

MANGALORE UNIVERSITY
M. Sc. Degree Programme in Industrial Chemistry
(Choice-Based Semester Scheme)

C O U R S E

Semester	Paper	Instruction hrs/Week	Duration of Exam(hrs)	Marks			Credits
				IA	Exam	Total	
I/II	4T	4x4	4x3	4x30	4x70	4x100	4x4
	4P	4x4	4x4	4x15	4x35	4x50	4x2
Semester							24
Total							
In the I and II semesters, there may be soft course in lieu of one of the practicals with 2hrs of theory instruction per week Or one hour of theory & 2 hrs of practicals per week(Exam: 2hrs of theory or 3 hrs of theory cum practicals							
III	4T	4x4	4x3	4x30	4x70	4x100	4x4
	3P	3x6	3x5	3x25	3x50	3x75	3x3
	Seminar	1		25		25	1
Semester							26
Total							
	Project work & viva, 20+5 Credits(IA+ Dissertation: 100+400 & Viva :100) (40 Hrs of Project work per week during the semester)						26
	Semester						26
Total							
Grand Total							100

MANGALORE UNIVERSITY
M. Sc. DEGREE PROGRAMME IN INDUSTRIAL CHEMISTRY
(Effective from the Academic Year 2010-2011)

Description of Papers	Teaching Hrs/week	Hrs. of exam	Max Marks: Exam+IA=Total
I SEMESTER			
i) Theory			
IC 401 : Industrial Inorganic Chemistry	4	3	70+30
IC 402 : Industrial Organic Chemistry	4	3	70+30
IC 403 : Industrial Physical Chemistry	4	3	70+30
IC 404 : Industrial Spectroscopic Techniques	4	3	70+30
IC 405 : Environmental Chemistry	2	2	35+15
ii) Practicals			
IC 406 : Industrial Inorganic Chemistry Practicals-I	4	4	35+15
IC 407 : Industrial Organic Chemistry Practicals-I	4	4	35+15
IC 408 : Industrial Physical Chemistry Practicals-I	4	4	35+15
II SEMESTER			
i) Theory			
IC 451 : Chemistry of Soil, Fertilizers & Agrochemicals	4	3	70+30
IC 452 : Organic Synthesis & Industrial Pharmacy	4	3	70+30
IC 453 : Energy Systems, Colloids and Petrochemicals	4	3	70+30
IC 454 : Chemical Engineering Technology	4	3	70+30
IC 455 : Quality Control, Assurance & Chromatographic Techniques	2	2	35+15
ii) Practicals			
IC 456 : Industrial Inorganic Chemistry Practicals-II	4	4	35+15
IC 457 : Industrial Organic Chemistry Practicals-II	4	4	35+15
IC 458 : Industrial Physical Chemistry Practicals-II	4	4	35+15
III SEMESTER			
i) Theory			
IC 501 : Industrial Safety, Environment, Corrosion and Green chemistry	4	3	70+30
IC 502 : Industrial Catalysis and Polymers	4	3	70+30
IC 503 : Health Care Chemicals	4	3	70+30
IC 504 : Chemistry of Paper, Textile & Soft Materials	4	3	70+30
ii) Practicals			
IC 505 : Industrial Inorganic Chemistry Practicals-III	6	5	50+25
IC 506 : Industrial Organic Chemistry Practicals-III	6	5	50+25
IC 507 : Industrial Physical Chemistry Practicals-III	6	5	50+25
IC 508 : Seminar and Industrial Visit	2		15+10
IV SEMESTER			
Project Work (4 Months)			
IC 551 : Project Report	40		400+100
IC 552 : Viva			100

BASIS FOR INTERNAL ASSESSMENT

Internal assessment marks in theory papers of 1st and 3rd semesters shall be based on the best of two tests conducted 10th and 14th weeks after the start of a semester. Internal assessment in second semester shall be awarded as: 20 marks for Test and 10 marks for report written on a given industrially related topic. Practical internal assessment marks shall be based on test and record in first and second semesters. In third semester practical IA shall be based on practical test (10marks), Viva (10marks) and record (5marks). The practical test may be conducted towards the end of the semester. The Seminar in the third semester shall be of at least 30 minutes duration for 15 marks and industrial visit report shall be for 10 marks

THEORY QUESTION PAPERS PATTERN

The Syllabus of each paper shall be grouped into units of 14 teaching hours. All the papers, except Environmental Chemistry and Quality Control, Assurance and Chromatographic techniques (IC 405 or IC 455) shall contain four such units each. Question Papers in all the four semesters shall consist of Parts A and B. Part A shall contain eight (8) very short answer objective type questions carrying 2 marks each drawn from all the four units of the syllabus (2 questions per unit). Five (5) questions are to be answered. Part B shall contain eight (8) brief and/or long answer questions carrying 12 marks each drawn from all the four units of the syllabus (2 questions per unit). There may be a maximum of three sub-divisions per question, carrying 3 or more marks per sub-division. Five (5) out of eight (8) questions are to be answered.

The Syllabi of the papers, Environmental Chemistry and Quality Control, Assurance and Chromatographic Techniques shall also be grouped into units of 14 teaching hours. They shall contain two such units each. Question Papers in Environmental Chemistry and Quality Control, Assurance and Chromatographic Techniques shall also consist of Parts A and B. Part A shall contain six (6) very short answer objective type questions carrying 2 marks each drawn from both the units of the syllabus (3 questions per unit). But there may be two sub-divisions per question. Four (4) questions are to be answered. Part B shall contain five (5) brief and / or long answer questions carrying 9 marks each drawn from both the units of the syllabus (2 questions per unit and a combined question from both the units). There may be a maximum of three sub-divisions per question, carrying 3 or more marks per sub-division. Three (3) out of five (5) questions are to be answered.

PRACTICALS EXAMINATION PATTERN

In the first and second semesters, the 35 marks shall be awarded based on the experiment. But in the third semester, out of 50 marks, 10 marks are for the viva to be conducted during practical and 40 marks for the experiment.

Candidates of IV semester shall undergo a compulsory project work in an industry for four months and prepare a report on their work. The Project Report *shall* be evaluated by two examiners as in the case of theory papers. Internal Assessment marks *shall* be jointly allotted by internal (Department) and Industry (external) guides. Viva is to be conducted jointly by the internal and external examiners in the department.

I Semester
IC 401: INDUSTRIAL INORGANIC CHEMISTRY

UNIT I

14 hrs

Preparation of samples for analysis, nature of errors, statistical treatment of errors, the t- and F-tests, significant figures, rejection of data. Precipitation phenomena: Precipitation from homogeneous solutions, organic precipitants in inorganic analysis. Solvent extraction of metal ions, nature of extractant, distribution law, partition coefficients, types of extractions and applications. Theories of redox indicators, titration curves, feasibility of redox titrations. Chelometric titrations-titration curves with EDTA, feasibility of EDTA titrations, indicators for chelometric titrations, selective masking and demasking techniques, industrial applications of masking.

UNIT II

14 hrs

Alkali and alkaline earth metal complexes of crown ethers, cryptands and calixarenes and their biological significance. Halogens and Noble gas chemistry—interhalogens, pseudohalogens, polyhalide ions, oxyhalogen species, xenon oxides and fluorides. oxyacids of N, P and S. Graphitic compounds, carbides, pure silicon, silica and silicates, zeolites. P-N, P-O and P-S compounds including cyclophosphazines, Sulphur-nitrogen and boron-nitrogen compounds

UNIT III

14 hrs

Methods of reduction of oxide ores, chemical and electrolytic reductions, reduction potentials, Latimer, Frost diagrams and Ellingham diagram effect of complexation on potential. Theory and applications of pyrometallurgy (Copper, Nickel, Gold and Titanium), hydrometallurgy (Uranium and nuclear fuels, Electrometallurgy (Nickel and lead). Powder metallurgy-Principles and applications.

UNIT IV

14 hrs

Organometallics: Historical development, classification and nomenclature, bond energies and stability. Transition metal alkyls and aryls- types, routes of synthesis, stability and decomposition pathways, Nucleophilic and electrophilic cleavage of metal-carbon sigma bonded compounds. Alkane activation. Transition metal to carbon multiple-bonded compounds-carbonyls, nitrosyls, metal-alkene, metal cyclopentadiene, metal-arene complexes, Transition metal hydrides—Synthetic routes, structure and reactivity, synthetic applications. Catalysis by organometallic compounds: 16- and 18-electron rules, oxidative addition, insertion, deinsertion and reductive elimination reactions.

References

1. Inorganic Chemistry, 3rd edn., G.L. Miessler and D.A. Tarr, Pearson Education inc.
1. Inorganic Chemistry, 4th edn., J.E Huheey, R.L. Keiter and A.L. Keiter, Addison Wesley, 1993.
2. Inorganic Chemistry of Biological Processes, 2nd edn., M.N. Hughes, Wiley, 1988.
3. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, Viva Books, 1998
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International, 1999.
5. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley, 1991.
6. Vogel's Textbook of Quantitative Chemical analysis, 5th edn, G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, ELBS, 1989
7. Chemistry of the Elements, N.N. Greenwood & A. Earnshaw, Butterman-Helmman, 2005.
8. Principles of Extractive Metallurgy, H. S. Ray and A. Ghosh.
9. Extraction of Nonferrous Metals, H. S. Ray, R. Shridhar and K. P. Abraham.

IC 402: INDUSTRIAL ORGANIC CHEMISTRY

UNIT I: Organic Reactions and Mechanisms

14 hrs

Reaction mechanism & types, types of organic reactions & reagents, reaction profile diagrams, thermodynamic & kinetic control, leaving group and solvent. Methods of determining reaction mechanisms: Kinetic & non-kinetic methods-identification of products, detection of intermediates, isotopic labelling, stereochemical evidences, cross-over experiments, kinetic evidences & kinetic isotopic effects. Reaction intermediates: Generation, structure, stability, reactivity & detection of classical & non-classical carbocations, carbanions, free radicals, carbenes, nitrenes & arynes. N, S & P ylides & enamines.

UNIT II: Organic Name Reactions and Rearrangements

14 hrs

Reactions, mechanisms and synthetic uses of Mannich reaction, Barbier-Wieland degradation, Oppenauer oxidation, Birch reduction, Claisen-Schmidt condensation, Cope and Hoffmann elimination, Vilsmeier-Haack reaction, Suzuki coupling, Woodward-Prevost hydroxylation, Swern oxidation Ugi, Biginelli and Mitsunobu reaction. **Classification and general mechanistic treatment of** nucleophilic, electrophilic & free radical rearrangements, Intermolecular & intramolecular migration, nature of migration & migratory aptitudes, Mechanisms of Wagner-Meerwein, Fries, Favorskii, Beckmann, Claisen, Neber & Smiles rearrangement.

UNIT III: Reagents in Organic Synthesis

14 hrs

Uses of 1,3-dithiane, organoboranes, Trimethyl silyl iodide, Tri-n-butyl tin hydride, Selenium dioxide, Wilkinson catalyst, Ozone, Periodic acid, Osmium tetroxide, Perbenzoic acid, Lead tetra acetate, Lithium aluminium hydride, Sodium borohydride, Organolithium, organomagnesium and Organo zinc compounds in organic synthesis and functional group transformations.

UNIT IV: Green Chemistry

14 hrs

Definition and principles, planning a green synthesis in a chemical laboratory, Green preparation- Aqueous phase reactions, solid state (solventless) reactions, photochemical reactions, Phase transfer catalyst catalysed reactions, enzymatic transformations & reactions in ionic liquids.

Sonochemistry: Introduction, instrumentation, the phenomenon of cavitation, types of sonochemical reaction, Sonochemical esterification, substitution, addition, oxidation, reduction and coupling reactions. Microwave induced organic synthesis: Introduction, reaction vessel and reaction medium, concept, specific effect, atom efficiency, % atom utilisation, advantages and limitations, alkylation of active methylene compounds, N-alkylation, condensation of active methylene compounds with aldehydes, Diels-Alder reaction, Leuckardt reductive amination of ketones, ortho ester Claisen rearrangement and synthesis of enamino ketones.

References

1. Organic Reactions and their Mechanisms, P.S. Kalsi, New Age, 2006.
2. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, MacMillan, 2007.
3. A Text Book of Organic Chemistry, V.K. Ahluwalia and M. Goyal, Narosa, New Delhi, 2000.
4. Organic Synthesis-Special Techniques, V.K. Ahluwalia & R. Aggarwal, Narosa, 2001.
5. Green Chemistry-Environment friendly alternatives, R. Sanghi & M.M. Srivatsava, Narosa, 2003.
6. Green Chemistry-Environment benign reactions, V.K. Ahluwalia, Ane Books India, 2006.
7. Modern Synthetic Reactions, H. O. House, W.A. Benjamin, California, 1972.
8. Name Reactions and Reagents in Organic Synthesis, 2nd Edn., B. P. Mundy, M. G. Ellerd and F. G. Favaloro, Wiley Interscience, 2005.
9. Advanced Organic Chemistry: PART A & PART B, F. A. Carey & R. J. Sundberg, Springer, 2007.

IC 403: INDUSTRIAL PHYSICAL CHEMISTRY

UNIT I

14 hrs

Thermodynamics: Terminology, Laws of thermodynamics. Heat changes in chemical reaction-Born-Haber cycle, bond energy, Kirchoff's equation, flame and explosion temperature, calculation of heat of reaction. Free energy change and work function. Entropy-Evaluation, dependence on variables of a system, degradation of entropy. Entropy change in chemical reaction. Thermodynamics of mixing. Theory and determination of Chemical Potential. Liquid mixtures. Excess functions for non-ideal solutions.

Chemical kinetics: A brief review of basic concepts and terminologies in reaction kinetics. Rate law and factors effecting rate law. Steady state approximation. Complex reactions-reversible, parallel, consecutive and chain reactions (qualitative aspects only). Explosive reaction (H_2-O_2).

UNIT II

Photochemical reactions: Comparison of Hydrogen-halogen reactions, Pyrolysis of aldehyde. Thermal decomposition of N_2O_5 . Fast reactions-Introduction, study by relaxation, Ionic strength, salt and solvent effect on the rate of a reaction.

Corrosion: Fundamentals of corrosion. Corrosion related damage, Types of corrosion (Galvanic, atmospheric, microbiological & stress). Methods of prevention & control (organic & inorganic coating, inhibitors, cathodic & anodic protection, material selection & design improvement). Corrosion problems in practice, passivity. Thermodynamics & kinetics of corrosion. Corrosion rate measurement (weight loss, Tafel extrapolation, polarization resistance) & monitoring. Concept & analysis of corrosion failure. Effect of metallurgical structure on corrosion. Corrosion in selected corrosive environments. Use of STM and ATM in corrosion study.

UNIT III

14 hrs

Chlor-alkali Industry: General concepts of brine electrolysis, modern technological developments, chlorine cell technologies, production of potassium hydroxide.

Electrosynthesis: Fundamentals of electroorganic & electroinorganic synthesis, Kolbe's synthesis, electroreduction and oxidation of hydrocarbons, electroreduction of nitrocompounds, synthesis of adiponitrile. Electroinorganic synthesis of fluorine, chlorate and ozone.

Electrochemical Engineering: Qualitative aspects of general considerations, costing of an electrolytic process, performance and figures of merit, electrolysis parameters, principles of cell design, laboratory data and scale up.

Electrochemistry of Environment: Global warming, role of electrochemistry in the transport system, fixing of CO_2 , sewage disposal and treatment of waste.

UNIT IV

14 hrs

Metal Finishing & Processing: Metal finishing & technological importance, Essentials of metal finishing, fundamentals of electrodeposition, effect of plating variables on the nature of electrodeposit, electroplating process, electroplating of copper, nickel, chromium & gold. Principles & applications of electroless plating, electrochemical etching, electrophoretic painting & electroforming.

Paints: Classification of paints, Constituents of paints-Pigments, oils & other additives. Manufactures of paints. Requirements of a good paint. Emulsion paints. Paint removers. Varnishes-manufacture of varnishes, importance characteristics of a good varnish.

References

1. Thermodynamics for Chemists, S Glasstone, East-west Editon, New Delhi, 2003.
2. Chemical Thermodynamics-Basic Theory and Methods, 4th Edn., Klotz, Rosenbeg, Benjamin, 1986
4. Chemical Kinetics-Hareesh Mehra, Alfa publishing, New Delhi, 2006.
5. Principles & Applications of Electrochemistry, D R Crow, 3rd Edn., Chapman & Hall, 1987.
6. Chemical Kinetics, K J Laidler, Harper & Raw.
7. Industrial electrochemistry by Peltcher
8. Modern Electrochemistry, Vol I, IIA & IIB (1998) J.O.M. Bockries and A.K.N.Reddy
9. Engineering Chemistry by Jain and Jain

IC 404: INDUSTRIAL SPECTROSCOPIC TECHNIQUES

UNIT I

14 hrs

Introduction to spectroscopic techniques, intensity of spectral lines, natural line width and line broadening. Rotational, vibrational and electronic energy levels and selection rules.

Microwave Spectroscopy: The rotation and classification of molecules, rotation spectra of diatomic and polyatomic molecules. Rigid and non-rigid rotator models. Determination of bond lengths, isotope effect on rotation spectra. Stark effect, nuclear and electron spin interaction. Microwave Spectrometer.

Vibrational Spectroscopy: Vibration spectra of diatomic molecules - linear harmonic oscillator, vibrational energies, zero point energy, force constants & bond strengths; anharmonicity of molecular vibrations- Morse PE diagram, selection rules, fundamental, overtones and hot bands. Vibrations of polyatomic molecules- normal modes of vibrations & nature of molecular vibrations (Ex-CO₂ & H₂O). **Vibration-rotation spectra** of diatomic and polyatomic molecules, selection rules, PQR branches.

Raman spectroscopy: Introduction, theory and applications of Raman spectra, mutual exclusion principles and its applications.

UNIT II

14 hrs

Application of infrared spectroscopy in the structural study-identity by fingerprinting and identification of functional groups. Characteristic vibrational frequencies of common functional groups (alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines). Study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides and acids). Factors affecting band positions and intensities-hydrogen bonding, phase and solvent.

UV/Electronic Spectroscopy: Basic principles, Beer-Lambert law, molar absorptivity, energy levels, types of electronic transitions. Franck - Condon principles, ground and excited electronic states of diatomic molecules. Chromophores, auxochromes, electronic spectra of polyatomic molecules. Emission spectra, spectra of transition metal complexes, charge transfer spectra. Instrumentation and application. Factors affecting the positions of UV bands. Electronic transitions and empirical correlations of predicting λ_{max} of organic compounds. Woodward-Fieser rules. UV absorption of aromatic compounds - effect of substituents and solvent effects. Empirical rules to calculate λ_{max} . Application of UV spectroscopy in the structural study of organic molecules.

UNIT III

14 hrs

Nuclear Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, theory and measurement techniques, NMR spectrometer, solvents used, chemical shift and its measurements, factors affecting chemical shift. Integration of NMR signals, spin-spin coupling, coupling constant. Shielding and deshielding. Chemical shift assignment of major functional groups, Classification (ABX, AMX, ABC, A₂B₂), spin decoupling; effects of chemical exchange, fluxional molecules, Hindered rotation through NMR spectrum, Karplus relationships (Karplus curve), double resonance techniques, solvent effects and Nuclear Overhauser Effect.

NMR of nuclei other than proton: ¹³C chemical shift & factors affecting it, Coupling constants. Decoupling-Noise decoupling & broad band decoupling. Off-resonance proton decoupling-some representative examples. Introduction to ¹⁹F & ³¹P NMR.

UNIT IV

14 hrs

Mass Spectrometry: Basic principles, interpretation of mass spectra, molecular ions, meta-stable ions and isotope ions, ion abundance. Fragmentation processes-representation of fragmentation, basic fragmentation types and rules. McLafferty rearrangement. Fragmentations (fragmentation of organic compounds with respect to their structure determination) associated with functional groups- alkanes, alkenes, cycloalkanes, aromatic hydrocarbons, halides, alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, esters, amides, acid chlorides, nitrocompounds and amines, retro Diels-Alder fragmentation and Nitrogen rule. Composite problems involving the applications of UV, IR, ¹H and ¹³C NMR and mass spectroscopic techniques.

Diffraction Techniques: X-ray diffraction-introduction, Bragg method, Debye-Scherrer method, method of X-ray structural analysis, index reflections, identification of unit cells from systematic absences, structure

of simple lattices and x-ray intensities, structure factor and its relation to intensity and electron density. Qualitative study of electron and neutron diffraction.

References

1. Fundamentals of Molecular Spectroscopy, Banwell & McCash, Tata McGraw Hill, 2001.
2. Organic Spectroscopy, 3rd Edn., W. Kemp, Pargrave Publishers, New York, 1991.
3. Spectrometric Identification of Organic Compound, Silverstein, Bassler & Monnil, Wiley, 1981.
4. Spectroscopy of Organic Compounds, 3rd Edn., P.S. Kalsi, New Age, New Delhi, 2000.
5. Structural Methods in Inorganic Chemistry, Vol I & II, E.A.V. Ebsworth, D.W.H. Ranklin & S. Cradock, Blackwell Scientific, 1991.
6. Crystallography, A K Tareen and Kutty, University Press, 2002.



IC 405: ENVIRONMENTAL CHEMISTRY

UNIT I

14 hrs

Air Pollution, Analysis & Control Methods: Qualitative study of environmental segments, air pollutants, prevention & control, Green house gases & acid rain. Carbon monoxide, industrial sources & transportation sources. SO_x -sources, ambient concentration, test methods, control techniques-scrubbing, limestone injection process. Ozone hole & CFC's. Photochemical smog & PAN. NO_x - Sources, ambient concentration, test methods, thermodynamics & NO_x control techniques. Particulates: Size distribution, particulate collection-settling chambers, centrifugal separators, wet scrubbers, electrostatic precipitators & fabric filters. Analysis of air pollutants, Dispersion of air pollutants-weather, wind speed and acidity. **Safety:** Flammable material handling and fire fighting equipments, control measures for toxic chemicals, industrial hygiene, safety in laboratories & plant, safety in the transportation & storage of chemicals. OHSAS 18000.

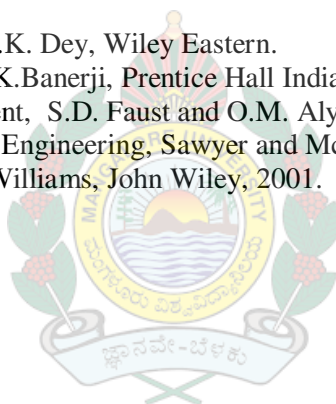
UNIT II

14 hrs

Water, Waste Water Treatment and Analysis: Hydrologic cycle, sources, chemistry of sea water, criteria & standards of water quality- safe drinking water, maximum contamination levels of inorganic & organic chemicals, radiological contaminants, turbidity, microbial contaminants. Public health significance & measurement of colour, turbidity, total solids, acidity, fluoride, alkalinity, hardness, chloride, residual chlorine, sulphate, fluoride, phosphate & different forms of nitrogen in natural & polluted water. Significance of DO, BOD, COD & TOC. Water purification for drinking & industrial purposes, disinfection techniques, demineralization, sewage analysis, desalination processes & reverse osmosis.

References

1. Environmental Chemistry, A.K. Dey, Wiley Eastern.
2. Environmental Chemistry, S.K. Banerji, Prentice Hall India, 1993.
3. Chemistry of Water Treatment, S.D. Faust and O.M. Aly, Butterworths, 1983.
4. Chemistry for Environmental Engineering, Sawyer and McCarty, McGraw Hill, 1978.
5. Environmental Chemistry, I. Williams, John Wiley, 2001.



IC 406: INDUSTRIAL INORGANIC CHEMISTRY PRACTICALS-I

1. Analysis of Hematite-insoluble residue by gravimetry & Iron by volumetry using Ce^{4+} .
2. Analysis of Dolomite - insoluble residue by gravimetry & Ca, Mg by complexometry.
3. Pyrolusite-Insoluble residue by gravimetry and Manganese content by oxalate method.
4. Analysis of solder- Pb and Sn by EDTA method.
5. Complexometric determination of Mn, Cu, Ni and Fe-Cr mixture
6. Hardness of water
7. Analysis of Halide Mixture - Iodide by KIO_3 and total halide by gravimetrically.
8. Colorimetric Determination of Iron by thiocyanate and Cu by aqueous ammonia.
9. Gravimetric Determinations of Mn, Ni, Mo, Pb/Cr, sulphide, thiocyanate.
10. Spot test for the detection of inorganic ions (any ten cations)
11. Statistical analysis of data.
12. Any other interesting experiments

Reference

1. Vogel's Text Book of Quantitative Chemical Analysis (5th Ed), G.H. Jeffrey, J. Bassette, J. Mendham and R.C. Denny, Longman, 1999.

IC 407: INDUSTRIAL ORGANIC CHEMISTRY PRACTICALS-I

Single and Two stage organic preparations: Preparations of 1,2,3,4-tetrahydrocarbazole, 7-hydroxy-4-methyl-coumarin, aspirin, adipic acid, Para red and Methyl red Preparations of p-bromo & p-nitroaniline from acetanilide, Ethyl resorcinol from Resorcinol, ϵ -Caprolactam from cyclohexanone, p-Aminobenzoic acid from p-Nitrotoluidine, s-Tribromobenzene from aniline, Benzylic acid from Benzoin, p-Chlorotoluene from p-Toluidine, 2,4-Dinitrophenylhydrazine from Chlorobenzene, m-Nitrobenzoic acid from methyl benzoate, 2,4-Dinitrophenol from Chlorobenzene, o-Aminobenzoic acid from Phthalic anhydride, hydantoin from benzyl, p-Aminoazobenzene from Aniline, thiazoles from acetophenones, pyrimidines from aldehydes/ketones and thiourea, phenazone from EAA and phenyl hydrazine, eosin from resorcinol & phthalic anhydride, Indigo from anthranilic acid, methyl orange from aniline, 5-hydroxy-1,3-benzothiole from hydroquinone.

Any other interesting experiments

References

1. Experimental Organic Chemistry-Vol. I & II-P. R. Singh et al, TMH New Delhi, 1981
2. Laboratory Manual in Organic Chemistry-Dey & Sitaraman, Allied, New Delhi, 1992.
3. Vogel's Text Book of Practical Organic Chemistry including Qualitative Organic Analysis- B. S. Furniss et al., Longman-ELBS, London, 1989.
4. Organic analytical chemistry, Theory and Practice-Jag Mohan, Narosa, 2003.
5. Practical organic chemistry by F.G. Mann & B.C. Saunders, 4th Edition, Longman, 1970.
6. Laboratory Manual of Organic Chemistry - Raj K Bansal, 2nd Edition, Wiley, 1990.
7. Systematic Lab Experiments in organic chemistry-Arun Sethi, New Age International, 2006.
8. Advanced Practical organic chemistry-Jag Mohan, Himalaya Publishing House, 1992.

IC 408: INDUSTRIAL PHYSICAL CHEMISTRY PRACTICALS-I

Any 12 experiments are to be carried out

1. Analysis of a binary mixture and determination of molar refraction of a solid and the composition of chloroform and acetone in its azeotropic mixture by refractometry.
2. Analysis of a binary mixture of two miscible liquids by viscometry and the relation between viscosity of a solution and the electrical conductivity.
3. Study of variation of viscosity of a liquid with temperature.
4. Determination of parachor value for CH_2 group by S.T method, the composition of a solution by S.T measurement and the CMC of a soap solution by S.T measurement.
5. Surface tension - concentration correlation for solutions (Gibbs equation).
6. Verification of F& L adsorption isotherms for acetic & oxalic acids on activated charcoal.

7. Analysis of a binary mixture by surface tension method.
8. Adsorption of iodine on charcoal from alcoholic solution.
9. Study of adsorption of picric acid on charcoal using a calorimeter.
10. Acid catalysed hydrolysis of methyl acetate and determination of catalytic strength of an acid.
11. Saponification of ethyl acetate by conductivity method.
12. Reaction between potassium persulphate and potassium iodide (including the study of salt effect and catalysis by Ag^+ , Fe^{2+} and Cu^{2+} ions).
13. Decomposition of diacetone alcohol by NaOH & Hydrolysis of t-Butylchloride.
14. Reaction between hydrogen peroxide and HI .
15. Determination of solubility of lead iodide at different T & hence molar heat of solution.
16. Determination of heat of solution of a sparingly soluble solute.
17. Any other interesting experiments

References

1. Findlay's Practical Physical Chemistry, B. P. Levitt, Longman, London.
2. Experiments in Physical Chemistry, James and Prichard.
3. Experimental Physical Chemistry, Daniels et al.
6. Experimental Physical Chemistry, Das & Behera, Tata McGraw Hill, New Delhi, 1983.
7. Advanced Practical Physical Chemistry, Yadav, 1989.
8. Experiments in Physical Chemistry, J.C.Ghosh, Bharathi Bhavan, 1974.



II Semester

IC 451: CHEMISTRY OF SOIL, FERTILIZERS & AGROCHEMICAL

UNIT I

14 hrs

Soil Chemistry: Essential elements for plants, Function of essential elements- Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Iron, Zinc, Molybdenum, Manganese, Copper, Boron, Chlorine, Sodium, Cobalt, **Forms of nutrients used by plants**-Ion Exchange in soils-Cation exchange, Cation exchange capacity (CEC), Anion exchange. **Nitrogen in Soils**-Forms of Nitrogen in soils, Forms of Nitrogen absorbed by plants, Nitrogen content of soils, Mineralization of organic nitrogen compounds, Gains of nitrogen in soils, Losses of nitrogen from soils, **Phosphorus in soils**-Forms of phosphorus in soils, Forms of phosphorus absorbed by plants, Gains of phosphorus in soils, Losses of phosphorus from soils, Reactions of phosphorus in soils, **Potassium in soils**-Forms of potassium in soils, Form of potassium absorbed by plants, Gains of potassium in soils, Losses of potassium from soil solution, Potassium availability to plants. Analysis of soil-Moisture, pH, total nitrogen, phosphorous, silica, lime, magnesia, manganese, sulphur, alkali salts and micronutrients.

UNIT II

14 hrs

Fertilisers: Introduction, Essential plant Nutrients, Classification of Essential Nutrients, Primary Nutrients, Secondary Nutrients, Micronutrients, Macronutrients, **Classification of Fertilizers**- Straight Fertilizers, Compound/Complex Fertilizers, Fertilizer Mixtures, **Feed Stock/ Raw materials**- Nitrogenous Fertilizers, Phosphatic Fertilizers, Potassic Fertilizers, **Manufacture and general properties of Fertilizer products**- Intermediates- Ammonia, Nitric Acid, Sulphuric Acid, Phosphoric Acid, Nitrogenous Fertilizers- Ammonium Sulphate, Ammonium Nitrate, Calcium Ammonium Nitrate, Calcium Nitrate, Ammonium Chloride, Urea, Phosphatic Fertilizers, Ground Rock Phosphate, Single Superphosphate, Triple Superphosphate, Potassic Fertilizers- Potassium Chloride (Muriate of Potash), Potassium Sulphate (Sulphate of Potash), Potassium Nitrate, Complex Fertilizers- Ammonium Phosphate Sulphate, Ammonium Phosphates, Mono Ammonium Phosphate (MAP), Di-Ammonium Phosphate (DAP), Nitrophosphates, Urea Ammonium Phosphates, NPK Complex Fertilizers, Fertilizer mixtures- Physical Mixtures, Granulated Mixtures.

UNIT III

14 hrs

Insecticides: Introduction, classification, Organochlorine insecticides-BHC, DDT, chlordane, heptachlor, aldrin, endosulfan, sevin, Organophosphorus insecticides-malathion, parathion, dimethoate, chlorpyrifos, chlorfenvinphos, dichlorovos, phenthoate., Carbamates-carbaryl, bygone, ziran, zineb, maneb, aldicarb, Naturally occurring insecticides-pyrethroids-natural pyrethrins-isolation and structures, synthetic pyrethroids, allethrin, cypermethrin, phenvalerate. Insect pheromones, general introduction and applications in integrated pest management.

UNIT IV

14 hrs

Repellents: Survey & synthesis of the repellents-N,N-diethyltoluamide, 2-ethyl-1,3-hexanediol, butoxytranexyl, dimethylcarbonate, dimethylphthalate, use of pheromones in pest management.

Fumigants: A general study.

Fungicides: Introduction, Inorganic & organic fungicides, Systemic fungicides-types & examples.

Herbicides: Introduction, study of sulfonyl ureas, heterocyclic sulfonamides, heterocyclic amines, dihydropyrano[2,3-b]pyridyl imidazolinones, pyrrolopyridylimidazolinones, 1,2,4-triazine-3,5-diones, hydroxyoxazolidinones & hydroxyl pyrrolidinones, pyridine herbicides & 1,3,4-oxadiazoles. Mechanism of action and toxicities of insecticides, fungicides and herbicides.

References

1. A Text Book of Fertilizers, Ranjan Kumar Basak.
2. Agronomy - Theory & Digest, Bidhan Chandra, Krishi Vishwavidyalaya, Mohanpur.
3. Fundamentals of Agronomy, S.S.Cheema, K.Dhaliwal, T.S. Shota, Punjab Agricultural University.
4. Principles and Practices of Agronomy, Shri.S.S.Singh, Allahabad Agricultural Institute.
5. Principles of Agronomy, T.Yellamanda Reddy, Agricultural Research Station, Anantapur.
6. Fertilizers, Organic Manures & Biofertilizers—A Product Quality Guide for Major & Micronutrients, HLS Tandon, Fertilizer Development and Consultation Organisation, New Delhi.
7. Handbook on Fertilizer Technology, Bham Swaminathan & Manish Goswami, The Fertilizer Association of India, New Delhi

IC 452: ORGANIC SYNTHESIS & INDUSTRIAL PHARMACY

UNIT I: Planning and Execution of Multistep Synthesis

14 hrs

Basic principles and technologies used in disconnection approach, synthons and synthetic equivalents, Interconversion of functional groups, one group C-X and two group C-X disconnections. Protecting groups-Principles of protection of hydroxyl, amino, carboxylic and carbonyl groups. Use of C-C one group and C-C two group disconnections in the synthesis of 1,2; 1,3; 1,4; 1,5 and 1,6-difunctionalised compounds. Retrosynthetic analysis of alcohols, carbonyl compounds, cyclic and acyclic alkanes, benzocaine, p-methoxyacetophenone, acetocyanohydrin, 2-methyl-6-methoxy-indole-3-acetic acid, 6-methylquinoline and 1-phenyl-4-p-methoxyphenyl-1,3-butadiene. Illustrative synthesis of Juvabione, Longifolene, Prelog-Djerassi lactone, Taxol and Epothilone A. Solid phase synthesis of polypeptides and oligonucleotides.

UNIT II: Chirality

14 hrs

Concept of chirality, optical isomerism, D,L-; R,S- designations, geometrical isomerism and E,Z designations, Stereoselective and stereospecific reactions, Racemisation, mechanism of racemisation, resolution of racemic mixtures, Asymmetric synthesis-definition, importance, mechanism, energy consideration, advantages and limitations, methods of determination of enantiomeric excess. Enantioselective reactions, The chiral pool, chiral auxiliaries and chiral reagents. Use of α -amino acids in the synthesis of benzodiazepines, carbohydrates in the synthesis of swainsonine (D-mannose) and tomatil (mannitol). Synthesis and applications of oxazaborolidines, IPC-BBN, IPC₂BH, (S)-BINAP-DIAMINE and (R)-BINAL-H. Use of (R,R)-DIPAMP, (S,S)-CHIRAPHOS, (R,R)-DIOP, SAMP, RAMP, S-Proline, S-PBMgCl, (-)-BOAlCl₂, (+) and (-)-DET.

UNIT III: Heterocyclic Compounds

14 hrs

Nomenclature of heterocycles-replacement and systematic nomenclature, Hantzsch-Widman system for naming monocyclic, fused and bridged heterocycles, Chemistry of derivatives of pyrazole, imidazole, oxazole, thiazole, benzofuran, indole, benzothiophene, pyridine, quinoline, isoquinoline, pyrimidine, pyrazine, pyridazine and purine. Interconversion of coumarin to benzofuran, pyrrole to pyridine, Pyrimidine to pyrazole, indole/isatin to quinoline, furans to pyrrole. Uses of heterocycles in the synthesis of nonheterocycles.

UNIT IV: Drugs

14 hrs

Introduction, Drug discovery- Historical examples, Natural products. Classification and nomenclature of drugs, concept of lead compounds, analogues and prodrugs, Drug receptor interactions- Forces involved in drug receptor interactions and molecular recognition, chirality and drug actions. Theories of drug action-occupancy, rate, induced fit and perturbation theory. Factors governing drug design, drug design through molecular disjunction and conjunction. Structurally specific and non-specific drugs, factors responsible for drug reaching the active site, Classification, synthesis and mode of action of following classes of drugs- Antipyretic analgesics (Cinchophen, phenacetin, phenazone), General anaesthetics (Thiopental sodium, Fentanyl citrate), Local anaesthetics (benzocaine, α -eucaine, dibucaine hydrochloride), cardiovascular drugs (methyldopa, diazoxide), antimalarials (chloroquine phosphate and pamaquine), antineoplastic agents (methotrexate hydrochloride, methotrexate and fluorouracil), antiviral drugs (methisazone and idoxuridine).

References

1. Organic Synthesis-Special Techniques, V.K.Ahluwalia and R. Aggarwal, Narosa, New Delhi, 2001.
2. Organic Synthesis, R.E.Ireland, Prentice Hall India, 1969.
3. Advanced Organic Chemistry, IV Edn., Part A & B, F.J.Carrey & R.J.Sundberg, Kluwer, 2001.
4. Organic Synthesis- A Disconnection Approach, Stuart
5. Art in Organic Synthesis, Anand, Bindra & Ranganath, Wiley, New Delhi, 1970.
6. Modern Methods of Organic Synthesis, N. Carruthers, Cambridge University, 1996.
7. Organic Reaction Mechanisms, V.K.Ahluwalia & R.K.Parashar, Narosa, 2006
8. Heterocyclic Chemistry, J. Joule & G. Smith, Van-Nostrand, ELBS, 1978.
9. Comprehensive Heterocyclic Chemistry, Vol.I-VI Edn., Katritzky & Rees, Pergamon, 1984.
10. Heterocyclic Chemistry, Raj K. Bansal, New Age International, 1999.
11. Stereochemistry- Conformation and Mechanism, P.S.Kalsi, Wiley Eastern, New Delhi, 1993.

IC 453: ENERGY SYSTEMS, COLLOIDS AND PETROCHEMICALS

Energy Systems

UNIT I

14 hrs

Chemical energy sources and their limitations (natural gas, coal, nuclear fission, nuclear fusion and Hydro power). Electrochemical energy systems-Introduction, classification, battery characteristics. Primary batteries-Laclanche dry cell (Zn and Mg), Alkaline MnO_2 batteries. Secondary batteries-Introduction, lead acid battery, Alkaline storage battery. Lithium batteries-The primary & secondary lithium batteries. Lithium based conducting polymer battery. Fuel cells-Introduction, efficiency, classification and types ($\text{H}_2\text{-O}_2$ fuel cell, methanol fuel cell, biofuel cell, solid polymer electrolyte fuel cell).

UNIT II

14 hrs

Non conventional energy systems:

Solar energy cells-Introduction, semiconductor electrodes, semiconductor-electrolyte interface, parameter controlling efficiency, stability of semiconductor electrodes, Photoelectrochemical and photogalvanic cells. Production of Hydrogen, hydrogen energy. Applications of photochemistry-photoelectrocatalysis, photoreduction of CO_2 and photoelectrochemical waste removal. Hydrogen storage by metal and metal-alloys.

Wind energy-Atmospheric circulations, factors influencing wind and Betz limit. Formation of biomass, photosynthesis; Biomass resources. Chemical constituents and physicochemical characteristics of biomass; Biomass conversion processes; Biofuel, Petrocrops.

Ocean energy resources, Principles of ocean thermal energy conversion systems.

Geothermal energy: Origin, types of geothermal energy sites.

UNIT III

14 hrs

Colloidal chemistry: Introduction, Method of determining particle size. Donnan membrane, equilibrium and potentials, Importance and applications of colloidal chemistry. Theory, properties and applications of gels and emulsion. Migration of an ion in an electric field, factors affecting electrophoretic mobility. Types of electrophoresis-free electrophoresis, zone electrophoresis-paper and cellulose acetate electrophoresis, gel electrophoresis.

Adsorption: Introduction, types, Adsorption isotherms-Langmuir and BET(no derivation), Gibbs adsorption isotherm, applications of adsorption- surface area determination. Kinetics of gaseous reaction on solid surface-uni and bimolecular surface reactions (qualitative study), Catalysis: Types and industrial applications.

UNIT IV

14 hrs

Petroleum and Petrochemicals: History of Petroleum-Origin, recovery and transportation, Composition of crude oils-Paraffins, Naphthenes, Aromatics, Sulphur compounds, Nitrogen compounds, Metallic constituents, Distillation-Pretreatment, atmospheric distillation, Vacuum distillation, Cracking-Thermal cracking, visbreaking, coking, catalytic cracking, hydrocracking, Reforming-Catalytic reforming.

Hydrotreatment and Sulphur Recovery: Finishing processes-Caustic washing, Merox process, Hydrofining, methods for improving storage stability, filter, Molecular sieves

Petroleum Products-LPG, LNG, Motor gasoline or Petrol, Diesel, Kerosene, Naphtha, Aviation turbine fuel, Heavy fuel oil, Bitumen, Lubricating oil, Greases, Petroleum waxes, Petroleum fractions for petrochemicals. Naphtha and Para xylene. General properties of petroleum products, alternative fuels.

References

1. Chemical and Electrochemical Energy Systems, Narayan R & B Viswanathan, University Press, 1998.
2. Energy Storage for Power Systems, Ter-Gazarian A., Peter Peregrinus, London, 1994.
3. Modern Electrochemistry, Vol 2A and B, JOM Bockris & AKN Reddy, Springer, NY, 1998.
4. Biochemical & Photosynthetic Aspects of Energy Production, Anthony San Pietro, Academic Press, N Y, 1980.
5. Bio Energy for Rural Energisation, R.C. Maheswari, Concepts Publication, 1997.
6. Wind Energy Systems, G L Johnson, Prentice Hall Inc, New Jersey, 1985.
7. Modern Petroleum Refining Process, 2nd Edn., Rao, IBH.
8. Introduction to Petrochemicals, Maiti, IBH.
9. Synthetic Organic Chemistry, G R Chatwal, Himalaya Publishing House.
10. A Text Book of Engineering Chemistry, M M Uppal, Khanna Publishers, 1986.
11. Modern Petroleum Chemistry-An overview, Kochu Baby, Manjaram & Kannatheri Publication, Kochi.
12. Colloids Chemistry, A.K.Sharma, Goel publishing House, Meerut, 1991.

IC 454: Chemical Engineering Technology

Unit Operations

UNIT I

14 hrs

Evaporation: Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporations, entrainment separators (upturned, deflector type, tangential type), effect of scale formation, multiple effect evaporators.

Distillation: Boiling and distillation, vapour-liquid equilibria, Raoult's law & Henry's law, relative volatility, azeotropic mixtures, flash distillation, steam distillation, vacuum distillation, fractional distillation, plate columns (Bubble cap, Sieve plate & Valve plate).

Extractions: Liquid equilibria, extraction with reflux, extraction with agitation, equipment, its use and performance, continuous contact equipment, agitator extractions, packed spray extractors, leaching, flow sheets of solid-liquid extraction, continuous leaching, counter current extraction.

UNIT II

14 hrs

Crystallisation: Theory & mechanisms of growth of crystal, saturation, nucleation, super saturation (Mier's theory), caking of crystals, effect of impurities, classification of crystallizers, agitated tank, Swenson Walkers, Krystal, Oslo, continuous vacuum crystallizers.

Gas absorption: Definition, examples, comparison of absorption and distillation, conditions of liquid-gas equilibrium, solution criteria for gas absorption, mechanically agitated vessels. Packed columns and plate columns, characteristics of tower packing, types of packing, merits of plate & packed tower.

Drying: General principles (significance & moisture content), rate of drying (constant & fall in rate period), drying equipments. **Filtration:** Classification & principles of filters.

Unit Processes

UNIT III

14 hrs

Unit process and flow sheet. **Nitration:** Nitrating agents, kinetics and mechanism of nitration of aromatic compounds, nitration of paraffinic hydrocarbons, nitrate esters, N-nitrocompounds, typical industrial manufacturing process. **Sulfonation:** Sulfonating agents, kinetics and mechanism, desulfonation, work-up procedures. Industrial equipment and technique, Batch and continuous processes, manufacturing processes for detergents, dye intermediates, turpentine oil, etc.

Alkylation and acylation: Alkylation & acylation at Carbon, Oxygen and Nitrogen, Friedel-Craft reaction, applications of active methylene compounds like diethyl malonate and ethyl acetoacetate. Industrial processes

UNIT IV

14 hrs

Catalytic hydrogenation and hydrogenolysis: Different types of catalysts, Industrial hydrogenation processes. **Halogenation:** Kinetics & mechanism of halogenation reaction, survey methods, catalytic chlorination, manufacturing processes for chlorobenzene, BHC, chlorinated methanes, vinyl chloride.

Oxidation: Oxidising agents with typical applications of each, liquid phase oxidation with oxidising compounds. **Esterification:** Kinetics and mechanism, esterification of carboxylic acid derivatives, esters by addition to unsaturated systems, industrial esterifications, ethyl acetate, methyl methacrylate, cellulose acetate and nitroglycerin.

References

1. Chemical Technology, F A Henglein, Pergamon.
2. Chemical Engineering, Vol. I, II & III, J M Coulson
3. The Chemical Process Industries, R N Shrove, MGH.
4. Introduction to Chemical Engineering, W L Badger & J T Bandchero, MGH.
5. Chemical Process Principles, Vol I & II, O A Hougen, K M Watson & R A Ragatz, John Wiley.
6. Unit Operation-II, K A Gavhane, Nirali Prakashan, Pune.
7. Unit Processes in Organic Synthesis, P H Groggins, MGH.
8. Chemical Technology, F A Henglein, Pergamon.

IC 455: QUALITY CONTROL, ASSURANCE & CHROMATOGRAPHIC TECHNIQUES

UNIT I

14 hrs

Quality Control and Assurance: Role, Government standards like ISI, MINAS, Agmark, I.P., D.P., U.S.P., ASTM. and FMTM, concepts of quality and quality control, the nature of variabilities. Specification and tolerances, sampling inspection, cost reduction and quality improvement experiments. Optimization.

Basic concepts of quality assurance, quality acceptance, sampling, reliability, cost aspects of quality decisions. Quality control in raw materials, production (in process) and finished product. Current trends in quality control, ISO 9000 and ISO 14000 series. Laws related to quality control. ISO 17025.

Chemical Warfare Convention: Definitions and schedules. Toxic chemicals, remote control systems, tear gas, chemical weapons, ocean dumping of chemical weapons.

UNIT II

14 hrs

Chromatographic Techniques: Principles, classifications and theory of chromatographic separations. Ion exchange chromatography: Structures of resins, selectivity, capacity of resins, ion exchange equilibria, applications-removal of interfering ions, concentration and recovery of traces, anion and cation separations and application for the separation of lanthanides and actinides. Techniques of column chromatography and size exclusion chromatography. Gas Chromatography: Principles, columns, detectors-TCD, FID, ECD and column efficiency, capacity factors, resolution. Practical aspects of GC-Hyphenated techniques. HPLC: Principles, equipment, columns, detectors, choice of column, materials. Paper chromatography: Theory and principle. Techniques: one, two- dimensional and circular paper chromatography. Mechanism of separation, structure of cellulose and types of paper. Methodology- Factors affecting R_f values. Advantages and applications. Thin layer chromatography, efficiency of TL plates, selection of stationary and mobile phases. Qualitative and quantitative analysis.

References

1. Analytical Chemistry, 6th Edn., G.D. Christian, John Wiley, 2004.
2. Quantitative Analysis, 5th Edn., A.Day and A.L. Underwood, Prentice Hall, India, 1998.
3. Instrumental methods of analysis, 7th Edn., H.H.Williard, L.L.Merrit and J.J.Dean, 1988
4. Principles of Instrumental Analysis, Skoog, Holler and Nieman, Harcourt Afca, 2001
5. Chemical Engineering for Chemists, R. G. Griskey, ACS, Washington DC, 1996.
6. Chemical Process Industries, 3rd Edn., Shreves & R.Norris, Mc Graw Hill, 1967.
7. Statistical Quality Control, 2nd Edn., Manohar Mahajan Dampat Rai and Sons, 1995.
8. Chemical Engineers Hand Book, 8th Edn., Robert H. Perry, Mc Graw Hill, 1995.
9. Principles of Industrial Chemistry, C. A. Clausen and G. Mattson.

IC 456: INDUSTRIAL INORGANIC CHEMISTRY PRACTICALS-II

1. Colorimetric determination of Ti (IV) and Zr (IV)
2. Simultaneous colorimetric determination of two metal ions – Mn and Cr.
3. Flame photometric determination of Na, K, Li and Ca individually and in mixtures.
4. Solvent extraction of Ni (II) and UO_2 (II).
5. Determination of composition of complexes: a) Job's method: Fe-1, 10-Phenanthroline complex
b) Mole ratio method: Zr-Alizarin red S complex, c) Slope ratio method: Cu ethylenediamine complex, d) Limiting logarithmic method: Uranyl sulphosalicyclic acid complex.
6. Determination of stability constants-Turner Anderson method: Fe-Tiron system,
7. Cement analysis: i) SiO_2 -Gravimetrically ii) Calcium, Volumetrically
iii) Iron, Volumetrically iv) Magnesium, Complexometrically iv) Aluminium, Gravimetrically.
8. Determination of available chlorine in bleaching powder and residual chlorine in water samples.
9. Determination of Iron present in sulpha- drugs; colorimetrically.
10. Determination the percentage of phosphorus present in terms of P_2O_5 from a fertilizer sample volumetrically.
11. Any other experiment of interest-Determination of oxygen by Oslet method, Determination of elements by AAS method-demonstration only.
12. Any other interesting experiment.

References

1. Physicochemical Experiments, J. Rose.
2. Vogel's Text Book of Quantitative Chemical Analysis(5th Ed), G.H.Jeffrey, J.Bassette, J.Mendham and R.C.Denny, Longman, 1999.

IC 457 : INDUSTRIAL ORGANIC CHEMISTRY PRACTICALS-II

Quantitative determination of sugars, amino acids, phenols, carboxylic acids, amides, esters, aldehydes, ketones, urea by various methods. Determinations of acid and ester and acid and amide in mixtures of two. Determination of functional groups like hydroxyl, vic-hydroxyl, enol, amino, amide, unsaturation and nitro groups by various methods.
Any other interesting experiment.

References:

1. Elementary Practical Organic Chemistry, Vol. II, quantitative Organic Analysis-A.I. Vogel
2. Experimental Organic Chemistry, Vol. I & II, P.R.Singh, Tata McGraw-Hill, 1981.
3. Practical Organic Chemistry- IV Ed- Dey & Sitaraman, Allied, New Delhi, 1992.
4. Laboratory Experiments in Organic Chemistry-Adam, Johnson & Wicon, McMillan, 1979.
5. Experimental Organic Chemistry, H.D.Durst & G.E.Goke, McGraw-Hill, 1980
6. More Spectroscopic Problems in Organic Chemistry-A.J. Baker et al., Heyden, 1975.
7. Spectral Problems in Organic Chemistry, Davis & Wells, Chapman & Hall, 1984.
8. Elementary Practical organic chemistry, Part 2: Quantitative organic analysis by Arthur I. Vogel, 2nd Edition, CBS Publishers and distributors, 1987.
9. Organic analytical chemistry, Theory and Practice-Jag Mohan, Narosa, 2003.
10. Laboratory Manual of Organic Chemistry - Raj K Bansal, 2nd Edition, Wiley, 1990.
11. Systematic Lab Experiments in Organic Chemistry-Arun Sethi, New age International, 2006.

IC 458: INDUSTRIAL PHYSICAL CHEMISTRY PRACTICALS-I

A. Electrochemistry: a. Conductometry (At least 5 experiments to be carried out)

1. Determination of hydrolysis constants (aniline hydrochloride etc.).
2. Titration of a mixture of acetic acid, monochloro and trichloroacetic acids with NaOH.
3. Determination of concentrations/amounts of sulphuric acid, acetic acid and copper sulphate using sodium hydroxide.
4. Measurements of the conductance of a weak acid, HOAc and of the strong electrolytes NaOAc, HCl and NaCl and to calculate the ionisation constant of the acid.
5. Analysis of the mixture of HCl and NH_4Cl .
6. Determination of activity coefficient of Zinc ions in 0.002M ZnSO_4 .
7. Determination of equivalent conductances and dissociation constants of weak acids.
8. Any other experiments of interest

b. Potentiometry (At least 7 experiments are to be carried out)

9. Determination of pK values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode.
10. Determination of acidic & basic dissociation constants and isoelectric point of an amino acid.
11. Determination of the potential of an electrochemical cell and mean ionic activity coefficient.
12. Determination of activity coefficient of an electrolyte at different molalities.
13. Determination of pH of buffer solutions with a pH meter & evaluation of pK_a of acids
14. Determination of thermodynamics of a cell reaction
15. Determination of pK_a values of mono, di and tri-acid base.
16. Determination of solubility of insoluble silver halide and the standard electrode potential using quinhydrone electrode
17. Determination of degree of hydrolysis of CH_3COONa and NH_4Cl .
18. Determination of hydrolysis constant of aniline hydrochloride.
19. Verification of Nernst equation for Ag^+ , Cu^{2+} and Zn^{2+} species.
20. Determination of transport number of ions by emf method (Ag^+ , Cd^{2+} , NO_3^{1-} , SO_4^{2-})
21. pH titration of (a) HCl versus NaOH, (b) $CuSO_4$ versus NaOH and (c) HOAC versus NaOH and (d) lead nitrate versus potassium chromate.
22. Potentiometric titration of halides in mixtures (Cl^- , Br^- and I^-) with silver nitrate.
23. Potentiometric determination of dissociation constants of weak acids.
24. Any other experiment of interest.

References

1. Findlay's Practical Physical Chemistry, B. P. Levitt, Longman, London.
2. Experiments in Physical Chemistry, James and Prichard.
3. Experimental Physical Chemistry, Daniels et al.
6. Experimental Physical Chemistry, Das & Behera, Tata McGraw Hill, New Delhi, 1983.
7. Advanced Practical Physical Chemistry, Yadav, 1989.
8. Experiments in Physical Chemistry, J.C. Ghosh, Bharathi Bhavan, 1974.



III Semester

IC-501: Industrial Safety, Environment, Corrosion and Green Chemistry

Unit-I

14 Hours

Safety: Flammable material handling and fire fighting equipments, control measures for toxic chemicals, industrial hygiene, safety in laboratories & plant, safety in the transportation & storage of chemicals. OHSAS 18000.

Chemical Warfare Convention: Definitions and schedules. Toxic chemicals, remote control systems, tear gas, chemical weapons, ocean dumping of chemical weapons.

Quality Control and Assurance: Role, Government standards like ISI, MINAS, Agmark, I.P., D.P., U.S.P., ASTM. and FMTM, concepts of quality and quality control, the nature of variabilities. Specification and tolerances, sampling inspection, cost reduction and quality improvement experiments. Optimization.

Basic concepts of quality assurance, quality acceptance, sampling, reliability, cost aspects of quality decisions. Quality control in raw materials, production (in process) and finished product. Current trends in quality control, ISO 9000 and ISO 14000 series. Laws related to quality control. ISO 17025.

Unit-II

14 Hours

Air Pollution: Qualitative study of environmental segments, air pollutants, prevention & control, Green house gases & acid rain. Ozone hole & CFC's. Photochemical smog, PAN and Bhopal Gas tragedy.

Water, Waste Water Treatment and Analysis: Hydrologic cycle, sources, criteria & standards of water quality- safe drinking water. Public health significance & measurement of colour, turbidity, total solids, acidity, fluoride, alkalinity, hardness, chloride, residual chlorine, sulphate, fluoride and phosphate in natural & polluted water. Significance of DO, BOD & COD. Water purification for drinking & industrial purposes, disinfection techniques, demineralization, desalination processes & reverse osmosis.

Energy systems

7hrs

Chemical energy sources and limitations. Electrochemical energy sources. Principle and importance of primary(dry cell), secondary(Lead-acid battery) and fuel cells(H_2 - O_2 and biochemical). Basics of solar energy system. Safety implications. Energy from wind, ocean, geothermal and biomass. 7hrs

Unit-III

14 Hours

Corrosion : Fundamentals of corrosion. Corrosion related damage, Types of corrosion. Methods of prevention & control (organic & inorganic coating, inhibitors, cathodic & anodic protection, material selection & design improvement). Corrosion problems in practice, passivity. Thermodynamics & kinetics of corrosion. Corrosion failure.

Metal Finishing & Processing: Metal finishing & technological importance, fundamentals of electrodeposition, electroplating process (copper and Nickel). Principles & applications of electroless plating.

Paints: Classification of paints, types, Constituents of paints. Requirements of a good paint. Emulsion paints. Paint removers. Varnishes.

Electrochemistry of Environment: Global warming, role of electrochemistry in the transport system, fixing of CO_2 , sewage disposal and treatment of waste

Unit-IV

14 Hours

Green Chemistry in Industrial Processes

Definition and principles, planning a green synthesis in a chemical laboratory, Green preparation- Aqueous phase reactions, solid state (solventless) reactions, photochemical reactions, Phase transfer catalyst catalysed reactions, enzymatic transformations & reactions in ionic liquids. Microwave induced reactions-introduction, advantages and limitations, alkylation of active methylene compounds, condensation of active methylene compounds with aldehydes, Diels-Alder reaction, ortho ester Claisen rearrangement and synthesis of enamino ketones. Sonication reactions: Introduction, cavitation phenomenon, Sonochemical esterification, substitution, addition, oxidation, reduction and coupling reactions.

References

1. Chemical Process Industries, 3rd Edn., Shreve & R.Norris, Mc Graw Hill, 1967.

2. Statistical Quality Control, 2nd Edn., Manohar Mahajan Dampat Rai and Sons, 1995.
3. Chemical Engineers Hand Book, 8th Edn., Robert H. Perry, Mc Graw Hill, 1995.
4. Principles of Industrial Chemistry, C. A. Clausen and G. Mattson.
5. Environmental Chemistry, A.K.De
6. Industrail electrochemistry by Peltcher
7. Modern Electrochemistry, Vol I, IIA & IIB(1998) J.O.M. Bockries and A.K.N.Reddy
8. Organic Synthesis-Special Techniques, V.K.Ahluwalia & R. Aggarwal, Narosa, 2001.
9. Green Chemistry-Environment friendly alternatives, R.Sanghi & M.M.Srivatsava, Narosa, 2003.
10. Green Chemistry-Environment benign reactions, V.K.Ahluwalia, Ane Books India, 2006
11. Engineering Chemistry by Jain and Jain.



IC 502: INDUSTRIAL CATALYSIS AND POLYMERS

Industrial Catalysis

UNIT I

14 hrs

Preparation of catalyst and their behaviour: Selection, preparation and evaluation of catalysts-test reaction, promoters, carriers and stabilisers, Role of supports, preparation & structure of supports, silica, alumina, silica-alumina, zeolites, carbon catalyst manufacture, catalyst size and shape, pre-treatments, deactivation process, sintering, poisoning and catalyst fouling. **Definition of performance criteria of catalysts:** Activity, selectivity, temperature response, catalyst life. Surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar concentration (CMC), factors affecting the CMC of surfactants.

UNIT II

14 hrs

Catalysis by Organometallic Compounds: Coordinative unsaturation, oxidative addition and reductive elimination and insertion reactions, olefin hydrogenation, Wacker process, Zeigler-Natta process, olefin metathesis, Monsanto process for the synthesis of acetic acid, heterogenisation of homogeneous catalysts using polymer supports.

Applications in Fertiliser and Petrochemical Industry: Catalytic reforming and refining, catalytic cracking, hydro-treatment, steam reforming, hydrocarbon from synthesis gas, Fischer-Tropsch process.

Techniques in Catalysis-Surface Investigations: Electron diffraction, scanning tunnelling microscopy (STM), X-ray and UV photoelectron spectroscopy (XPS & UPS), Auger electron spectroscopy (AES)-basic principles & applications.

Industrial Polymers

UNIT III

14 hrs

Polymer Chemistry: Basic concepts and techniques in polymer chemistry. General structures & classifications of polymers. Techniques of polymerization and molecular weight determination. Structural factors, properties and uses of commercial and engineering polymers. Thermoplastics, thermosets and elastomers. Polymer processing techniques, additives for improvement of polymer properties, spinning of industrial polymers, wet and dry. Melt spinning.

UNIT IV

14 hrs

Polymer blend and composites-preparation, properties and uses. Introduction to nano composites. Polymers as separation devices-principles and applications of reverse osmosis, ultra and nano filtration and electrodialysis, Uses in food industry and biotechnology. Medical applications of polymers: Concepts and design of oral, transdermal and targeted drug delivery systems-micro, macro and nano sized systems. Biodegradable polymers- Sources of plastic waste, waste management techniques, environmental issues of waste management.

References

1. Material science and Engineering, W D Callister, Wiley.
2. Solid State Chemistry, A R west.
3. Modern Prospective in Solid State Chemistry, C N R Rao and J Gopalakrishnan.
4. Principles of Polymer Science, Bahadur P and N.V Shastri, Narosa, New Delhi, 2000.
5. Polymer Science and Engineering, D.J.Williams, Prentice Hall Inc, New Jersey, 1971.
6. Theory and Basics of Polymer Science, F.W. Billmeyer, John Wiley & Sons, NY, 1984.

IC 503: HEALTH CARE CHEMICALS

UNIT I

14 hrs

Perfumery: Introduction, Compounds used in perfumery and their classification, methods of preparation and importance of phenyl ethanol, Yara yara, Ionone musk ketone, musk ambrette, musk xylene, phenyl acetic acid and its esters, benzyl acetate, synthetic musks and jasmine.

Flavours: Introduction, classification, Chemical basis for flavour, flavours in dairy products, flavours formed by heating or cooking-caramelisation & Maillard reaction, flavour degradation by oxidation-rancidity, molecular structure & odour/taste, sweetness, acidity & sourness, saltiness, bitterness, synthetic chemicals, Natural flavouring materials & classification. Flavouring materials-Acidulants, sweeteners, potentiators, enhancers & sodium-restricted food flavourings. Organic chemicals used in flavorings & food colorants.

Essential oils: Source, constituents, isolation & uses.

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick and nail polish, shampoos, hair dyes and tooth pastes. A formulary of cosmetic preparation-Godwin.

UNIT II

14 hrs

Oils, soaps and Detergents: Refining of edible oils, manufacturing of soaps, detergents-classification-anionic, cationic, non-ionic and amphoteric detergents, comparison of soaps and detergents, detergent builders and additives, liquid soaps. Manufacturing of fatty acids and glycerol, greases from fatty acids, turkey red oil. Paints, varnishes and inks-constitutions, examples of preparation and applications.

Food Analysis: Moisture, ash, crude protein, crude fiber, fat, carbohydrate, calcium, potassium, sodium and phosphates, food adulteration-common adulteration in food, contamination of food stuffs, microscopic examination of food for adulterants, pesticide analysis in food products.

Role of Chemistry in Animal Health and Growth

UNIT III

14 hrs

Citric acid cycle-Krebs cycle, Uric acid formation; Antinutritional factors present in feed components and degradation methods, Antioxidants- Role of antioxidants in animals, Mechanism of actions; Proteins-Metabolism of proteins in animals-Sources of proteins for animals, Protein deterioration due to stress, Role of amino acids for growth and development; Toxins- Toxins found in feed ingredients, Origin of toxins, Effects of toxins on animal productivity, Adsorption techniques for irreversible toxin binding. Lipids-Storage of lipids in animals, Structural lipids in membranes, Oxidation of fatty acids, Metabolism of lipid in animals.

UNIT IV

14 hrs

Dairy Chemistry-Rumen metabolism, role of ruminants in global warming; Antibiotics-Role of antibiotics in animal growth, commonly used antibiotics, structure & activity relationship, Implications of use of antibiotics in the food chain; Enzymes-Role of enzymes in animal growth & development, enzymes kinetics, regulatory enzymes; Probiotics-Role of probiotics in animal growth & development; Vitamins & minerals-Role of vitamins in animals, Importance trace minerals & their role in animal nutrition; Carbohydrates-Biosynthesis & Metabolism of carbohydrates.

References

1. Synthetic organic chemistry, G R Chatwal, Himalaya publishing house.
2. A formulary of paints and other coatings, M Ash & I Ash
3. Encyclopedia of Chemical Technology, Kiiik & others.
4. Perfumery Technology, B. Billot and F. V. Wells
5. Lehninger principles of Biochemistry, David .L Nelson and Michael M Cox
6. Dairy chemistry and animal nutrition, V.K. Chhozllani
7. Principles of Animal nutrition and Feed technology Part I and II, D.V Reddy
8. Feeds and Principles of animal nutrition, G.C.Banerjee.
9. Source book of flavors, Heath.

IC 504: PAPER, TEXTILE & SOFT MATERIALS TECHNOLOGY

UNIT I

14 hrs

Pulp and Paper Science: Raw materials for paper, Important fiber producing plants, woody & non woody fibers used in paper industry, physical and chemical characteristics. Structure of wood, structural elements of wood and bark, cell wall & fiber morphology, chemical components of wood; **Pulp Manufacture:** Mechanical pulping, Thermomechanical and Refiner mechanical pulping, Semichemical & chemical pulping. Kraft pulping. **Papermaking:** Beating and Refining of pulp, Fillers used in papermaking. Pressing: Objectives, types of presses, Drying: Theory and types, Finishing: Unwinding and rewinding. Evaluation of Paper: Physical, optical, electrical properties and Chemical properties of paper. Introduction to coating of Paper and metal foils.

UNIT II

14 hrs

Textile Technology: Brief history on origin of textiles. Introduction to textile fibers and basic requirements of textile fibers. Manufacture of eco-friendly regenerated fibre. Brief study of physical & chemical properties of cotton, wool, silk & bast fibers. Importance and need of ginning. Impurities in the cotton and remedies to minimize impurities in cotton. Definition and objects of mixing and blending. Types of blending and common blends. Blends of Polyester/cotton and polyester/viscose. Introduction to textile testing & quality control. Sampling techniques. Frictional, optical, electrical and thermal properties of textile. Introduction to synthetic fibres. Raw materials for production of PET. Production of modified viscose rayon, brief out line on production of acetate & cupramonium rayon.

Dyes: Terminology & theory of dyeing, classification of dyes, chemistry and mode of application of azo, acid, basic, azoic, reactive and vat dyes, mordant and disperse dyes. Fluorescent brightening agents.

UNIT III

14 hrs Soft

Materials: Thin Films and Langmuir-Blodgett Films, Preparation techniques, vaporation/sputtering, chemical process, MOCVD, sol-gel etc. growth technique, photolithography, properties and applications of thin and L-B films.

Liquid Crystals: Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientation, ordernematic & smectic mesophases, nematic transition & clearing temperature-homotropic, planer & schlieren textures, twisted nematic, chiral nematic, molecular arrangement in smectic A & Smectic B phases, optical properties of liquid crystals, Dielectric susceptibility & dielectric constants, Lyotropic phases & their description or ordering in liquid crystals.

Organic Solids and Fullerenes: Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes: doped fullerenes as superconductors.

UNIT IV

14 hrs

Ceramics: Classification and properties of ceramics. Basic raw materials, manufacturing of ceramics, manufacture of porcelain,

Refractories: classification, properties & manufacture of refractories, manufacture of enamel glass & application of enamel. **Portland cement:** Type, raw materials, manufacturing and processing of Portland cement. Other cements, gypsum, calcium and magnesium compounds.

Composites: General characteristics & classification of composite materials. Fibre reinforced composites, Noncrystalline phase, preparation procedures, special properties & their applications.

References

1. Bleaching of Pulp, R. P. Singh, TAPPI Press.
2. Joint Text Book Committee of the Paper Industry, Vol. I to X, Technical Editor Benjamin A. Thorp Series Editor Michael J. Kocurek, Published by the technical section Canadian Pulp and Paper Association.
3. Hand Book for Pulping and Papermaking, Christopher J. Biermann
4. Environmental Friendly Technologies for the Pulp and Paper Industries, Young and Akhtar TAPPI Press.
5. Hand Book for Pulp and Paper Technologists, Gary A. Smook
6. Formation of synthetic fibres, Walczalk.K. Gordon & Sci. London
7. Manual of Cotton Spinning, Coulson. A.F.W. (Ed.), Vol. I to IV,

8. Textile Institute Pub., Manchester, 1989.
9. Spun Yarn Technology, Osteby, Butterworths, London, 1987.
10. Physical Testing of Textiles, B.P. Soville, Wood Head, 1999.
11. Principles of Textile Testing, Booth J. E., Butterworth, Wendon III Edition.
12. Technology of Textile Processing, Technology of Dyeing, Shenai, V.A. 4th Edn., Sewak Publications, Bombay, 1988.
13. The Chemistry of Synthetic Dyes, Vol 1-7, K. Ventatraman, Academic Press.
14. Dyes and their Intermediates, Abbbbranart, Pergamon.
15. Industrial Dyes, Klans Hunger, Wiley, VCH, Germany.
16. Handbook of Liquid Crystals, Kelker and Hatz, Chemie Verlag.
17. Materials Science, J.C.Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
18. Material Science and Engineering-An Introduction, W.D.Callister, Wiley.



IC 505 : INDUSTRIAL INORGANIC CHEMISTRY PRACTICALS-III

1. Analysis of brass—Cu gravimetrically using α -Benzoinoxime & Zn complexometrically.
2. Analysis Cu-Ni alloy.
3. Analysis of Stainless Steel-Insoluble residue by gravimetry, Ni gravimetrically using DMG, Fe volumetrically using Ce(IV) & Cr(III) volumetrically by persulphate oxidation.
4. Analysis of Type metal -Sn gravimetrically, Pb electrogravimetrically and Sb titrimetrically using KBrO_3
5. Chemical Separation Techniques
 - (i) Cu(II) + Fe(II)-Cu gravimetrically as CuSCN and Fe using Ce(IV).
 - (ii) Cu(II) + Ni(II)-Cu gravimetrically as CuSCN and Ni using EDTA.
 - (iii) Fe(III) + Ca(II)-Fe gravimetrically as Fe_2O_3 and Ca using EDTA.
 - (iv) Cr(III) + Fe(III)-Using EDTA by Kinetic masking method.
6. Analysis of chalcopyrites, magnetite and ilmenite.
7. Ion-exchange chromatography: Separation & determination of $\text{Mg}^{2+}/\text{Zn}^{2+}$, $\text{Zn}^{2+}/\text{Cd}^{2+}$ & Cl^-/Br^- .
8. Determination of COD of a water sample
9. Determination of dissolved oxygen (DO) by Winkler's method
10. Determination of nitrate & nitrite in water samples and sea water.
11. Analysis of heavy metals in waste water, sea water (Pb, Hg etc. By spectrophotometry)
13. Determination of available NPK in soil and Fertilizer analysis.
14. Nephelometric determination of sulphate/phosphate.
15. Determination of alkalinity of water samples
16. Determination of fluoride in drinking water by spectrophotometry and ion selective electrode
17. Determination of phosphates in detergents
18. Spectrophotometric determination of sulphur and phosphorus present in soil.
19. Any other experiment of interest: Oil analysis using IR.

References

1. A Text book of Quantitative Inorganic Analysis, A.I. Vogel, ELBS, 1978.
2. Standard Method for the Examination of Water and Waste Water, APHA, AWWA and WPCF, Washington DC, 1989.
3. Quantitative Chemical Analysis, I. M. Kolthof and E.P. Sandell, McMillan, 1980.
4. Environmental Chemistry, I. Williams, Wiley, 2001
5. Comprehensive Analytical Chemistry, Lobinski and Marczenko, Vol.30, Elsevier, 1996.

IC 506: INDUSTRIAL ORGANIC CHEMISTRY PRACTICALS-III

Isolation of natural products like Caffeine, Ricinoleic acid, Azelic acid, Piperine, Hesperidine, Cysteine, Casein, Lycopene and enzymes like Lipase and Sucrase. Extraction of Groundnut oil, Coconut oil and eucalyptus oil. Determination of acid, saponification and iodine values of oils and fats. Isolation of Carotenes, purification by paper, Column and TLC. Characterization of natural products by oxidation studies & derivatization of natural products (oxidation of hydrocarbons to carboxylic acid, phenols to aryloxy acetic acid and determination of their equivalent weights. A few green synthesis.

Separation of components from mixture of organic compounds by fractional crystallization, fractional distillation and adsorption, Elucidation of structure of organic compounds using UV, IR, NMR and Mass spectra. Locating an organic compound by reference to literature (Chemical Abstract).

Any other experiment of interest: Estimation of protein from feed samples, Estimation of cellulose using cellulose, Qualitative analysis for trace minerals found in feed, Quantification of rancidity and peroxide values in oils, Estimation of urease activity in the feed ingredient, Proximate analysis and calculation of metabolizable energy, Chemical analysis of milk, Identification of mycotoxins found in feed ingredients

References

1. Elementary Practical Organic Chemistry-Quantitative Organic Analysis, Vol. III, A.I. Vogel.

2. Vogel's Text Book of Practical Organic Chemistry, Furniss et al., ELBS, London, 1978.
3. Experimental Organic Chemistry, Vol. I & II, P.R.Singh, Tata McGraw-Hill, 1981.
4. Practical Organic Chemistry, IV Edn., Dey & Sitaraman, Allied, New Delhi, 1992.
5. Laboratory Experiments in Organic Chemistry, Adam, Johnson & Wicon, McMillan, 1979.
6. Experimental Organic Chemistry, H.D.Durst & G.E.Goke, McGraw-Hill, 1980
7. More Spectroscopic Problems in Organic Chemistry, A.J. Baker et al., Heyden, 1975.
8. Spectral Problems in Organic Chemistry, Davis & Wells, Chapman & Hall, 1984.
9. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST
10. Organic Analytical Chemistry-Theory and Practice, Jag Mohan, Narosa, 2003.
11. Lehninger Principles of Biochemistry, David. L Nelson and Michael M Cox.
12. Dairy chemistry and animal nutrition, V.K. Chhazllani.
13. Principles of Animal nutrition and Feed technology, Part I and II, D.V Reddy.
14. Feeds and Principles of Animal Nutrition, G. C. Banerjee.

IC 507: INDUSTRIAL PHYSICAL CHEMISTRY PRACTICALS-III

Any twelve experiments are to be carried out

Thermodynamic Experiments (Any 6 Experiments to be carried out)

1. Determination of molecular weight and size parameters of polymers by viscometry.
2. Determination of sequences in polyvinyl alcohol by viscometry.
3. Study of association of benzoic acid in benzene.
4. Determination of partial molar volumes of a) Salts – water and b) alcohol – water (methanol & ethanol) systems by density method.
5. Determination of specific heat of liquids and solutions by calorimetry.
6. Study of phase diagram of a ternary aqueous system of potassium chloride and water.
7. Study of phase diagram of a ternary system of benzene – acetic acid – water or DMSO- water – benzene or ethanol – benzene – water etc.
8. Determination of heat of solution of KNO_3 in water, integral heat of dilution of H_2SO_4 and heat of ionization of acetic acid and ammonium hydroxide calorimetrically.
9. Determination of heat of neutralisation of two acids and hence their relative strength.
10. Determination of conc. of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ by spectrophotometer.
11. Determination of pKa values of indicators.

Voltammetry & Polarography Experiments (Any 6 Experiments to be carried out)

12. Determination of the half-wave potential of Cd(II) , Cu(II) & Zn(II) ions in 0.1M solutions.
13. Determination of metal ions individually and in mixtures.
14. Determination of the formula and the stability constant of a lead oxalate.
15. Study of the polarogram of supporting electrolyte with and without dissolved oxygen.
16. Determination of Huckel β value of aromatic hydrocarbon reduction at dropping mercury electrode.
17. Verification of Ilkovic equation.
18. Determination of i) stability constant of a metal complex (lead oxalate or copper glycinate) and ii) concentration of metal ions polarographically.
19. Amperometric titrations.
20. Study of potential-pH diagrams.
21. Determination of thermodynamic parameters of a cell reaction by EMF method.
22. Electroplating of i) Nickel, ii) Chromium, iii) Aluminium and iv) copper on a copper plate.
23. a) Verification of Tafel equation of hydrogen evolution reaction.
b) Determination of rate of corrosion by weight loss method.
24. a) Identification of deposits by chemical spot tests.
b) Determination of electrochemical equivalent of copper.
25. Coulometric Experiments
26. Any other experiment of interest.

References

1. Findlay's Practical Physical Chemistry, B. P. Levitt, Longman, London.
2. Experiments in Physical Chemistry, James and Prichard.
3. Experimental Physical Chemistry, Daniels et al.
6. Experimental Physical Chemistry, Das & Behera, Tata McGraw Hill, New Delhi, 1983.
7. Advanced Practical Physical Chemistry, Yadav, 1989.
8. Experiments in Physical Chemistry, J.C.Ghosh, Bharathi Bhavan, 1974.

