces theory.

Radioactive decay: Group displacement law – decay series – rate of disintegration – half life – average life – units of radioactivity – secular and transient equilibria – theories of alpha decay, beta decay, gamma emission, positron decay, nuclear isomerism, internal conversion and electron capture – Auger effect.

Unit II: Nuclear fission and Fusion and application of radioactive isotopes

Bethe's notation of nuclear process – nuclear reaction energies (Q value) – fission – energy release in nuclear fission – mass distribution of fission products – theory of nuclear fission – fissile and fertile isotopes – energy from nuclear fusion – thermonuclear reactions in stars – classification of reactors – power nuclear reactor – breeder reactor – nuclear reactors in India.

Applications of radioactive isotopes: characteristics of tracer isotopes – chemical investigations – age determination – medical field – agriculture – industry – analytical applications – isotope dilution analysis – neutron activation analysis – biological effects of radiation – waste disposal management

Unit III :Electoanalytical&Thermoanalytical methods:

Electroanalytical Techniques:

Electrogravimetry: Theory of electrogravimetric analysis – electrolytic separation and determination of metal ions. Coulometry: Electrolytic cell-working electrodes – auxiliary electrode and reference electrode – Coulometric titrations. Voltammey: Cyclic voltammety – Stripping voltammetry – Chronopotentiometry, Amperometry: Amperometric titrations.

Thermoanalytical Methods: Theory, Instrumentation and applications of thermogravimetry

– Differential Thermal Analysis and Differential Scanning calorimetry- Factors affecting TG and DTA curves – Difference between DTA and DSC.

Unit IV: Spectroanalytical Methods and Data handling

i) Spectroanalytical methods: Law of absorption and quantitative law of luminescence – principles and applications of spectrophotometry, fluorimetry, nepheleometry and turbidimetry – Emission spectroscopy and flame spectroscopy – atomic absorption, atomic emission and atomic fluorescence spectroscopy. Optical rotatory dispersion and circular dichroism.

ii) Data Analysis: Significant figures and Significant figures in Numerical computations-Mean and standard deviation, significant figures and computation – comparison of results – F-Test and Student's t test – Rejection of results – Q Test – Correlation coefficient and linear regression - method of least square.

Unit V: Computer in Chemistry:

History and development of computers, Mainframe, micro and Super computer systems – CPU and other peripheral devices – Evolution of proramming languages: Machine language, assembly language and higher level language.

Internet – History of internet – applications of internet in Chemistry – websites in Literature Survey in Chemistry – popular websites and data bases in Chemistry– downloading the attachment / PDF files – opening, browsing and searching a website – literature searching online.

Email: Introduction – working way – mailing basics – e.mail ethics – advantages and disadvantages – creating e-mail id – receiving and sending e-mails.

Suggested Readings:

1. S.Glasstone, Source Book on Atomic energy, 3rdEdn., Van Nostrand Reinhold Company, New York, 1967.
2. G. Friedlander, J.W. Kannedy, E.s. Macias and J.M. Miller, Nuclear and Radiochemistry, John Wiley & Sons Inc., New York, 1981.
3. Asim K das, Fundamental concepts of Inorganic Chemistry, Vol 1 and 7, , 2nd edition, CBS publisher and Distribution Pvt. Ltd, 2016
3. F.J.Holler, S.R. Gouch, D.A. Skoog and D.M. West Fundamentals of Analytical Chemistry, 9thEdn, (2014), Cengage Learning India Private Limited., New Delhi.
4. U.N. Dash, Nuclear Chemistry, Sultan Chand Sons, New Delhi, 1991.
5. J.Basset et al. Vogel's Text book of Quantitative Inorganic Analysis, Longman, 5thEdn. ELBS, Essex, 1989.
6. H.H. Willard, LL.Merritt and J.A. Dean, Instrumental Methods of Analysis, East-West Press, New Delhi, 1988.

7. J.G.Dick, Analytical Chemistry, Tata-McGraw Hill, 1973.
8. Alexis Leon and Mathews Leon, "Fundamentals of Information Technology", Leon Vikas, Chennai (1999).
9. Barbara Kasser, "Using the Internet", 4thEdn. EE Edition, New Delhi, 1998.
10. H.I. Arnikar, Essentials of Nuclear Chemistry, 3rdEdn., Wiley Eastern Ltd,
11. Fundamentals of Analytical Chemistry, Saunders College Publishing Co., Philadelphia, 1982.

Paper III - Chemical kinetics, Surface, Biophysical and Photochemistry

Unit I : Chemical kinetics I: Empirical rate laws – influence of temperature on the rate of reaction – Theories of reaction rates – Arrhenius theory , collision theory and transition state theory of reaction rates – potential energy surfaces – kinetic isotope effect- Theory of unimolecular reactions – Lindemanns theory , Hinshelwood theory , RRK theory, RRKM theory and slaters theory – chain reactions – steady state approximations – kinetics of chain reactions – thermal reaction between H_2 and Br_2 – thermal decomposition of N_2O_5 and acetaldehyde – H_2 – O_2 explosive reactions. Reaction in solutions – influence of solvent dielectric constant , ionic strength – Bronsted – Bjerrum equation – primary and secondary salt effect – effect of pressure on reaction rates – significance of volume activation.

Unit II : Chemical Kinetics II and Catalysis : Fast reactions – Fast reactions techniques – flow methods (Continous and stopped flow methods) – relaxation methods (T and P jump methods) – pulse techniques (Pulse radiolysis , flash photolysis) – shock tube method – molecular beam method – life time method – Homogeneous catalysis – acid base catalysis – vant Hoff and Arrhenious intermediates for protolytic and prototropic mechanism. Catalysis in Biological systems- enzyme catalysis – Michaelis – Menten kinetics – Lineweaver and Burk plot – Eadie plot – influence of pH on the enzyme catalysis. Heterogeneous catalysis – kinetics and mechanism of unimolecular and bimolecular reactions – Langmuir – Hinshelwood and Langmuir – Rideal mechanism – ARRT of surface reactions – NH_3 synthesis , hydrogenation of C_2H_4 and cracking of hydrocarbon.

Unit III: Surface chemistry: Introduction – adsorption of gases on solid – physisorption and chemisorption – adsorption isotherms – Freundlich – longmuir – BET – Temkin adsorption isotherms, Adsorption on liquid surface – surface tension – Gibbs absorption isotherm – surface area determination – solution and interfacial behavior of surfactant – Definition and classification of surfactants – preparation of LB films- Micelles – critical micelles concentration (CMC) – structure – bimolecular reaction occuring in a micellar solution – reverse micelles – micro emulsion – Application of photo electron spectroscopy – ESCA and Auger spectroscopy to the study of surfaces.

Unit IV : Biophysical chemistry : Thermodynamics in biology – concept of irreversible thermodynamics – standard free energy, entropy and chemical potential change in biochemical reactions – Energy flux – Onsager reciprocal relationship – Bio energetics and metabolism – catabolism – anabolism – energy relationship between catabolic and anabolic path ways. High energy metabolites – ATP and its role in bioenergetics – phosphoryl group transfers and ATP – Role of single oxygen in biology – Biophysical application of Mossbauer effect – Mossbauer effect in hemoglobin – spin labeling –molecular recognition. Introduction to supra - molecular chemistry and photochemistry

Unit V: Photo and Radiation chemistry: Absorption and emission of radiation - Physical properties of the electronically excited molecules – excited state dipole moments, Pka and redox potentials – photo – physical processes in electronically excited molecules – Fluorescence. Phosphorescence and other deactivation processes. Excimer and Exciplex complex formation. Stern – volmer equation and its applications – Electronic energy transfer mechanisms – photosensitization and chemiluminescence. Experimental techniques in photochemistry – light sources – chemical actinometry – measurement of quantum efficiency – photosynthesis – PSI and PSII – photochemical conversion and storage of solar energy.Radiation chemistry – Source of high energy – interaction of high energy radiation with matter radiolysis of water – determination of G-value – mode of reactions of hydrated electrons – Experimental techniques of radiation chemistry – Dosimetry – Application of radiation chemistry in biology and industry.

Recommended Books

1. K.J.Laidler, Chemical Kinetics, 3rdEdn., Harper International Edn., London (1987).
2. K.J.Laidler, Theories of Chemical Reaction Rates, McGraw Hill Book Co., London (1969).
3. F.Wilkinson, Chemical Kinetics and Reaction Mechanisms, Van Nostrand Reinhold Co., New York (1980).
4. C.Kalidad, Chemical Kinetic Methods, New Age International, 1996.
5. Margaret Robson Wright, Fundamental Chemical Kinetics- An Explanatory Introducation to the Concepts, Horwood Publishing Ltd., West Sussex 1999.
6. A.W. Adamson, Physical Chemistry of Surfaces 5thEdn., John wiley& Sons, New-York (1990).
7. D.Attwood and A.T.Florence, Surfactant Systems- Their Chemistry, Pharmacy and Biology, Chapman and Hall, New-York (1983).
8. K.K.Rohatgi Mukherjee, Fundamentals of Photochemistry, Wiley Eastern
9. N.J. Turro, Modern Molecular Photochemistry. Benjamin Cummings.
10. Hamil, Williams and Mackay, Principles of Physical Chemistry II Edn., Prentice-Hall of India, Pvt., Ltd., New Delhi (1968). (Radiation Chemistry)

ELECTIVE OPTION 1 - POLYMER CHEMISTRY

Unit I: Classification of Polymers and Chemistry of Polymerization

General definition – Nomenclature of polymer-Classification of polymers- Linear polymers, non-linear or branched polymers, cross-lined polymers, homo chain hetero chain, homopolymers co-polymers block polymers and graft polymers.

Chemistry of polymerisation: Types of polymerization – mechanism – Chain, growth, free radical, ionic, co-ordination, ring opening, matalhetical, group transfer, polyaddition and polycondensationpolymerisation.

Unit II: Individual Polymers

Individual polymers: Monomers required general methods of preparation, repeat units and uses of the following polymers and resins – polyethylene, polystyrene, polyacrylonitrile, polymethylmethacrylate, PVC, polytetra – fluoroethylene, polyisoprenes, polybutadienes and polychloroprene, polyesters, polycarbonates, polyimides, polyamides (Kevlar), polyurethanes, polyethylene, glycols, phenol – formaldehyde, urea-formaldehyde, melamine – formaldehyde and epoxy resins – silicone polymers.

Unit III: Properties of Polymers

General properties of Polymer (Rheological, Mechanical, Thermal, optical and electrical) – basic idea of isomerism of polymers – configuration of polymer chain – geometrical structure – syndiotatic, isotatic and atatic polymers.

Glass transition temperature: Definition – factors affecting glass transition temperature – relationships between glass transition temperature and (a) molecular weight, (b) melting point and (c) plasticiser – importance of glass transition temperature – heat distortion temperature.

Molecular weight and size of polymers: Number average, weight average, sedimentation and viscosity average molecular weights – molecular weights and degree of polymerization – poly dispersity – molecular weight distribution in polymers – size of polymer molecules – kinetics of polymerisation.

Unit IV: Polymerisation Techniques, Degradation and Uses of Polymers

Polymerisation Techniques Bulk, solution, suspension, emulsion, melt condensation and interfacial polymerisations.

Degradation: Types of degradation – thermal, mechanical, ultrasonic and photodegradation – photo stabilisers – oxidative degradation – antioxidants – Uses of polymers in electronics and biomedicine.

Thermal (TG, DTA and DSC) and SEM methods of characterization of Polymers

Unit V: Polymer processing and polymer composites

Polymer processing plastics (thermo and thermosettings), elastomers, fibres, compounding, plasticisers, colorants, flame retardants. Compression and injection mouldings – film extrusion and calendaring – die casting and rotational casting – thermofoaming – reinforcing.'

Introduction to polymer composites – Types- Role of matrix in composites – Smartcomposites and smart materials

Reference Books:

1. V.R. Gowariker, N.V.Viswanatha and JayadevSreedher, "Polymer Science", Wiely Eastern Ltd., New Delhi, 1986.
2. G. Odian, "Principles of Polymerization", 2nd edn., John Wiley and Sons, New York, 1981.
3. D.W. Van Krevelen and P.J. Hoftyrager, "Properties of Polymers", Elsevier, New York, 1976.
4. B.K. Sharma, "Polymer Chemistry", GoelPublishig House, Meerut, 1989.
5. P.J. Flory, Principles of Polymer Chemistry", Cornell Univ. Press, Ithaca, 1953.
6. F.W. Billmeyer, "Text Book of Polymer Science", 3rdEdn.John Wiley and Sons, New York, 1984.
7. Harry R. Allcock, F.W. Lampe and J.E. Mark, "Contemporary Polymer Chemistry", 3rd Edition, Pearson, Prentice Hall, Delhi, 2005.
8. N B Singh and S S Das, Introduction to Polymer Science and Technology, New Age International Publishers, 2nd edition, 2017.
9. M C Gupta, A P Gupta, Polymer Composite, New Age International Publishers, 2007.

ELECTIVE OPTION 2 - INTRODUCTION TO NANOSCIENCE

Unit I: General Introduction

Forms of Matter – Crystal structures – Electronic properties of atoms and solids – Surface energy and surface tension – Defining nanodimensional materials – 0D, 1D and 2D nanostructures – sizes dependence of properties – special properties resulting from nanodimensionality – Potential uses of nanomaterials.

Unit II: Synthesis of nanomaterials

General approaches – Nucleation process – size of the crystal – Influence of nucleation rate on the size of the crystal – Chemical methods – Sol-gel techniques – Control of grain size – Co-precipitation – Hydrolysis – Sonochemical method – Colloidal precipitation – Bottom up and top down approaches – Kinetically confirmed synthesis of nanoparticles.

Unit III: Principle of Instrumentation

Spectrophotometry, XRD, EXAFS, XPS, SEM, TEM, AFM – application to nanomaterials characterization.

Unit IV: Optical properties of nanomaterials:

Optical properties of nanomaterials: UV-Vis, IR absorption – PHotoluminescence and stimulated emission – Nonlinear optical mixing – photoconductivity.

Magnetic Properties: Concepts of dia, para and ferro-magnetion – Exchange correlation – Exchange interaction.

Electrical Properties: Electrical conductivity – Hall effect – charge carrier density – activation energy, electronic properties – field emission properties.

Unit V: Biological nanomaterials

Biological nanomaterials: Sizes of building blocks – Proteins – DNA double nanowire – Enzymes – Protein synthesis – Micelles and Vesicles – Biomimetric nanostructures – Worm micelles and Vesicles from block copolymers.

Reference Books:

1. C.P. Poole Jr. F.K. Owens, Introduction to Nanotechnology, John Wiley & Sons, 2003.
2. M.D. Ventra, S.Evoy, J.R. Heflin, Jr., (Eds), Introduction to Nanoscale Science and Technology, Kluwer Academic, 2004.
3. G. Cao., Nanostructures &Nanomaterials: Synthesis properties and applications, Imperial College Press.
4. B S Murty, P Shankar, Baladev, B BRath and J Murday, Text book of Nano Science and Nanotechnology, University Press, 2012.
5. C.N.R. Rao, A. Muller, A.K. Cheetham (Eds.) The Chemistry of Nanomaterials: Synthesis, Properties ad Applicationis, WILEY-VCH Verlag GmbH & Co., KGaA, Weinheim, 2004.
6. P. Knauth, J. Schoonman (Eds), Nanostructured Materials: Selected Synthesis Methods, Properties and Applications, KLUWER ACADEMIC, 2002.
7. G. Schmid, Nanoparticle: From Theory to Applications, Wiley-VCH Verlag GmbH & Co. KGaA, 2004.
8. P. Dutta, S.Gupta (Ed), Understanding of Nanoscience and Technology, Global Vision Publishing House, 2006.
9. C.C. Koch, Nanostructured Materials: Processing, Properties and Applications, Jaico Publishing House, 2006.
10. Challa S.S.R. Kumar (Ed) Biological and Pharmaceutical Nanomaterials, John Wiley VerlogCmbh& Co., KgaA, 2006.

Semester III & IV

Practicals and Project

Conductometric and Potentiometric Titrations and, Kinetic, Adsorption and Spectral Measurements-Practical

I. Electrochemistry

a. Conductometric titrations

i) Conductivity mixture of acids –base titration.
ii) Conductometric displacement titration.
iii) Conductivity precipitation titration.
iv) Conductometric acid – base displacement titration.
v) Estimation of acetic acid – sodium acetate buffer.

b. Potentiometric titrations

i) Potentiometric redox titration MnO_4^- - I^- system.
ii) Potentiometric redox titration Ce^{4+} - Fe^{2+} system.
iii) Potentiometric precipitation titration Ag^+ - Cl^- - I^- system
iv) Determination of dissociation constant, Kd and Determination of pH of Buffer by potentiometry.

c. Precipitation titration

i) Na_2CO_3 ---→$Pb(NO_3)_2$--- → Na_2CO_3
ii) K_2SO_4 ---→$BaCl_2$-- → $K2SO_4$

II. Thermochemistry

i) Heat of solution – Oxalic acid, Ammonium oxalate and potassium nitrate.

III. Adsorption Isotherm

i) Adsorption of oxalic acid on charcoal.
ii) Adsorption of acetic acid on charcoal.

IV. Kinetic Experiments

i) $S_2O_8^{2-}$vs I^- kinetics of salt effect

ii) Kinetics of alkaline hydrolysis of ester by potentiometric method

V. Partition coefficient

VI. Experimentas based on UV-Visible and infraredspectrophotometer

VII. Titration using pH meter

Determination of the first, second & third dissociation constant of Phosphoricacid.