VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI

SYLLABUS

Department of Studies in

INDUSTRIALCHEMISTRY

MASTER OF SCIENCE

(I to IV Semester)

Choice Based Credit System(CBCS)

With effect from 2016-17

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BELLARY

INDUSTRIAL CHEMISTRY (PG)

(2016-17)

Credit Based, Choice Based, Continuous Assessment Patterned Semester Scheme.

The Board has amended the Syllabus / Scheme of examination of Choice Based Credit Based System (CBCS) and recommended for implementation from 2014-2015. The following are the core papers and scheme of examination proposed by the Board.

1. M.Sc, Degree in Chemistry / Industrial Chemistry I & II Semester
2. M.Sc, Degree in Chemistry – III and IV Semester.
3. M.Sc, Degree in Industrial Chemistry – III and IV Semester.

The pattern of matrix for two year Master's Degree Program in Chemistry/Industrial Chemistry shall be as follows.

No	COURSES	I SEM			II SEM			III SEM			IV SEM			TOTAL		
		C	**P**	**M**	**C**	**P**	**M**	**C**	**P**	**M**	**C**	**P**	**M**	**C**	**P**	**M**
1.	HARD CORE (Theory)	12	3	300	12	3	300	12	3	300	12	3	300	48	16	1200
2	HARD CORE(Practicals)	6	3	150	6	3	150	6	3	150	6	2	150	20	12	600
2.	SOFT CORE	4	1	100	4	1	100	4	1	100	4	1	100	16	4	400
3.	OPEN ELECTIVE	-	-	-	4*	1	100	4*	1	100	-	-	-	08	2	200
	TOTAL	**22**	**5**	**550**	**26**	**6**	**600**	**24**	**6**	**550**	**22**	**5**	**500**	**92**	**22**	**2400**

***The M.Sc. Chemistry/Industrial Chemistry students have to choose open elective papers from other disciplines**

COURSE STRUCTURE AND SCHEME OF EXAMINATION

M. Sc. DEGREE IN INDUSTRIAL CHEMISTRY

FIRST SEMESTER

THEORY

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks/Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I test	II test	
ICI HCT:1.1	Concepts and Models of Inorganic Chemistry	4h &4	100	15%	15%	3h & 70%
ICO HCT:1.2	Theoretical Organic Chemistry	4h &4	100	15%	15%	3h & 70%
ICP HCT:1.3	Chemical Thermodynamics and Chemical Kinetics	4h &4	100	15%	15%	3h & 70%
Soft Core Papers Soft Core-I (For Chemistry & Industrial Chemistry Students Only)						
ICA SCT:1.4 OR ICM SCT:1.5	Analytical Chemistry - I	4h &4	100	15%	15%	3h & 70%
	Mathematics & Computer for Chemists	4h &4	100	15%	15%	3h & 70%

PRACTICALS

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks/Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I test	II test	
ICI HCP:1.6	Inorganic Chemistry Lab-I	4h &2	50	15%	15%	4h & 70%
ICO HCP:1.7	Organic Chemistry Lab-I (preparations)	4h &2	50	15%	15%	4h & 70%
ICP HCP: 1.8	Physical Chemistry Lab_I	4h &2	50	15%	15%	4h & 70%

Note:

1. All hard core papers are **compulsory** for all the students (Chemistry & Industrial Chemistry).
2. The students of chemistry/ Industrial Chemistry have to select **one** of the two soft core papers.
3. Students of both chemistry & non-chemistry, when register for additional credits, can opt for more than one soft core papers. However a minimum of **ten** students have to register for additional credits for operationalization of such a paper.
4. Open elective / cross border-papers are for other than chemistry students. Students have to opt one of the two open
   elective papers. However for operationlization of such paper, a minimum of **ten** students are required to opt such a paper

M.Sc. DEGREE INDUSTRIAL CHEMISTRY
SECOND SEMESTER

THEORY

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks /Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I test	II test	
ICI HCT:2.1	Co-ordination Chemistry	4h &4	100	15%	15%	3h & 70%
ICO HCT:2.2	Heterocyclic Chemistry, Natural Products & reagents	4h &4	100	15%	15%	3h & 70%
ICP HCT:2.3	Electro-,Quantum-& Photo Chemistry	4h &4	100	15%	15%	3h & 70%
Soft Core Papers, Soft Core-II (For Chemistry & Industrial Chemistry Students Only)						
ICA SCT:2.4 OR ICB SCT:2.5	Analytical Chemistry – II	4h &4	100	15%	15%	3h & 70%
	Selected Topics in Chemistry-I	4h &4	100	15%	15%	3h & 70%

PRACTICALS

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks/Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I test	II test	
ICI HCP:2.6	Inorganic Chemistry-Lab II (Semimicro qualitative analysis)	4h &2	50	15%	15%	4h & 70%
ICO HCP:2.7	Organic Chemistry Lab-II (Qualitative Analysis)	4h &2	50	15%	15%	4h & 70%
ICP HCP: 2.8	Physical Chemistry Lab-II	4h &2	50	15%	15%	4h & 70%
OPEN ELECTIVE/ CROSS BORDER PAPER-I (FOR NON – CHEMISTRY STUDENTS ONLY)						
THEORY						
OET SCT:2.1 OR OET SCT:2.2	Environmental Chemistry	4h &4	100	15%	15%	3h & 70%
	Inorganic & Physical Chemistry	4h &4	100	15%	15%	3h & 70%

Note:

1. All hard core papers are **compulsory** for all the students (Chemistry & Industrial Chemistry).
2. The students of chemistry/ Industrial Chemistry have to select **one** of the two soft core papers.
3. Students of both chemistry & non-chemistry, when register for additional credits, can opt for more than one soft core papers. However a minimum of **ten** students have to register for additional credits for operationalization of such a paper.
4. Open elective / cross border-papers are for other than chemistry students. Students have to opt one of the two open
   elective papers. However for operationlization of such paper, a minimum of **ten** students are required to opt such a paper

M. Sc., DEGREE IN INDUSTRIAL CHEMISTRY
THIRD SEMESTER

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks/Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I test	II test	
ICS HCT:3.1	Spectroscopy-I	4h &4	100	15%	15%	4h & 70%
ICU HCT:3.2	Industrial Chemistry-I (Unit Process & Unit Operations)	4h &4	100	15%	15%	4h & 70%
ICI HCT:3.3	Industrial Materials-I (Refractiories, glass, Cement Metallurgy & Fuels)	4h &4	100	15%	15%	4h & 70%
Soft Core Papers Soft Core-III						
ICG SCT:3.4	Green Chemistry , Chemistry of Soil and Energy Systems	4h &4	100	15%	15%	4h & 70%
ICE SCT:3.5	Environmental and Biochemical analysis	4h &4	100	15%	15%	4h & 70%

PRACTICALS

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks/Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I Test	II Test	
ICI HCP:3.6	Industrial Technical Analysis –I	4h &2	50	15%	15%	4h & 70%
ICO HCP:3.7	Industrial Technical Analysis –II	4h &2	50	15%	15%	4h & 70%
ICO HCP-3.8	Industrial Technical Analysis –III	4h & 2	50	15%	15%	4h & 70%
OPEN ELECTIVE/CROSS BORDER PAPER-II(FOR NON – CHEMISTRY STUDENTS ONLY) THEORY						
0ET SCT:3.1 Organic & Analytical Chemistry		4h &4	100	15%	15%	3h & 70%
OET SCT:3.2 Quality Control Assurance & Chromatographic Techniques		4h &4	100	15%	15%	3h & 70%

Note:

1. All hard core papers are compulsory for all the Chemistry students
2. The students of Industrial chemistry have to select **one** of the two soft core papers.
3. A minimum of **ten** students have to opt for soft core papers for operationalization.

M.Sc. DEGREE IN INDUSTRIAL CHEMISTRY
IV SEMESTER

Hard Core Papers	Paper Title	Contact Hours/ Week & Credits	Total Marks/Paper	Assessment Weightage		Semester End Exam Duration(hrs) & Assessment Weightage
				I test	II test	
ICO HCT:4.1	Industrial Chemistry-II (Fermentation Technology, Industrial pharmacy Insecticides and Fungicides, Pulp and Paper Technology, Paints and Adhesives)	4h &4	100	15%	15%	3h & 70%
ICD HCT:4.2	Industrial Materials-II (Dyes Drugs & Detergents, Rubber, Explosives Insecticides)	4h &4	100	15%	15%	3h & 70%
ICS HCT:4.3	Spectroscopy and Chromatography	4h &4	100	15%	15%	3h & 70%
	Practicals/Project work					
CHP HCP-4.6	a. Preparation and Spectral analysis (UV-visible, IR) b. Interpretation of spectral data(NMR, Mass spectra minimum 12 samples)	4h & 2	50	15%	15%	4h & 70%
ICP HCP:4.7	**Project Work/Inplant Training**	8h &4	100	15%	15%	Project viva & evaluation 70%
Soft Core Papers Soft Core - IV						
ICP SCT: 4.4	Polymer Science and Technology	4h &4	100	15%	15%	3h & 70%
ICA SCT: 4.5	Advanced Topics in Chemistry	4h &4	100	15%	15%	3h & 70%

Note:

1. All hard core papers are compulsory for all the Industrial Chemistry students
2. The students of Industrial chemistry have to select **one** of the two soft core papers.
3. A minimum of **ten** students have to opt for soft core papers for operationalization.

Theory question paper format for CBCS Semester Examinations:

Part – A (Compulsory)

Q.1 Ten sub questions carry one mark each. **Total 10 marks**.

Part – B

Will consist of four questions, one from each unit of **15 marks**. Each question will have sub-divisions a, b, & c with an internal choice for only sub-section c. **Marks 15X4=60**

Time Duration: 3 Hrs **Total Marks=70**

*** ICP HCP: 4.7 Project work:**

The project work may include in plant training* in an Industryl/Short term work in the department/other educational institutes/R&D organization/Data mining/Review of current literature/Theoretical methods/Computer applications. Experimental work may involve studies on Synthesis/Measurements, Study of properties/Characterization by physico-chemical methods/activities for reported/unreported research or any suitable combination thereof.

Incase of the student who would work outside the campus, the supervising staff members may visit to the work place at least once during the period and may be eligible for TA/DA as per the University rules. The other general academic regulations will be same as laid by University.

Scheme of examination for project work:

Thesis evaluation: 50 marks; Viva-Voce: 20 marks

Scheme for Practical examination:

Viva-voce: 05 Marks; Experiment:30 Marks

* Inplant training is only for Industrial Chemistry students. However, students can opt either project work or In plant Training.

FIRST SEMESTER

Code : **ICI HCT:1.1** Univ Code :101
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICI HCT:1.1-Concepts and Models of Inorganic Chemistry:

56 Hrs.

Review of periodic properties- atomic size, ionization potential, electron affinity and electro negativity.

Ionic Bond:

Ionic bond-properties of ionic compounds, ionic radii, factors affecting ionic radii, radius ratio rules, types and structures of simple ionic compounds, lattice energy, Born-Lande equation, Kapustinskii equation, Born-Haber cycle-applications, size effects, polarizing power and polarizability of ions, Fajan's rule, covalent character in ionic compounds, solubility of ionic solids and hydration energy.

Covalent Bond and Metallic Bond:

VBT approach, VSEPR-shapes of molecules, concepts of resonance and hybridization, Energetics of hybridization, partial ionic character, covalent coordinate and multicentre bonding, M.O theory-LCAO approach, σ, δ and π molecular orbits. M.O treatment of homo nuclear and hetero nuclear diatomic molecules, Bond order in delocalized π- bonding systems, Ex: CO_3^{2-}, NO_3^- and SO_3. Metallic bonding – electron sea model, VBT. **[14 hrs]**

UNIT-II

Chemistry of Transition Metals:

Coordination numbers, factors affecting coordination numbers, stereochemistry of coordination compounds. Catalytic properties, non-stoichiometry, metal-metal bonding and cluster compounds, stability of oxidation states.

Chemistry of lanthanides and actinides-trends in physical and chemical properties, stereochemistry, magnetic and spectral behavior, synthesis and separation of trans-uranium elements, super heavy elements. **[14 hrs]**

UNIT-III

Chemistry of S and P-Block Elements:

Alkali metals, alkaline earth metals and their complexes, crown ethers, oxides of alkali metals. Synthesis, properties and structure of boron hydrides, boranes, borazines, boron-phosphorus and boron-arsenic compounds. Oxides and oxy acids of nitrogen, phosphorus, sulphur and halogens. Interhalogen compounds and noble gas compounds, silicates and zeolites. **[14 hrs]**

UNIT-IV

Acid – Base Concept:

Introduction different definitions, types of reactions, solvent systems and leveling effect. Generalized acid-base concept-basicity of metal oxides, hydration and hydrolysis. Measurement of acid – base strengths. Steric affects-back strain, front strain and internal strain. Solution effects with respective to liquid ammonia, anhydrous sulphuric acid, acetic acid and liquid sulphur dioxide, acetic acid, HF, N_2O_4, super acids and molten salts. HSAB-classification & strength of hardness and softness. Irving-William's series. Theoretical bases of hardness and softness. **[14 hrs]**

REFERENCES

1. Basic Inorganic Chemistry – 3rd edition, F.A Cotton, G.Wilkinson and P.L.Gaw, John wiley and sons (2002).
2. Inorganic chemistry – James E Huheey, Harper and Row Publishers (2004)
3. Concepts and Models of Inorganic Chemistry – 3rd edition, B.E Douglas, D.H. Mc Daniel and Alexander, Wiley (2001)
4. Inorganic Chemistry – 2nd edition, D.F Shriver, P.W.Atkins and C.H.Langtore Oxford University Press (1994).
5. Chemistry of Elements – N.N. Greenwood and A.Earnshaw, Pergaman (2000).
6. Inorganic Chemistry – 2nd edition, C.E Housecraft and A.G Sharpe, Pearson Education Ltd. (2005).
7. Concise Inorganic Chemistry – J.D. Lee, ELBS

Code : **ICO HCT: 1.2** Univ Code :102
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICO HCT: 1.2:Theoretical Organic Chemistry

56 Hrs

UNIT-I

Bonding in Organic molecules and Aromaticity

Atomic and molecular orbits, concepts of bonding, anti bonding and non bonding molecular orbitals, hybridization – sp,sp^2 & sp^3, geometry and shape of simple molecules, bond length, bond angel and bond energies. Bonding in fullerenes, H-bonding. Bond polarity, dipole moment.

Bonds weaker than covalent bonds, addition compounds, crown ethers, cryptonds, inclusion compounds, cyclodextrins, catananes, and rotaxanes.

Aromaticity in benzenoid and non benzenoid compounds, alternant, nonalternant hydrocarbons, Huckl's rule, annulenes. Aromaticity, antiaromaticity, nonaromaticity of organic systems(3-7 numbered rings & ring ions). **[14 hrs]**

UNIT-II

Stereo Chemistry

Elements of symmetry, concepts of chirality, optical isomerism, projection formulae, Fisher, Saw horse, Newman and Flying wedge formulae and their inter conversion, optical isomerism due to one or more than one chiral centres.

Threo and erythro isomer, enantiomers, diastearic isomers and epimers. D-L and R-S conversions. Optical activity in the absence of chiral carbon – Biphenyls, allenes and spiranes, optical isomerism of nitrogen compounds , conformational analysis of (cyclic and acyclic systems) – ethane, propane, butane, mono & disubstited cyclohexanes.

Geometrical isomerism – cis-trans, syn-anti and E-Z nomenclature, isomerism in ketoximes and aldoximes, Beckmann rearrangement. [**14 hrs]**

UNIT-III

Reaction Mechanisms, Reactive Intermediates & Named reactions:

Types of mechanism, methods of determination of reaction mechanism – cross over experiments, product analysis, presences of intermediates, isotopic labeling, steriochemical evidences, thermodynamic and kinetic requirements, use of catalysts. Formation, structure and stability of carbocations, carboanions, free radicals, carbenes, nitrenes and aryne intermediates.

Name reactions and rearrangements – Aldol, Perkin, Dickman condensation, Hofmann, Schmidt, Lossen, Curtiurs rearrangements, Reimer-Tiemann reaction, Wittig reactions (Mechanism with examples). **[14 hrs]**

UNIT-IV

Pericyclic Reactions:

Definition, classifications of pericyclic reactions. Molecular orbital symmetry, Frontier orbital of ethylene, 1,3 butadiene, 1.3.5-hexa triene and allyl systems. Woodward and Hoffmann correlation diagram. FMO & PMO approach, electrogatic reactions-conrotator and disrotatory motions, 4n, 4n+2 and allyl systems.

Cycloaddition – antrafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes. 1, 3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements, superfacial and antrafacial shifts of H., shifts involving carbon moieties, 3, 3-and 5, 5 – sigmatropic rearrangements, claisen, cope and azo cope rearrangements. **[14 hrs]**

REFERENCES

1. Advanced organic chemistry – Reaction mechanism & structure – Jerry March.
2. Reaction mechanism in organic chemistry – S.M Mukharji & S.P Singh
3. Advanced organic chemistry – C.K Ingld
4. A guide book to mechanism in organic Chemistry – Petersexes
5. Stereo chemistry of carbon compounds – E.L Eliel
6. Stereo Chemistry of carbon compounds – D. Nasipuri
7. Stereo Chemistry of carbon compounds – P.S Kalsi
8. Text book of organic Chemistry – I.L Finar, Vol- I & Vol-2.
9. Text book of organic Chemistry – R.T Marrison & R.N Boid.
10. Chemistry of natural products – Gurudeep Chatwal, Vol- I & Vol-2
11. Reactive intermediates in organic chemistry – N.S Isaacs
12. Named reaction in organic chemistry – Surrey
13. Named reaction in organic chemistry – Gurudeep Chatwal
14. Text book of advanced organic chemistry – B.S Bhal & Arun Bhal

---

Code : **ICP HCT: 1.3** Univ Code :103

Contact Hours : 56 Work load : 4 hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICP HCT: 1.3- Chemical Thermodynamics and Chemical Kinetics.

56 Hrs

UNIT-I

Chemical Thermodynamics:

A brief resume of laws of thermodynamics (combined form of 1st and 2nd laws), entropy as a measure of unavailable energy, concept of fugacity and free energy, entropy and free energy changes and spontaneity of processes. Variation of free energy with T & P. Maxwell's relations, thermodynamic equations of state, limitations of Van't Hoff' s equation, Nernst Heal theorem & its applications. Third law of thermodynamics, determination of third law of entropies.

Application of Thermodynamics:

Entropy and free energy of mixing, partial molar quantities, partial molar volume and free energy (chemical potential), their significance and determinations. Gibbs- Duhem and Duham-Margules equations.

Thermodynamics of Ideal Solutions:

Deductions of laws of Raoult's ebullioscopy, cryoscopy and osmotic pressure. Quantitative treatment of Le-Chatelier principle.

Thermodynamics of Non-ideal Solutions: Activity, activity coefficient-standard states. **[14 hrs]**

UNIT-II

Theories of Reaction Rates:

Activated complex theory and its applications to reactions in solution. Theory of unimolecular reactions- Lindeman, Hinsel-Wood and RRKM theory

Chemical Kinetics:

Complex reactions- parallel, consecutive and reversible reactions. Chain reactions (H_2-halogen reactions). Branched chain reactions- general rate expression, explosion limits. Photochemical (H_2-halogen reactions) and oscillatory reactions.

Reactions in Solution: Ionic reactions - salt and solvent effects. Substituent effects on the rates of reactions, linear free energy relationships - Hammett and Taft equations,. **[14 hrs]**

UNIT-III

Catalysis:

Homogeneous catalysis-equilibrium and steady state treatments, activation energies of catalyzed reactions. Acid-base catalysis (general and specific), protolytic and phototropic mechanisms, catalytic activity and acid strength measurements. Kinetics of enzyme catalyzed reactions-Michaelis- Menten equation. Effect of pH, temperature & inhibitors. Industrial applications of catalysts.

Surface Reaction Kinetics:

A review of adsorption isotherms, uni- and bi-molecular reactions, multilayer adsorption-BET equation-application in surface area determination. Harkin-Jura equation- application. Desorption & heterogeneous catalysis-catalytic activity at surfaces. Mechanism of surface reactions.

[14 hrs]

UNIT-IV

Electrochemistry - I

Electrochemistry of Solutions:

Ionic atmosphere, physical significance of k (Cuppa), Debye-Huckel theory to the problem of activity coefficient, Debye-Huckel limiting law, Debye-Huckel equation for appreciable concentration. The Huckel and Bronsted equation. Qualitative verification of Debye-Huckel equation, Debye-Huckel Onsager conductance equation, Bjerrum theory of ion association-triples ion-conductance minima.

[14 hrs]

REFERENCES:

1. Physical Chemistry, 5th Ed., - Atkins (ELBS) 1995.
2. Physical Chemistry - G. M. Barrow (McGraw Hill, Int. St. Ed) 1988.
3. Fundamentals of Physical Chemistry - Maron and Lando (Collier Macmillan) 1974.
4. Thermodynamics for Chemists - S. Glasstone (East-west) 1973.
5. Themodynamics - Rajaram and Kuriokose (East-West) 1986.
6. Chemical Kinetics - K.J.Laidler (Harper and Row) 1987.
7. Electrochemistry - Glasstone, Affiliated to East-West Press, 1942.
8. Principles and Applications of Electrochemistry-Crow (Chapman hall, London) 1988.

Code : **ICA SCT: 1.4** Univ Code :104
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICA SCT: 1.4- Analytical Chemistry – I

56 Hrs

UNIT – I

Errors and Sampling:

Limitations of analytical methods, classifications of errors, accuracy, precision, minimization of errors, significant figures and computations, mean and standard deviation, distribution of random errors, relativity of results, confidence interval, comparison of results, comparison of the means of two samples, Paired t- test, the number of replicate determinations, correlation and regression, linear regression, comparison of more than two means (analysis of variance), Least square method, 6 sigma concept. Quality control and quality assurance. The basis of sampling, sampling procedure, sampling statistics, sampling and physical state, crushing and grinding, hazards in sampling. **[14 hrs]**

UNIT – II

Titrimetic and Gravimetric analysis:

Acid base titrations:

Principle, titration curves for strong acid - strong base, weak acid – strong base, weak base –strong acid, determination of equivalence point – theory acid base indicators, colour change range of indicator, applications for nitrogen, nitrates and carbonates estimation.

Complexometric Titrations:

Introduction, a simple complexation titration, titration curves, types of EDTA titrations, titrations of mixtures, selectivity, masking and demasking agents, metal ion indicators, some practical considerations.

Precipitation Titrations:

Precipitation reactions, titration curves, factors influencing the sharpness of end points, chemical indicators for precipitation titrations, applications of precipitation titration analysis.

Oxidation –Reduction Titrations:

Redox process, titration curves, redox indicators and applications.

Gravimetric analysis:

Requirements & conditions of precipitations, co-precipitation, post precipitation, nature of the precipitate, super saturation, precipitation from homogeneous solution and effect of excess of precipitant, temperature, pH and complex formation on completeness of precipitation. Filtration, washing of precipitates, drying and ignition of precipitates.

Organic Reagents in Inorganic Analysis:

Organic precipitants, general properties, reagents as precipitants. **[14 hrs]**

UNIT-III

Separation Techniques

Basic separation techniques in analysis, classification

Solvent Extraction:

Principle, distribution law, choice of solvents for extraction, synergic extraction, techniques-batch, continuous and multiple extractions and applications.

Paper and thin layer Chromatography:

General principles and classification of chromatographic methods-paper, thin layer, column and liquid chromatography.

Ion Exchange Chromatography:

Definitions, requirements for ion exchange resin, synthesis and types of ion exchange resins, principle, basic features of ion exchange reactions, ion exchange capacity, applications of ion exchange chromatography in preparative, purification and recovery processes, process of elution.

[14 hrs]

UNIT – IV

Conductometry :

Theory- Measurement of Conductivity - Basis for Conductometric titrations - Conductometry as an analytical tool.

Potentiometry :

Principles - Reference electrodes - indicator electrodes, selective electrodes - measurement of cell emf - potentiometric titrations.

Voltametry :

Polarography - Direct current Polarography - Theory - Dropping Mercury Electrode- Quantitative technique - Measurement of Wave Heights - Pulse Polarography - Rapid Scan Polarography - Stripping Voltametry - Cyclic Voltametry.

Amperometry :

Pricnciples, amperometric titrations with examples.

Elecrogravimetry:

Theory, completeness and nature of the deposit, instrumentation, electrolytic separation of metals and applications. **[14 hrs]**

REFERENCES

1. Fundamentals of Analytical Chemistry D.A Skoog, D.M West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing New York.
2. Analytical Chemistry, G.D Christian, 5th edition, 2001, John Wiley and Sons Inc, India.
3. Vogel's Test book of Quantitative Chemical Analysis, J. Mendham, R.C Denny, J.D Barnes and M.J.K Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Educations Pvt. Ltd., New Delhi.
4. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
5. Instrumental Methods of Analysis, H.H Willas, L.L Merritt and J.A Deay, 7th edition, 1988.
6. Instrumental Methods of Analysis, W.M Dean and Settle, 7th edition, 1986, CBS Publishers, New Delhi.

Code : **ICM SCT: 1.5** Univ Code :105

Contact Hours : 56 Work load : 4 hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICM SCT: 1.5-Mathematics and Computers for Chemists

[56 hrs]

UNIT – I

Matrix Algebra:

Matrix algebra, basic idea of inverse, adjoint, transpose and special matrices, matrix equation, Eigen functions and determents. Differential calculus- rules for differentiation, maxima and minima with respect to population of rotational energy levels, Bohar's radius, most probable velocity and Maxwell's exact and mexact differentials in thermodynamics properties. **[14 hrs]**

UNIT – II

Integration and Differentiation:

Basic rules of integration, partial differentiation, coordinate transformation (e.g Cartesian to spherical polar), elementary differential equations: variables – separable and exact first order differential equations, homogeneous, exact and linear equations, applications to chemical kinetics, secular equilibrium, quantum chemistry.

Fourier series, solutions of harmonic oscillator and Legendre equation, spherical harmonics, second order differential equation. Permutations and probability average root mean square and most probable errors with respect to kinetic theory of gases, least square curves fitting. **[14 hrs]**

UNIT – III

Computers for Chemists:

Introduction to computer and computing – basic structure, operating system, introduction to windows, data processing and principles of programming Flow charts. Introduction to computer languages (FORTAN & C), elements of computer languages, constants, variables, statements, operations and symbols. **[14 hrs]**

UNIT – IV

Computational Chemistry:

Programming in chemistry – developments of programmers involving simple formulae in chemistry, Vander Wall's equation, pH titration, dynamics, radioactive decay. Elementary structural features-bond angels, bond lengths, dihedral angles of molecules. Running standard programs and packages: linear regression, X-Y plot, differential equations, operation of packages – M.S Word, M.S Excel, Windows, ORIGIN and SIGMA programs. Recent trends in computer applications. **[14 hrs]**

REFERENCES

1. The chemistry of mathematics – E.Staner, Oxford University Press.
2. Mathematics for chemists, Droggeti & Sucliffe, Longman.
3. Mathematical preparations for physical chemistry, F. Damiels, Mc Graw-Hill.
4. Chemical mathematics – D.M.Hist, Longman
5. Basic mathematics for chemists –Tebbutt, Willey .
6. Basic programming –Self Taught; Harch.
7. Computer programming :Shaum's outline series.
8. FORTRA-VI , V.Rajaraman.
9. Microcomputer quantum mechanics, J.P.Kilngbeck and Adan Hilger.
   An introduction to digital computer design-V.Rajaraman and T.Radhakrishanan,Prentice Hall.

Code : **ICI-HCP: 1.6** Univ Code :106

Contact Hours : 48 Work load : 4 hours per week

Credit Points : 2

Evaluation: Continuous Internal Assessment - 15 marks

Semester and Examination - 35 marks

ICI HCP: 1.6 Inorganic Chemistry Lab-I

1. Determination of iron using KMnO4 (0.02M) and cerric ammonium sulphate (0.02M) as titrants.
2. Determination of calcium using KMnO4 (0.02M) as titrants.
3. Determination of copper volumetrically using KIO3 .
4. Estimation of calcium and magnesium carbonates in dolomite solution using EDTA titration.
5. Estimation of lead using EDTA titration.
6. Gravimetric analysis of sulphate with barium.
7. Gravimetric analysis of iron.
8. Determination of nickel gravimetrically using dimethyl glyoxime.
9. Separation and determination of two metal ions, iron and nickel, involving volumetric and gravimetric methods.
10. Separation and determination of two metal ions, copper and iron, involving volumetric and gravimetric methods.
11. Separation and determination of two metal ions, calcium and iron, involving volumetric and gravimetric methods. [64 hrs]

REFERENCES

1. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition, 5th edition. .
2. Quantitative chemical analysis – Daniel, C.Harris, 7th edition 2006.

Code : **ICO HCP: 1.7** Univ Code :107
Contact Hours : 48 Work load : 4 hours per week
Credit Points : 2

Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

ICO HCP: 1.7-Organic Chemistry Lab-I

Preparations-two stage (Any 6 preparations from the following list)

1. Preparation of p-bromo aniline from analine.
2. Preparation of p-nitro aniline from analine.
3. Preparation of acetanilide from Acetophenone.(Beckmann Rearrangement)
4. Preparation of Benzanilide from Benzophenon
5. Preparation of 7-hydroxy-4-methyl coumarin(Pechmann reaction) from resorcinol
6. Remier tiemann reaction (preparation of Salicyldehyde/B-hydroxynaphthadehyde)
7. Preparation of 2-4 dinitro benzene from benzene
8. Preparation of benzoic acid from toluene.
9. Cannizaros reaction.
10. Preparation of pthalimide from pthalic acid
11. Preparation of indigo from Anthranilic acid.
12. Preparation of adipic acid from cyclohexanol

REFERENCES

1. Comprehensive practical organic chemistry preparation and quantitative analysis-Ahluwalia.V.K and Renu Agarval, University Press, Hyderabad (LCS edition 2000).
2. Comprehensive practical organic chemistry-quantitative analysis-V.K.Ahluwalia and university press-Hyderabad.
3. Advanced practical organic chemistry – N.K.Vishnu, second revised edition, Vikas Publication (2000).
4. Advanced practical organic chemistry – D.P.Agarwal, Goel Publishing house, Meerut (U.P).
5. Quantative & qualitative organic analysis, A.I.Vogel (CBS Publishers, New Delhi-2002).

Code : **ICP HCP: 1.8** Univ Code :108
Contact Hours : 64 Work load : 4 hours per week
Credit Points : 2
Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

ICP HCP: 1.8 -Physical Chemistry Lab-I

(any six)

1. Study of kinetics of hydrolysis of an ester using HCl/H_2SO_4 at two different temperatures, determination of rate of constants and energy of activation.
2. Study of kinetic reactions between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and Energy of activation.
3. Conductometric titration of mixture of HCl and CH_3COOH against NaOH.
4. Conductometric titration of mixture of HCl and CH_3COOH and $CuSO_4$ against NaOH.

5.Conductometry-To determine the degree of hydrolysis and hydrolysisconstant of aniline hydrochloride.

6. Conductometric titration of potassium iodide with mercuric perchlorate.
7. Phase diagram for Three component liquid system, acetic acid, benzene and water.
8. Kinetics of dissociation of trichloroacetic acid.

[64 hrs]

REFERENCES

1. Practical Physical Chemistry- A.J.Findlay.
2. Experimental Physical Chemistry-F.Daniel et el.
3. Selected Experiments in Physical Chemistry- Latham.
4. Experimental Physical Chemistry- Janes and Parichard.
5. Experimental Physical Chemistry- Shoemaker.
6. Experimental Physical Chemistry- Yadav, Goel Publishing House.
7. Experimental Physical Chemistry- Das R.C and Behera B., Tata Mc Graw Hill.

SECOND SEMESTER

Code : **ICI HCT: 2.1** Univ Code :201
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICI HCT: 2.1; Coordination Chemistry

56 Hrs

UNIT – I

Metal-Ligand Bonding:

Valance Bond Theory (VBT)-the electron-pair bond, the concept of effective atomic number, electronic configuration of metal complexes by VBT, draw backs of VBT.

Crystal Field Theory(CFT)-salient features, crystal field splitting of d orbitals in octahedral, tetrahedral, tetragonal and squarer planer field s Magnitude of Δ,factors affecting Δ, crystal field stabilization energy (CFSE), effects of crystal field splitting, energy of ligation, stabilities of oxidation states(Co^{III}). Spectrochemical series, nephelauxetic series, short comings of CFT, evidences for covalence, John-Teller distortion in metal complexes and metal chelates. M.O treatment of co ordination compounds involving σ and Π bonding. **[14 hrs]**

UNIT-II

Geometry, Magnetic and Spectral Properties of Metal Complexes:

Geometry of Metal Complexes:

Stereochemistry, coordination numbers, 3 to 8, isomerism in metal complexes, geometrical isomerism, optical isomerism, coordination isomerism, ionization isomerism, linkages isomerism.

Magnetic Properties of Metal Complexes:

Magnetic susceptibility, types of magnetic behavior, diamagnetic corrections, orbital contribution, spin-orbit coupling, ferro and anti-ferromagnetism.

Spectral Properties of Metal Complexes:

Term symbols, selection rules for electronic transitions-spin selection rule, the Laprotic selection rule, Orgel diagrams, Tanabe-Sugano diagrams, stereo isomerism, chirality, CD, ORD, Cotton effect and magnetic circular dichroism, absolute configuration. [**14 hrs]**

UNIT-III

Metal-Ligand Equilibria in Solution:

Step-wise and over-all formation constant and their relationships, trends in step wise constant, kinetic and thermodynamic stability of metal complexes, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate and macro cyclic effects and their thermodynamic origin, determination of binary formation constants by pH meter, spectrophotometry, polarography and by ion exchange methods.

Kinetics and Mechanism of Reactions of Coordination Compounds:

Introduction, inert and labile complexes. Mechanism of substitution reactions, classification of ligand substitution reactions in octahedral and square planar complexes, molecular rearrangements of four and six coordinated complexes.

Electron Transfer Reactions (Redox Reactions):

Inner and outer sphere mechanisms, one electron, two electron, complimentary and non complimentary electron-transfer reactions. **[14 hrs]**

UNIT IV

Organometallic Chemistry

Classification & nomenclature of organometallic compounds – 16 & 18 electron rules – electron counting by neutral atom & oxidation state method.

Organometallic compounds of main group elements:- General methods of synthesis structure, bonding and reactivity in alkyls of Li, Mg, & Al. Transition Metal alkyls(synthesis and stability),metal carbonyls, nitrosyls, carbenes, Fischer and Shock synthesis and bonding.

General methods of synthesis, structure & bonding in metal olefins, and metallocenes.

[14 Hours]

REFERENCES

1. Basic Inorganic Chemistry, F.A.Cotton, G.wilkinson and P.L.Gau, Jhon Wiley and sons, Inc, 6th edition,1999.
2. Inorganic Chemistry,J.E.Huheey, E.A.Keiter and R.L.Keiter, 4thedn 1993.
3. Chemistry of the Elements, N.N.Greenwood and A.E.Earnshaw, Buttrerworth Heilemann,1997.
4. Essential Trends in Inorganic Chemistry, D.M.P.Mingos, Oxford univ press 1998.
5. Magnetochemestry, R.L.Carlin, Springer Verlag.
6. Coordination Chemistry, Fred Basolo and Ronald C. Johnson, Wiley, New York, 1984.
7. Chemistry of Complex Equilibria, M.T Beck, Rinhold, London, 1990.
8. Concise Coordination Chemistry, R Gopalan and V Ramalingam, Vikas Publishing House Pvt Ltd., New Delhi, 2005.
9. Shriver and Atkin's Inorganic Chemistry, Atkins, Overton, Rourke, Weller, Armstrong, 5th Ed, Oxford University press, 2012
10. Organometallic Chemistry – R.C. Mehrothra and A. Singh, 2nd Edn., New Age, International Publications, 2006.
11. Fundamental Transition Metal Organometallic Chemistry – Charles M Lukehart, Brookes, Govel Publishing Company, 1985
12. The Organometallic Chemistry of the Transition metals: Robert H. Crabtree, 4th Edn., Wiley Interscience, 2005.
13. Basic Organ Metallic Chemistry – B.D. Gupta and A.J. Elias, Universities Press, 2010.
14. M.N. Hughes: Inorganic Chemistry of Biological Processes (2nd Edn.) Wiley
15. I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine: Bioinorganic Chemistry, Viva Books.
16. R.C. Mehrotra ad A. Singh: Organometallic Chemistry, New Age International.

Code : **ICO HCT: 2.2** Univ Code :202
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICO HCT: 2.2-Heterocyclic Chemistry, Natural Products Reagents in Organic Synthesis

56 Hrs

UNIT-I

Heterocyclic Chemistry:

IUPAC nomenclature of heterocyclic ring systems (3-7 memberd rings and simple fused systems) comparative aromaticity of pyrrole, furon, thiophene, pyridine. Methods of synthesis, electorphilic and nucleophilic substitutions reactions of pyrrole, furon, thiophene, pyridine ring systems. Compression of basecity of pyridine, piperidine and pyrrole.

Fused heterocycles of 6 & 5 memberd rings-synthesis and reactions of indole, benzofurn, quinoline, isoquinoline with special references to Fischer indole synthesis, and Skraup synthesis, Bischler-Napier Laski synthesis, mechanism of electorphilic substitution reaction of indole, quinoline and benzofurn.

[14 hrs]

UNIT-II

Chemistry of Natural Products Alkaloids Terpenoids and steroids.

Alkaloids – classifications occurrence, general methods of structural elucidation, stereo Chemistry and synthesis of quinine, papareine, morphine.

Terpenoids – occurrence general methods of structural elucidation, stereo Chemistry and synthesis of following representative molecules-citral, camphor and santonin.

Steroids – cholesterol, ergosterol-structure and synthesis. **[14 hrs]**

UNIT-III

Carbohydrates, Proteins and Nucleic acids

Carbohydrates-determination of ring structures of monosaccharides and disaccharides with reference to glucose, fructose, maltose and sucrose.

Proteins – Amino acids, peptides, peptide synthesis using blocking reagents, modern methods of peptide synthesis. Structure of proteins – primary. secondary & tertiary structure, sequence of amino acids in proteins, end group analysis.

Nucleic acids- chemical and enzymatic hydrolysis of nucleic acids, purine & pyrimidine bases, double helix of DNA, base pairing via H-bonding, various types of RNA & their functions. **[14 hrs]**

UNIT-IV

Reagents in organic synthesis:

Use of following reagents in organic synthesis and functional group transformation

i)	Dicyclohexylcarbodiimide (DCC),	ii)	Tri-n-butyltin hydride
iii)	Wood ward and Pre Vost hydroxylation,	iv)	Osmium tetroxide
v)	DDQ,	vi)	Selinium dioxide
vii)	Phase transfer catalysis,	viii)	Crown ethers
ix)	Merrifield resin ,	x)	Peterson's synthesis
xi)	Lithium aluminum hydride,	xii)	Wilkinson's catalyst
xiii)	Gilman's reagent,	xiv)	Zigler-Natta catalyst **[14 hrs]**

REFERENCES

1. Pericyclic Reactions-S.M.Mukharji and Singh S.P
2. Heterocyclic Chemistry- J.Joule and Smith
3. Introduction to Chemistry of heterocyclic compounds
4. Heterocyclic Compounds – Raj Bansal
5. Textbook of Organic Chemistry-R.J.Moorism and Boyd

6. Text book of Advanced Organic Chemistry-Arun Bhal

Code : **ICP HCT: 2.3** Univ Code :203
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICP HCT: 2.3-Electro-, Quantum- and Photochemistry

56 Hrs

UNIT-I

Electrochemistry - II

Electrochemistry

Debye-Huckel theory of strong electrolytes, Debye Huckel – Onsager equation, Debye – Huckel limiting equation for activity coefficients, modifications and verifications. Electrical double layer and its thermodynamics. A brief survey of Helmholtz – Perrin, Gouy – Champman and Stern electrical double layer, EMF cells, liquid junction potential and its determination. Energetics of cell reactions, effect of temperature, pressure and concentration on energetics of cell reactions (Calculation of ΔG, ΔH and ΔS)Electrochemical energy sources – Batteries, classification, characteristics, primary, secondary and Fuel cells. **[14 hrs]**

UNIT-II

Irreversible Electrode Process:

Introduction, reversible and irreversible electrodes. Polarization, Ohmic overvoltage, concentration overvoltage, activation overvoltage. Hydrogen over voltage and oxygen over voltage. Effect of temperature, current density and pH on over voltage. Experimental determination of over voltage. Equations for concentration over potential, diffusion current, stationary current, potential curves, thickness of diffusion layer, diffusion controlled current potential curves at a dropping mercury electrode, polarography, half wave potential, application in qualitative and quantitative analysis. Energy barrier and electrode kinetics, Buttler-Volmer equation, Tafel equation. **[14 hrs]**

UNIT-III

Quantum Mechanics:

Wave – particle duality of material particles, de Broglie equation, Heisenberg uncertainty principle. Concept of operators (operator – operand), algebra of operators, commutative and non commutative operators, linear operators, Laplacian operator, Hamiltonian operator, Eigen value, Eigen function, Hermitian operator, turn over rule, atomic units. Wave equation for stretched rings Schrodinger wave equation for particles. Postulates of quantum mechanics. Application of Schrodinger equation to a free particles and to a particle trapped in a potential field (one dimension & three dimension). Degeneracy, wave equation for H-atom separation and solution of R, ϕ and Θ equations. Application of Schrodinger equation to rigid rotator and harmonic oscillator. Approximate methods-necessity of approximate methods, perturbation method, the theory of perturbation method-first order and second order correction, application to He – atom (first order correction only)-calculation of first ionization potential and binding energy. Variation theorem statement and proof.

[14 hrs]

UNIT-IV

Photochemistry:

Introduction to photochemistry, quantum yield and its determination, factors affecting quantum yield, actinometry-uranyloxalate and potassium ferrioxalate actinometres, acetone and diethylketone actinometres. Term symbols and significance. Photosensitization: by mercury, dissociation of H_2, photochemical kinetics of: decomposition of CH_3 CHO, formation of HCl. Photodegradation: photocatalyst-ZnO, TiO_2, principle, application of ZnO/TiO_2 in the photodegradation of dyes(IC), pesticides(DDT) and in industrial effluents. Effect of photodegradation on COD values. **[14 hrs]**

REFERENCES

1. Elements of physical chemistry – Lewis and Glasstone.
2. Physical chemistry –P.W.Atkine, ELBS, fourth edition 1990.
3. Basic physical chemistry –W.J.More.
4. Physical chemistry-G.M.Barrow.
5. Introduction to electro chemistry-S.Glastone.
6. Modern electro chemistry, vol I & II, J.O.M.Bockris and A.K.N.Reddy, 1970.
7. Electrochemistry-principles and applications-E.G Potter.
8. Quantum chemistry- A.K Charlra, second edition, 1983.
9. Quantum chemistry-Eyring, Walter and Kimball, John Wiley and Sons.
10. Quantum chemistry-R.K Prasad, 1996.
11. Advances in photochemistry by Rohatgi # Mukharjee
12. Principles and applications of photochemistry by R.P.Wayne Elesvier New York 1970
13. Molecular reactions and photochemistry by Dupey & Chapman, Prenctice Hall international, Tokyo, -

---

Code : **ICA-SCT 2.4** Univ Code :204
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICA-SCT 2.4-Analytical Chemistry-II

[56 hrs]

UNIT – I

Group Theory and Symmetry:

Symmetry elements & Symmetry operations, groups, subgroups, cyclic groups conjugate relationships, classes, molecular point groups, Schoenflies notations, matrix representations of symmetry operation, matrix representations of groups, Reducible and Irreducible representations, characters of representations, The great orthogonality theorem, character tables and their construction (C_{2v}, C_{2h}, C_{3v})– Mullikan symbols, molecular models. Determination of vibration modes, hybridization, molecular orbitals on the basis of group theory.

[14 hours]

UNIT – II

Electromagnetic radiation

Characterization – quantization of energy levels – regions of electromagnetic radiation spectrum – interaction electromagnetic radiation with matter – representation of spectra-intensity and width of spectral lines.

UV-Visible Spectroscopy: Quantitative aspects of absorption – Beer- Lambert's law. Terminology associated with absorption measurements. Criteria for spectrophotometric determinations with examples (Fe, Mo and Ni). Limitations of the law, Types of absorption bands, modes of electronic transitions, simple chromophoric –auxochrome theory, solvent effect and choice of solvent. Prediction of λ-max value by using Wood-Ward and Fieser rules for conjugated diens, trienes and cyclic α, β unsaturated aldehydes and ketones, Instrumentation (single beam and double beam spectrophotometers). Quantitative applications of UV-Visible spectroscopy in structural determination. **[14 Hours]**

UNIT – III

Flame Photometry and Atomic Absorption Spectrometry:

Principles and Theory - Instrumentation - Flames - Burners - Nonflame Techniques - Spectral and Chemical Interferences - Experimental Aspects.

Atomic Emission Spectrometry and Inductively Coupled Plasma:

Principles and Instrumentation - Excitation source - Limitations of AES - Principles of Plasma Spectroscopy - Excitation Source in ICP -Applications.

Nephelometry and Turbidometry:

Tyndall, Rayleigh and Raman Scattering - Principles, Instrumentation and Applications. **[14 hrs]**

UNIT-IV

Thermal Methods of Analysis

Thermo Gravimetric Analysis:

Introduction, thermo gravimetric analysis(TGA) – types of thermo gravimetric analysis, principles, factors affecting the results – heating rate, furnace instrument control/data handling. Applications-purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination of kinetic parameters of thermal degradation.

Differential Thermal Analysis (DTA):

Theory , variables affecting the DTA, general principles, instrumentation, applications – analysis of the physical mixtures and thermal behavior study, determination of decomposition point.

Differential Scanning Calorimetry (DSC):

Basic principle, differences between DTA and DSC, instrumentation – power compensated DSC, heat flux DSC, applications – studies of thermal transistors and isothermal crystallization, pharmaceutical industry for testing the purity of the samples. Thermometric titrimetry and direct injection enthalpimetry-principle, instrumentation, applications. **[14 hrs]**

REFERENCES

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
6. Principles and Practicals of Analytical Chemistry, F. W. Fifield and Kealey,3rd edition, 2000, Blackwell Sci., Ltd. Maiden, USA.
7. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
8. Introduction to Instrumental Analysis, Robert. D. Braun, Pharm. Med. Prem. India, 1987.
9. Instrumental Method of Analysis, W. M. Dean and Settle, 7th edition, 1986, CBS Publishers, New Delhi.
10. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva books Pvt. Ltd., 2002.
11. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
12. Principles and Practice of Analytical Chemistry, F. W. Fifield and Kealey, 5th edition, 2000, Blackwell Sci., Ltd. Maiden, USA.
13. Basic Concepts of Analytical Chemistry, S.M.Khopkar, New Age Intrenational.
14. Chemical Applications of Group Theory, F.A. Cotton, John – Wiley.
15. Symmetry and Molecular Spectroscopy, K. Veerareddy, New age international.

Code : **ICS SCT: 2.5** Univ Code :205

Contact Hours : 56 Work load : 4 hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICS SCT: 2.5-SELECTED TOPICS IN CHEMISTRY- I

[56 hrs]

UNIT-I

Amino Acids: General structure, Physiological properties

Peptides: Structure and conformation of peptide bond, peptide synthesis: Solution phase and Merrifield's solid phase synthesis, Racemization and use of HOBt, Synthesis of oxytocin and vasopressin, biological importance of insulin, selective cleavage of polypeptide bonds (chemical and enzymatic).

Proteins: Structure determination: C and N terminal residue determination, primary, secondary, tertiary and quartenary structure determination, denaturing and renaturing of proteins.

Nucleic acids: Introduction, structure and synthesis of nucleosides and nucleotides, protecting groups for hydroxy group in sugar, amino group in the base and phosphate functions. Methods of formation of internucleotide bonds: DCC, phosphodiester approach and phosphoramide methods. Solid phase synthesis of oligonucleotides. Structure of RNA and DNA, Crick-Watson model, role of nucleic acids in the biosynthesis of proteins. Genetic code, replication of DNA. **[14 hrs]**

UNIT - II

Carbohydrates: Introduction, Ring size determination of monosaccharides, configuration and conformations of monosaccharides, anomeric effect, Hudson's rules, epimerization and mutarotation. Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose, maltose and lactose.

Polysaccharides: General methods of structure elucidation. Industrial importance and biological importance of cellulose, starch, glycogen, dextran, hemicellulose, pectin, agar-agar. Photosynthesis and biosynthesis of carbohydrates.

Lipids: Nomenclature, classification, purification, synthesis of lipids, phospholipids, sphingolipids, biological importance of lipids: Lecithin, sphingolipids, oils and fats.

Prostaglandins: Introduction, classification and biological importance, constitution of PGE1.

[14 hrs]

UNIT - III

CHEMOMETRICS

Introduction to Chemometrics, principles of experimental design, factorial and fractional factorial design, Specific applications. Response surface methodology and Optimization, Response surface designs, Sequential optimization, specific, numerical problems. Modelling and Knowledge processing: multiple linear regressions, test parameter estimation, PCR PLS, PCA etc. Cluster analysis and descriminant analysis, modelling of multiway regression, A I and expert systems, Neural Networks, Fuzzy theory, Genetic Algorithms approach for Analytical Chemistry applications. **[14 hrs]**

UNIT-IV

RESEARCH METHODOLOGY

INTRODUCTION : Nature and importance of research - aims, objective, principles and problems - selection of research problem - survey of scientific literature - primary and secondary sources - citation index for scientific papers and journals - patents.

CONDUCT OF RESEARCH WORK : Physical properties useful in analysis and methods of separation prior to analysis - Isolation techniques - extraction - Soxhlet extraction, crystallization, sublimation - methods for vacuum sublimation and distillation under reduced pressure.

Chemistry of working with hazardous materials - acid / water sensitive, corrosive, toxic, explosive and radioactive materials. **[14 hrs]**

References:

1. I. L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
2. K. Albert, L. Lehninger, D.L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ publishers, 1st edition, New Delhi, 1993.
3. Harper's Biochemistry, Ed. R.Harper, 22nd edition, Prentice Hall Press, New York, 1990.
4. Encyclopedia of Chemical Technology – Kirck-Othmer series
5. Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer and V.W. Rodfwell, 15th edition, Maurzen Asian Edition, California, 1981.
6. Brian R. Eggins, Chemical Sensors and Biosensors, Analytical Techniques in the Sciences (ANTS), 2nd Edition, Wiley, 2002.
7. Gabor Harsanyi, Sensors in Biomedical Applications - Fundamentals, Technology and Applications, CRC Press, 2000.

8. Raluca-Ioana Stefan, Electrochemical Sensors in Bioanalysis, CRC Press, 2001.

9. Susan R. Mikkelsen and Eduardo Cortón, Bio Analytical Chemistry, John Wiley & Sons Inc, 2004
10. Andreas Manz and Nicole Pamme, Bio Analytical Chemistry, Imperial College Press, 2012
11. J. Anderson, H.M. Durston and M.Poole, Thesis and assignment writing - Wiley Eastern Ltd., (1970).

OPEN ELECTIVE/ CROSS BORDER

PAPER-I

(NON CHEMISTRY STUDENTS ONLY)

PAPER –I

Code : **OET SCT: 2.1** Univ Code :206
Contact Hours : 56 Work load : 4 Hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

OET SCT: 2.1-ENVIRONMENTAL CHEMISTRY

56 Hrs

UNIT-I

Soil and Radio Active pollution

Segments of atmosphere Soil pollution: Definition; Sources; Man made and natural-Agricultural, Domestic, Industries, Mining Causes, Consequences and remedies for prevention.

Radioactive Pollution:

Sources of pollutants; effect of vegetation and health. Detection and monitoring of radioactive pollutants. Methods of safe disposal of radioactive waste. **[14hrs]**

UNIT-II

Air Pollution:

Types and sources of air pollutants; natural background, concentrations of air pollutants; principles and methods of sampling; a survey of reactions and methods involved in the determination of carbon dioxide, sulphur dioxide, nitrogen oxides, hydrocarbons & particulates; consequences of air pollution.

[14hrs]

UNIT-III

Water Pollution:

Origin of waste water, types of water pollutants and their effects; sources of water pollution; domestic, industrial and agricultural soil has source of pollution. Objectives of analysis. Parameters of analysis; color, turbidity, total solids, conductivity, acidity, alkalinity and hardness, chloride, sulphate, fluoride, silica, phosphate and different forms of nitrogen. **[14hrs]**

UNIT-IV

Heavy Metal Pollution:

Public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey in instrumental techniques for the analysis of heavy metals in aquatic systems; pesticides as water pollutants and their analysis; water pollution laws and standards. **[14 hrs]**

REFERENCES

1. Standard Methods for Chemical Analysis, A.J Welcher (Part-B), Robort E Kiegor Publishing Co., USA, 1975.
2. Environmental Chemistry, S.E Manahar, Willard Graut Press, London, 1983.
3. Environmental Chemistry, A.K De, Wiley Eastern Publishers.
4. Environmental Chemistry, B.K Sharma, Himalaya Publishing House.
5. Environmental Chemistry, C. Baird & W.H Freeman.

Code : **OET SCT: 2.2** Univ Code :207
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

OET SCT: 2.2-INORGANIC AND PHYSICAL CHEMISTRY

[56Hrs

UNIT-I

Periodic Properties: Atomic size, ionic radii, ionization potential, electron affinity and electro negativity. Applications of electro negativity.

General Characteristics of s, p, d and f -block Elements: Comparative study with reference to electronic configuration, oxidation states, chemical properties, spectra and magnetic properties of d- and f- block elements. Survey of essential and trace elements in biological systems.

[**14Hrs]**

UNIT-II

Chemical Bonding: Ionic bond- size effect and solubility. Covalent bond- simple binary systems, hydrogen bond-water and in biological systems.

Concepts of Acids and Bases: Arrhenius, Bronsted-Lowry, Lewis, Lux-Flood and solvent system concepts.

Non-aqueous Solvents: Classification of solvents, properties of solvents (dielectric constant, donor and acceptor properties),protic (anhydrous H_2SO_4 and acetic acid) and aprotic solvents (liquid $S0_2$ and N_2O_4)

[14 hrs]

UNIT-III

Microwave Spectroscopy:

Rotation spectra of diatomic molecules. Applications - Principles of determination of bond length and moment of inertia from rotational spectra.

Infrared Spectroscopy:

Vibration of diatomic molecules, vibrational energy curves for simple harmonic oscillator. Theory of infrared absorption. Types of absorption, intensity of absorption bands. Number of fundamental vibrations and theoretical group frequencies. Identification, interpretation of infrared spectra - correlation chart. Important spectral regions, characterization of functional groups and structure determinations - CO_2 and H_2O, CH_3COCH_3. **[14Hrs]**

UNIT_IV

Applications of Physical Chemistry:

Concepts of entropy and free energy. Partial molar volume and its determination by density measurements. Symmetry elements and symmetry operations with examples of simple molecules. X-ray diffraction. Bragg equation and Miller indices. Order of a reaction and its determination. Energy of activation and its determination. Assumptions of activated complex theory. Fast reactions with examples. Polymers and their classification. Arrhenius theory of strong and weak electrolytes. Assumptions of Debye-Huckel theory of strong electrolytes. Types of electrodes. Corrosion and its prevention. Laws of photochemistry. Quantum yield and its determination, photodegradation.

[14hrs]

REFERENCES:

1. Inorganic Chemistry, 3rd edn., G.L. Miessler and D.A. Tarr. Pearson Education (2004).
2. Inorganic Chemistry, 2nd edn., D.F. Shriver. P.W. Atkins and C.H. Langford, Oxford University Press (1994).
3. Inorganic Chemistry, 2nd edn., C.E. Housecraft and A.G. Sharpe, Pearson Education Ltd. (2005).

4. Basic Inorganic Chemistry - 3rd edn., F.A. Cotton, G. Wilkinson and P.L . Gaus, John Wiley and Sons (2002).
5. Inorganic Chemistry, 3rd edn., James E. Huheey, Harper and Row Publishers (1983).
6. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash. 4th edition, Tata McGraw-Hill, New Delhi.
7. Introduction to Spectroscopy- Pavia, Lampman and Kriz, 3rd edition, Thomson.
8. Spectroscopy, B. P. Straughan and S. Walker. John Wiley & Sons Inc., New York, Vol. 1 & 2, 1976.
9. Vibration Spectroscopy Theory and Applications, D. N. Satyanarayana, New Age International, New Delhi.
10. Organic Spectroscopy, William Kemp, 3rd edition. Palgrava. 1991. 1 I. Chemical Kinetics by K.J. Laidler.
11. Chemical Kinetics – K.J.Laidler.
12. Chemical Kinetics-Moore and Pearson.
13. Kinetics and Mechanism of Chemical Transformation - J. Rajaram and J.C. Kuriacose.
14. Introduction to Electrochemistry by S. Glasstone.
15. Thermodynamics for Chemists by S. Glasstone. Affiliated to Liasl-West Press. New Delhi, (1965).
16. Advances in Photochemistry - Rohatgi Mukherjee.
17. Principle and Applications of Photochemistry - R.P Wayne. Elsevier, New York. (1970).
18. Elements of Physical Chemistry - Glasstone and Lewis.

Code : **ICI HCP: 2.6** Univ Code :207
Contact Hours : 64 Work load : 4 hours per week
Credit Points : 2
Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

ICI HCP : 2.6 -Inorganic Chemistry LAB-II

Semi micro Inorganic qualitative analysis (minimum of eight mixtures with three cations (one rare element) and two anions)

[64 hrs]

REFERENCES

1. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition.
2. Vogel's text book of quantitative chemical analysis – J.Basset, R.C.Denney, G. H. Jeffere and J. Mendhom, 5th edition.
3. Quantitative chemical analysis – Daniel, C.Harris, 7th edition 2006.

Code : **ICO HCP: 2.7** Univ Code :208
Contact Hours : 64 Work load : 4 hours per week
Credit Points : 2
Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

ICO HCP: 2.7 - Organic Chemistry Lab-II

(Any six)

Systematic qualitative analysis of organic binary mixture (solid + solid) with derivative preparation (min six mixtures)

NOTE: In the examination, candidate has to separate the binary mixture and analyse one component indicated by the examiner.

REFERENCES

1. Comprehensive practical organic chemistry preparation and quantitative analysis-Ahluwalia.V.K and Renu Agarval, University Press, Hyderabad (LCS edition 2000).
2. Comprehensive practical organic chemistry-quantitative analysis-V.K.Ahluwalia and university press-Hyderabad.
3. Advanced practical organic chemistry – N.K.Vishnu, second revised edition, Vikas Publication (2000).
4. Advanced practical organic chemistry – D.P.Agarwal, Goel Publishing house, Meerut (U.P).
5. Quantative & qualitative organic analysis, A.I.Vogel (CBS Publishers, New Delhi-2002).
6. Fundamentals of Analytical Chemistry-D.A.Skoog, D.M.West, Holler and Crouch, 8th edn., Sunders College Publishing, New York, 2005.
7. Quantitative Analysis-R.A.Day and A.L.Underwood, 6th edn., 3rd Indian Regrint, Pearson Education Pvt. Ltd., New Delhi, 2003.
8. Vogel's Textbook of Quantitative Chemical Analysis, J.Mendhan, R.C.Denny, J.D Barnes and M.J.K Thomas, 6th edn., 3rd Indian Regrint, Pearson Education Pvt. Ltd., New Delhi, 2003.
9. Analytical Chemistry, G.D Christian, 5th edn., John Wiely & Son's, Inc., India, 2001.
10. Analytical Chemistry Principles, John H.Kennady, 2nd edn., Saunders College Publishing, California, 1990.

Code : **ICP HCP: 2.8** Univ Code :209

Contact Hours : 64hrs Work load : 4 hours per week

Credit Points : 2

Evaluation: Continuous Internal Assessment - 15 marks

Semester and Examination - 35 marks

ICP HCP: 2.8 Physical Chemistry Lab-II

(any six)

1. Potentiometric titrat6ion of KI vs $KMnO_4$ solution.
2. Potentiometric titration of Fe(II) vs Ce(IV).
3. To obtain the absorption spectra of colored complexes, verification of Beer's law and estimation of metal ions in solution using spectrophotometer.
4. Spectrophotometric titration of $FeSO_4$ against $KMnO_4$.
5. Adsorption of acetic acid on charcoal
6. Adsorption of Oxalic acid on activated charcoal
7. Potentiometric determination of available chlorine in bleaching powder.
8. Determination of dissociation constant of weak acid by conductance method
9. Conductometric determination of equivalent weight and K_a for a weak acid.

[64 hrs]

REFERENCES

1. Practical Physical Chemistry- A.J.Findlay.
2. Experimental Physical Chemistry-F.Daniel et el.
3. Selected Experiments in Physical Chemistry- Latham.
4. Experimental Physical Chemistry- Janes and Parichard.
5. Experimental Physical Chemistry- Shoemaker.

6. Experimental Physical Chemistry- Yadav, Goel Publishing House.
7. Experimental Physical Chemistry- Das R.C and Behera B., Tata Mc Graw Hill.

THIRD SEMESTER

Code : **ICS HCT: 3.1** Univ Code :301
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICS HCT: 3.1-SPECTROSCOPY – I

[56 hrs]

UNIT – I

Microwave Spectroscopy

The rotation of molecules – rotation spectra of diatomic molecules – the rigid diatomic molecule – rotational energy levels – selection rules – effect of isotopic substitution – the non rigid rotator – spectrum of a non rigid rotator – polyatomic linear molecules – techniques and instrumentation.

Vibrational Spectroscopy

Vibrating diatomic molecule – simple harmonic oscillator – vibrational energy levels – anharmonic oscillator selection rules – fundamental vibrations, overtones and hot bands – diatomic vibrator rotator, vibration rotation spectra of carbon monoxide – interaction of rotation and vibration – Born – Oppenheiner approximation

Raman Spectroscopy:

Classical theory of Raman Effect – rotational Raman spectra – Linear – Vibrational Raman Spectra – Instrumentation. **[14 Hours]**

UNIT – II

Infra Red Spectroscopy

Introduction – Molecular vibrations – Mode of Vibrations, calculation of vibrational frequencies, instrumentation- – FT – IR Spectrometer. Sampling techniques, interpretation of IR spectra factors affecting group frequencies and band shapes – Physical state of samples vibrational coupling, electrical and inductive effects, Hydrogen bonding and ring structures, co-relation chart, important regions in the IR spectrum – H stretching, triple bond, double band stretching, finger print region, applications of IR spectroscopy in the structural elucidation of organic. Compounds, application of far IR spectroscopy – Limitations of IR spectroscopy. (Problems & Exercise). IR spectraof coordination modes of ligands like nitrate, thiocynate, sulphate, carbonate(bridging, bidentate etc.,),and water. **[14 Hours]**

UNIT – III

HNMR Spectroscopy

Introduction – Nuclear spin and magnetic moment, origin of NMR spectra, Theory of NMR spectroscopy, resonance flipping, instrumentation and sampling, inter preparation of NMR spectrum, equivalent and non-equivalent protons, chemical shifts(down field and up field), factors influencing chemical shifts, anisotropic effects, NMR scale, units, internal references, simple and complex splitting / coupling, coupling constant, correlation chart of chemical shifts, spin-spin relaxations, deuterium exchange techniques limitations of H NMR spectroscopy – Introduction and applications of ^{13}C NMR spectroscopy, 2 DNMR spectroscopy, use of PMR spectrum in structural elucidation of organic compound. ^{31}P and ^{10}F NMR spectra of simple organic molecules, phosphates, polyphosphates, PH_3, phosphohalides, fluoro acetic acid, SF_4, P_4S_4, HPF_2. **[14 Hours]**

Unit IV

X-Ray Diffraction: Production of X-Rays - Measurement of X-Rays Principles of X-Ray absorption - Principles and instrumentation in X-Ray fluorescence.

X-Ray diffraction - Bragg's laws - Miller indices laws - transmission and reflection method - Debye Scherrer method - single crystal and polycrystalline diffraction studies. Electron microprobe – principles and instruments – principles of electron diffraction - working of SEM and TEM.

Photoelectron Spectroscopy:

Basic principles-photoelectric effect, ionization-process, Koopman's theorem-photoelectric spectrum of simple molecules, ESCA-chemical information from ESCA. **[14 Hours]**

REFERENCES:

1. Physical Methods in Inorganic chemistry, R.S. Drago, East-West Press
2. Structural Methods in Inorganic chemistry, EAV Ebsworth, David W H Eankin Stephen Cradock, Blackwell scientific publications.
3. An introduction to Magnetic Resonance spectroscopy, D.N. Sathyanarayana, I.K. International.
4. Rotational and Vibrational Spectroscopy D.N. Sathyanarayana, New Age Publications
5. Chemical Applications of Group Theory, F.A. Cotton, John – Wiley.
6. Symmetry and Molecular Spectroscopy, K. Veerareddy, New age international.
7. Molecular Spectroscopy, G. Aruldhas, Prentice Hall, India.
8. Fundamentals of Molecular Spectroscopy, C.N. Barnwell, Tata McGraw Hill.
9. Fundamentals of Molecular Spectroscopy, G.M. Barrow McGraw Hill.
10. Spectroscopy of Organic compounds – P.S. Kalsi, Wiley Eastern Ltd. (India) / New Age International Publications, New Delhi (4^{th} Edn.)
11. Organic Spectroscopy – William Kemp 3^{rd} Edn. ELBS
12. Application of obsorption spectroscopy of organic compound – John R Dyer, Prentice Horll India, EEE, Recent Edn.
13. Instrumentation Method of Chemical analysis – G.R. Chatwal and S.K. Anand, Himalaya Publication House, Delhi (Recent Edn.)
14. Instrumentation method of chemical analysis. – B.K. Sharma – Goel Publishing House – Meerut.
15. Spectroscopic methods in organic chemistry – D.H. Williams, I. Fleming – Tata McGraw Hill.
16. Introduction to NMR Spectroscopy – R.J. Abraham, J. Fisher, P. Loftus, - Wiley Publications.
17. Spectroscopic Identification of Organic Compounds – R.M. Silverstein, G.O. Basster and T.C. Morril – John Wiley Publication.
18. Elements of X-Ray Crystallography, L.V.Azaroff, McGraw Hill.
19. X-Ray Crystallography, M.J.Buerger, John Wiley.
20. Elements of X-Ray Diffraction,B.D.Cullity.
21. An Introduction to X-Ray Crystallography, M.M.Woolfson Cambridge University Press.
22. The Basics of Crystallography and Diffraction, Christopher Hammond, Oxford Science Publications.

Code : **ICU HCT: 3.2** Univ Code :302

Contact Hours : 56 Work load : 4 hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

INDUSTRIAL CHEMISTRY-I

ICU HCT: 3.2 Unit processes , operations and Management

56Hrs

UNIT – I

Unit Processes and Operations

Introduction, relevance of various organic unit processes in chemical industries. Le-Charlie's principle, types of process, types of reactors, effect of shape and design of reactors. Factors influencing the optimum yield, I law of thermodynamics, process principles – Thermodynamics kinetics, reagents – their application, back mixing etc., with respect to some selected unit process – nitration, halogenation, esterification, sulphonation, diazotization, oxidation, reduction.

[14 Hours]

UNIT – II

Unit Operations:

Evaporation:

Introduction, principle, types of evaporation – vacuum, film, steam heated, open vessel, closed vessel, under reduced pressure, multiple effect evaporation.

Distillation:

Role of pressure on distillation, vapour – liquid equilibrium, flash distillation, batch distillation, rectification of binary mixtures, types of equipments and accessories for distillation.

Crystallization:

Role of stability, types of crystallization – atmospheric cooling with stirring, agitated batch crystallization, sensors – Walker crystallization.

Drying:

Theory, important variables, different drying equipments used in industries.

Extraction:

Liquid–liquid, solid-liquid extraction, counter current extraction, extraction equipments and their applications.

[14 Hours]

UNIT – III

Transportation of fluids

Pipes, fittings, valves, pumps, fans, blowers, compressors used in industries.

Filtrations:

Theory of filtrations, effect of temperature, pressure, viscosity, case thickness, filter medium & filter aids, types of filters.

Mixing:

Mixing operation and selection of mixtures for dry blending of solids, mixing of immiscible liquids and suspended solids in liquids.

[14 Hours]

UNIT – IV

Industrial Management:

Rational Industrialization – Factors favouring and inhibiting industrial action.
Industrial Location – Weber's theory, factors of location and selection of site.
Personal Management – Concept, scope, role and functioning.
Human Resource Development – Contents.
Personnel Problems – Absenteeism, employees turnover, motivation, morale enforcement and discipline.
Industrial Relations – Meaning, nature and significance.
Industrial Disputes – Methods of settling industrial disputes. Collective bargaining, workers participation in management.

[14 Hours]

REFERENCES:

1. Roger's Manual of Industrial Chemistry, C.C. Furna's (Editor) VI Edition, Vol.-I, D. Van Nostrand Co., Inc.
2. Unit Operations of Chemical Engineering, W.L. Mc. Cab & J.C. Smith.
3. Chemical Engineer Operations, Rumford.
4. Shrev's Process Industry, George T Austion.
5. Transport Phenomenon, R.B. Bird, E.W. Stewuart and E.N. Lightfort.
6. Principles of Management, R.C. Tripathi and P.N. Reddy.
7. Essentials of Management, I.L. Hessie.
8. The Practice Management, P.F. Drucker.

Code : **ICI HCT: 3.3** Univ Code :303
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICI HCT: 3.3 INDUSTRIAL MATERIALS – I

56Hrs

UNIT – I

Refractories and Allied Materials:

Ceramics: Classification and general properties of ceramics, basic raw materials, chemical conversions, manufacturing process, white wares and porcelain – manufacturing process.

Industrial carbon, Lampblack, carbon black, activated carbon, natural graphite, manufactured graphite and carbon, Industrial diamonds.

Refractories:

Classification, properties and manufacture of refractories, vitreous – enamel, raw materials, manufacture of enamel glass and application of enamel.

[14 Hours]

UNIT – II

Glass and Cement:

Glass: Commercial glass, composition of glass, Properties of glass, raw materials and methods of manufacturing of some special glasses.

Portland cement: Types, raw materials, manufacture and process of Portland cement, Setting and hardening of cement, Other cements, gypsum, calcium and magnesium compounds.

Chlor-alkali Industries: Manufacture of soda ash, sodium bicarbonate, chlorine and caustic soda, Bleachng powder, calcium and sodium hypochlorites, sodium chlorite.

[14 Hours]

UNIT – III

Metallurgy of copper, Iron and Steel:

Copper – occurrence, extraction, hydrometallurgy and pyrometallurgical methods, refining of copper-electrolytic, alloys of copper – brass, German silver, bell metal and bronzes.

Iron – Raw materials, manufacture of pig iron, cast iron and wrought iron.

Steel – manufacture steel by different methods

Extraction and refining of zinc and nickel, extraction of Magnesium. **[14 hours]**

`UNIT – IV

Fuels and Petroleum Products:

Fuels – essential requirements of fuels, modern concept of fuels, origin, classification and selection of solid, liquid and gaseous fuels.

Coal – composition and carbonization of coal, proximate and ultimate analysis of coal – moisture, ash, crude, proteins, calcium, potassium, sulphur and phosphorus.

Analysis of petrol and petroleum products – flash point, fire point, cloud point, pour point, aniline point, viscosity, specific gravity and vapour pressure.

Detection and estimation of lead an antiknock compound in gasoline and sulphur in petroleum products.

[14 Hours]

REFERENCES:

1. Industrial Chemistry – B.K. Sharma, Goel publishing House, Meerut, 2010
2. Standard Methods of Chemical Analysis – F.J. Welcher, 6th Edn. Vol.3, Part-B, D. Van Nostrand Company, Inc.,
3. Petrochemical Industries – A.V.C. Hann,

4. Roger's Manual of Industrial Chemistry Furnas, Vol. I & II.
5. Engineering Chemistry – P.C. Jain and M.Jain.
6. Shreve's Chemical Process Industries, George T Austin, 5th Ed., McGraw-Hill,

---

Code : **ICG SCT: 3.4** Univ Code :304
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICG SCT: 3.4 GREEN CHEMISTRY, SOIL AND ENERGY SYSTEMS

56Hrs

UNIT – I

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 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.

[14 Hours]

UNIT – II

Green Chemistry:

Definition and principles, plant green synthesis in a chemical laboratory, preparation – aqueous phase reactions, solid state (solventless) reactions, photochemical reactions, phase transfer catalyst catalyzed reactions, enzymatic transformations and reactions in ionic liquids.

Sono chemistry:

Introduction, instrumentation, the phenomenon of cavitations, types of sonachemical reaction, sonchemical etherification, substitution, addition, oxidation, reduction and coupling reactions.

Microwave induced organic synthesis:

Introduction, reaction vessel and reaction medium, concept, specific effect, atom efficiency, % atom utilization, advantages and limitations, N-alkylation and alkylation of active ethylene compounds with aldehydes, synthesis of Ibuprofen by BHC and BOOTS approaches, Diels – Alder reaction, Leuckardt reductive amination of ketones, oxidation of alcohols and sulfides.

[14 Hours]

UNIT – III

Energy Systems:

Merits and demerits of chemical energy sources – natural gas, coal, nuclear fussion, nuclear fission. Hydropower, electro chemical energy systems – introduction. battery specification, evaluation of battery performance, battery components, classification, battery characteristics. Primary Batteries – Leclancha dry cell (Zn and Mg), alkaline MnO_2 batteries. Secondary batteries – introduction, lead acid battery, alkaline storage battery. Battery charging – lithium batteries – the primary and secondary lithium batteries. Lithium based conducting polymer battery, safety in the use of batteries.

[14 Hours]

UNIT – IV

Fuel Cells:

Introduction, efficiency, classification, types, H_2-O_2 fuel cell, methanol fuel cell, biofuel cell, solid polymer electrolyte fuel cell, general development of a fuel cell. Solar energy cells – introduction, semiconductor electrodes, semiconductor electrolyte interface, parameter controlling efficiency, stability of semiconductor electrodes. Photo electrochemical and photo galvanic cells, PEC cells, production of hydrogen by photo electrolytes. Photo assisted electrolysis of water, hydrogen energy. Applications of photochemistry – photo electro catalysis, production of CO_2, photoelectrochemical waste removal. Hydrogen storage by metal alloys.

[14 Hours]

REFERENCES:

1. Principles of Agronomy – T. Yellamanda Reddy Agricultural Research Centre, Anantapur.
2. Soil Chemistry and its applications – C. Malcolm, K. Killham and Edwards, Cambridge, 1993.
3. Soils – M. Raymond and J.C. Sichuan, 5th Edn. Prentice Hall, India, 1987.
4. Green Chemistry – Environment Friendly Alternatives – R. Sanghi and M.M. Srivatsava, Narosa, 2003.
5. Green Chemistry – Environment Benign Reactions, V.K. Ahluwalia, Ane Books India, 2006.
6. Chemical and Electrochemical Energy Systems – R. Narayana and B. Viswanathan, University Press, 1998.
7. Energy Storage for power systems – Ter – Gazarian A. Peter Pergrinus, London – 1994.
8. Bio-Energy for Rural Energisation – R.C. Maheswari, Concepts Publication, 1997.
9. Wind Energy Systems – G.L. Johnson Prentice Hall Inc., New Jersey, 1985.

Code : **ICE SCT: 3.5** Univ Code :305

Contact Hours : 56 Work load : 4 hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICE SCT: 3.5 ENVIRONMENTAL AND BIOCHEMICAL ANALYSIS

56 Hrs

UNIT – I

Environmental Segments, Air Pollution and Soil Pollution:

Air pollutants, prevention and control, Green house effect and acid rain. CO – industrial and transportation sources. So_x- sources, ambient concentration, test methods, control techniques – scrubbing, limestone injection process. Ozone hole and CFC's. Photochemical smog and PAN. NO_x – sources, ambient concentration, test methods, thermodynamics and NO_x, control techniques. Particulates: size distribution. Bhopal gas tragedy. Noise pollution.

Composition of soil – Inorganic and organic components in soil, micro and macro nutrients, nitrogen and sulfur pathways.

Soil pollution:

Classification of pollutants and their characteristics, sources, prevention and control. **[14 Hours]**

UNIT – II

Hydrologic cycle, sources, criteria and standards of water quality:

Safe drinking water, public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, sulphate, fluoride, phosphate and different forms of nitrogen in natural and polluted water. Determination of BOD, COD and TOC.

Toxic chemicals in the environment, impact of toxic chemicals on enzymes. Detergents – pollution aspects, Pesticides – pollution of surface water. Heavy metal pollution. Chemical speciation – biochemical effects of heavy metals (Hg, As, Pb, Se), carbon monoxide, nitrogen oxides, sulphur oxides and hydrocarbon. Treatment of industrial liquid wastes. **[14 Hours]**

UNIT – III

Soil Analysis:

Physical properties of soils – soil texture and soil structure. Chemical properties of soil – types of soil collides, types of clays and their swelling and adsorption properties, cation exchange capacity and its determination, acid soils – types of soil acidity, liming, measurement of pH and conductivity of soil – saline and alkaline soils, analysis of major constituents of soil – organic matter, nitrogen, sulphur, potassium and calcium.

Fuel Analysis:

Solid, liquid and gaseous fuels; ultimate and proximate analysis, heating values, grading of coal; liquid fuels; flash point, anline point, octane number and cetane number, carbon residue; gaseous fuels; producer gas and water gas, calorific valves. **[14 Hours]**

UNIT – IV

Food Analysis:

Estimation of moisture, ash, crude protein, fat, crude fiber, carbohydrate, calcium, potassium, sodium and phosphate in foods; Analysis of common adulterants in food; Milk and milk products – alcohol test, fermentation test, dye reduction tests (methylene blue and resazurin), tests to distinguish butter and margarine, phosphate test for pasteurization, estimation of added water; Beverages – caffeine and chicory in coffee, methanol in alcoholic drinks; estimation of saccharin, coal tar dyes, aflatoxins in foods; pesticide analysis in food products – extraction and purification of sample, gas chromatography for organophosphates, thin-layer chromatography for chlorinated pesticides. **[14 Hours]**

References:

1. Principles of Instrumental Analysis, Skoog, Holler and Nieman, Harcourt Afca, 2001.
2. Environmental Chemistry – A.K. De, (Wiley Eastern).
3. Environmental Chemistry – S.K. Banerji, (Prentice Hall India), 1993.
4. Chemistry of Water Treatment – S. D. Faust and O. M. Aly, (Butterworths), 1983.
5. Environmental Chemistry – I. Williams, John Wiley, 2001.
6. Food Analysis – A. G. Woodman, McGrawHill, 1971.
7. Foods: Facts and Principles – Shadaksharaswamy and Manay, Wiley Eastern, 1987.
8. A Text Book of Soil Chemical Analysis – P. R. Hesse, CBS Publishers, 1994.

Code : **ICI HCP: 3.6** Univ Code :306

Contact Hours : 64 Work load : 4 hours per week

Credit Points : 2

Evaluation: Continuous Internal Assessment - 15 marks

Semester and Examination - 35 marks

ICI HCP: 3.6 Industrial Technical analysis-I

1. Analysis of Fertilizers – Ammonium Phosphate /Sulphate and mixed fertilizers.
2. Analysis of paints and pigments
   a. Volatile matter b. Non Volatile matter c. T_iO_2 d. Lithopone
3. Ore analysis (i) Hematite (ii) pyrolusite (iii) Dolomite
4. Analysis of Alloys
   (i) Type Metal (ii) Cu-Ni alloy (iii) Solder Metal (iv) Brass
   (v) Stainless Steel (vi) Ferro Manganese and Ferrosilicon
5. Analysis of Portland cement.

REFERENCES:

1. A text book of quantitative inorganic analysis- A.I.Vogel, 3rd edition.
2. Vogel's text book of quantitative chemical analysis – J.Basset, R.C.Denney, G. H. Jeffere and J. Mendhom, 5th edition.
3. Quantitative chemical analysis – Daniel, C.Harris, 7th edition 2006.

Code : **ICO HCP: 3.7** Univ Code :307
Contact Hours : 64 Work load : 4 hours per week
Credit Points : 2
Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

ICO HCP: 3.7 Industrial Technical Analysis-II

1. Determination of elements in organic compounds.
   (i) Nitrogen (ii) Chlorine (iii) Sulphur
2. Determination percent purity of the following:
   (i) Esters by saponification (ii) Methyl ketone by Iodoform method
   (iii) Aniline by bromination (iv) Acetic Anhydride
   (v) Citric acid.
3. Oil analysis
   (i) Acid value (ii) Peroxide value
   (iii) Iodine value (iv) Saponification value
4. Analysis of Coal
   (i) Moisture content (ii) Volatile matter
   (iii) Ash (iv) Fixed Carbon in Coal.
5. Analysis of pulp
   (i) Copper number (ii) Ash content
   (iii) Moisture content
6. Analysis of medicinal compounds from drugs.
   (i) Aspirin (ii) Phenacetin
   (iii) Ascorbic acid (iv) Paracetamol

REFERENCES:

1. A text book of Quantitative Inorganic analysis – A.I. Vogel.
2. A text book of Quantitative Organic analysis – A.I. Vogel.
3. Encyclopedia of Industrial Chemical Analysis –
4. A text book of metallurgical Analysis – Agarwal & Joul.
5. Volumetric Analysis – Kolthof & Belcher
6. Standard Methods of Chemical Analysis – Welcher, Vol. I to III
7. Physical methods of Inorganic Analysis - R.S. Drago.
8. Commercial methods of Analysis – F.D. Snell & B.M. Be
9. Scotts standard methods of analysis – W.W. Scott & N.H. Furman
10. Encyclopedia of Industrial Chemical Analysis – (All Volumes) – J. Wiley Inter Science.

Code: ICO HCP-3.8 Univ Code;307
Contact Hours: 64 Work load : 4 hours per week
Evaluation: Continuous Internal Assesment _ 15 Marks
Semester examination --35 Marks

ICO HCP-3.8 -Industrial Technical Analysis –III

1) Preperation of Polymers:

i) Urea-Farmoldehyde resin
ii) Pheno-l Farmoldehyde resin
iii) Preperation of Nylon-66

2) Determination of sulphated ash in a Drug sample.
3) Extraction of Caffine from commercial Tea powder
4) Preperation of Dyes-Methyl orange
5) Preperation of Dyes-Methyl Red
6) Separation and identification of Amino acids by Ascending Paper Chromatography
7) Extraction of Nicotine from Tobacco by Soxhelet extractor.

REFERENCES:

1. A text book of Quantitative Inorganic analysis – A.I. Vogel.
2. A text book of Quantitative Organic analysis – A.I. Vogel.
3. Encyclopedia of Industrial Chemical Analysis –
4. A text book of metallurgical Analysis – Agarwal & Joul.
5. Volumetric Analysis – Kolthof & Belcher
6. Standard Methods of Chemical Analysis – Welcher, Vol. I to III
7. Physical methods of Inorganic Analysis - R.S. Drago.
8. Commercial methods of Analysis – F.D. Snell & B.M. Be
9. Scotts standard methods of analysis – W.W. Scott & N.H. Furman
10. Encyclopedia of Industrial Chemical Analysis – (All Volumes) – J. Wiley Inter Science.

Code : **OET SCT: 3.1** Univ Code :308
Contact Hours : 56 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

- OPEN ELECTIVE/ CROSS BORDER

PAPER-I

(NON CHEMISTRY STUDENTS ONLY)

OET SCT: 3.1-Analytical and Organic Chemistry

56Hrs

Unit-I

Principles of Chromatography:
Distribution coefficient**, modes of** chromatography, selection of stationary and mobile phases, analyte development and elution. Chromatographic performance parameters-retention time and volume capacity factor, plate height and resolution.

Gas Liquid Chromatography:
Principle, apparatus, columns, simple application, mobile phase, stationary phases, detectors Applications.

[14 hrs]

UNIT-II

HPLC Principles:
Instrumentation-columns, stationary phase and matrices, simple applications, mobile phase pumps, detectors.
Ion-Exchange Chromatography: Principle, material and applications.

Thin Layer Chromatography: Principles, apparatus, preparations of plates, simple applications, plate development, detection of analytes. Selection of chromatographic systems.

[**14 Hrs]**

Unit-III

Organic Chemistry:

Introduction, classification of organic compounds with examples, classification of organic reactions with examples.

Nomenclature of Organic Compounds: IUPAC name of simple organic compounds.

[14Hrs]

UNIT-IV

Structure and Reactivity:

Acids and bases, structural effects on acidity and basicity, hydrogen bonding, resonance, inductive effect and hyperconjugation. Application of Huckel's rule to simple organic molecules.

Insecticides: Introduction, classification, mode of action of chlorinated insecticides, synthesis of DDT, malathion and beygon.

[14 hrs]

REFERENCE

1. Modern analytical chemistry-David Harvey, Mc Graw Hill, New Delhi, 2000.
2. Fundamentals of analytical chemistry-D.A Skoog, D.M West, Holler and Crouch,8th edition, Sunder College Publishing, New York, 2005.
3. Analytical chemistry-G.D.Christian,5th edition John Willey and Son's, Inc., India,2001.
4. Organic chemistry-I.M.Morrison and Boyd.
5. Advanced organic chemistry-Jerry March.
6. Organic chemistry-I.L.Finar, Vol.I &II.

Code : **OET SCT: 3.2** Univ Code :309

Contact Hours : 56 Work load : 4 hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

OET SCT: 3.2-Quality Control, Assurance and Chromatographic Techniques

56 Hrs

UNIT-I

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 variability. 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 and finished product. Current trends in quality control, ISO 9000 and ISO 14000 series. Laws related to quality control. ISO 17025.

[14Hrs]

UNIT-II

Chemical Warfare Convention:

Definition and schedules. Toxic chemicals, remote control system, tear gas, chemical weapons, ocean dumping of chemical weapons.

[14hrs]

UNIT-III

Chromatographic Techniques:

Principles, classifications and theory of chromatographic separation.

Ion exchange chromatography:

Structures of resins, selectivity, capacity of resins, ion exchange equilibria, application-removeval of interfering ions, concentration and recovery of traces, anions and cations separation and application for separation of lanthanides and actinides. Techniques of column chromatography and size exclusion chromatography.

[14hrs]

UNIT-IV

Paper chromatography: Theory and principle.

Gas chromatography:

Principles column detectors- TCD, FID, ECD and column efficiency, capacity factors, resolution. Practical aspects of GC-Hypernated techniques.

HPLC: Principles, equipments, column, detectors, choice of column, materials.

[14 hrs]

REFERENCE

1. Analytical chemistry – G.D.Christian, 6th edition, John Willey, 2004.
2. Quantitative analysis, A.Day and A.L.Underwood, 5th edition,1998.
3. Principles of instrumental analysis-Skoog, Holler and Nie man, Harcourt Afca, 2001.
4. Instrumental methods of analysis-H.H.Williard, L.L.Merit and J.J.Dean, 7th edition, 1988.
5. Chemical process industries-Shreves and R.Norries, 3rd edition, Mc Graw Hill, 1967.
6. Statistical quality control, 2nd edition, Manohar Mahajan, 1995.
7. Chemical engineers hand book-Robort H. Perry, 8th edition, Mc Hill, 1995.

FOURTH SEMESTER

Code : **ICO HCT:4.1** Univ Code :401

Contact Hours : 56 Work load : 4hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICO HCT:4.1 INDUSTRIAL CHEMISTRY-II

56Hrs

UNIT-I

Fermentation Technology and sugar:

Introduction, bio-reactors, detection and assay of fermentation products – physical and chemical methods, biological assays. Important steps of fermentation process-stock culture, fermentation media, inoculums preparation, scale-up of fermentation and increasing product yields. Types of fermentation processes-dual or multiple and continuous fermentation.

Industrial preparation of alcohol from molasses, preparation of vinegear from alcohol. Composition of alcoholic beverages – spirits, wines and beers.

Sugar and Sugar based chemicals:

Manufacture of sugar from sugar cane. Sugar industry byproducts – acetic acid, ethyl acetate, oxolic acid, aceticanhydride, furfurol from bagasse, citric acid by fermentation (manufacturing process & their industrial applications). **[14 hrs**]

UNIT-II

Industrial Pharmacy:

Introduction, classification of dosage formulations, solutions, emulsions, suspensions, aerosols, extraction, parenteral preparations, tables, capsules and pills. Coating of pharmaceutical dosage forms. Equipments used for various types of formulation preparations, packing materials and equipments used in pharmaceutical preparations, labeling aspects of drugs. **[14 hrs**]

UNIT – III

Insecticides and Fungicides:

Insecticides – Classification, inorganic insecticides – lead arsenate, calcium arsenate, paris-green, fluorine and sulphur compounds, natural insecticides – nicotine, pyrethenrine, rolenone, allethrin, organic insecticides-DDT, dinitor phenol, methoxy-chlor, BHC, gammoxane, chlordane, heptachlor, aldrin, dialdrin, toxaphane, TEPP, melathion and parathion.

Fungicides – Inorganic and organic fungicides.

Pulp and Paper Technology:

Introduction, qualities of pulp for papers, raw materials, manufacture of pulp by Kraft's process (sulphite process), bleaching of pulp, recovery of chemicals, paper making by Frurdniner process. Manufacture of rayon by viscose process.

[14 Hours]

UNIT-IV

Electro Organic Synthesis:

Basic concepts of electro-organic reaction, electro-organic synthesis involving reduction of nitro compounds, Kolbe synthesis, oxidation of hydrocarbons, hydro isomerisation, electro-polymerization reactions.

Soft Materials:

Thin Films and Langmuir – Boldgett 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 & dielectic constants, Lyotropic phases & their description or ordering in liquid crystals. **[14 Hours]**

REFERENCES:

1. Roger's Manual of Industrial Chemistry, C.C. Furnas (Edition), 6th edition, Vol.I, D. Van Nostrand Company, Inc.
2. Industrial Chemistry by B.K. Sharma.
3. Chemistry in Engineering and Technology, J.C. Kuriacose and J. Rajaram Vol.-II, Tata Mc. Graw Hill Publishing Company Ltd., New Delhi.
4. Engineering Chemistry, 4th Edition, V.P. Mehta, Jain Brothers, New Delhi.
5. Engineering Chemistry, by P.C. Jain and M. Jain.
6. Industrial Microbiology – L.E. Casida Jr.
7. Dryden's Outlines of Chemical Technology – Gopal Rao and Marshal Sitting.
8. Alcohols, their chemistry, properties and manufacture – John A Monick.
9. Theory and Practice of Industrial Pharmacy – Lachmann et., al.
10. Pharmaceutics-I & II – Mehata, Asgar Ali and Mahamuni

Code : **ICD HCT:4.2** Univ Code :402

Contact Hours : 56 Work load : 4hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICD HCT:4.2 INDISTRIAL MATERIALS-II

56Hours

UNIT-I

Dyes, Drugs and Detergents:

Dyes-colour and constitution, classification, dyeing, some typical dyes-nitroso, nitro, azo, anthene and anthro-quinone dyes. Methods of application of dyes of fibres.

Drugs; Definition, Classification, nomenclature,drug action, methods of drug action assay, synthesis and applications of Antiseptics- chloramines-T,vioform , antihistamines-benadryl, phenandamine , CNS stimulants-coramine,amphetamine, Antibiotics-pencillin,chloroamphenicol , Antineoplastic agents-chlorambucil, mechlorethamine , Anesthetics-thiopental sodium, fentylcitrate,benzocaine, Antipyretic&analgesic drugs-chinchophen,phenacitin.

Detergents – Introduction, classification-anionic, cationic, non-ionic and amphoteric detergents, biodegradability of surfactants and manufacture of shampoos. **[14 Hours]**

UNIT-II

Rubber and Rubberlike Products:

Rubber plantation, manufacture of natural rubber from latex, chemistry of natural rubber, compounding of rubber, vulcanization of rubber, Rubber products, synthetic rubbers-synthesis and applications of-Buna-S, Buna-N, styrene rubber, butyl rubber, neoprene rubber, Thiokol rubber, Hyplon rubber, poly acrilonitrile, polyisoprene rubber.

Leather Chemistry;

Hides and skins, classification of hides and skins, structure of animal skin, hide damages, pre-tannage processes, inhairing, bating and pickling. The tanning processes-chrome tanning, vegetable tanning, vegetable tanning materials, tanning extracts, miscellaneous tannages and finishing processes. Commercial aspects of the leather industry and the Fur industry. **[14Hours]**

UNIT-III

Phosphorous, potassium and nitrogen Industries:

Phosphate rock, superphosphate, phosphoric acid, phosphates, baking powders, fire retardant chemicals.

Potassium chloride, sulphate, bisulphate, hydroxide, carbonate, acid tartarate, permanganate and dichromate.

Synthetic ammonia, ammonium nitrate, sulphates, phosphates, urea, nitric acid, cyanamide. **[14Hours]**

UNIT-IV

Paints:

Paints – pigments: manufacture and uses of white lead, zinc white, ultramaine, carbon black, lithophore, red lead, chrome green. Manufacture of paints, characteristics of a good paint, paint failure, varnishes, sprit varnishes, oleoresins, varnish and paint industries in India.

Adhesives:

Introduction, theories of adhesion, advantages and disadvantages of using adhesives, chemistry and uses of adhesives, natural product based adhesives, pressure sensitive adhesives, hot melt adhesives, solvent and emulsion based adhesives.

Explosives:

lassification, characteristics, preparation of explosive, nitro cellulose, TNT, Dynamite, Cardite, Gun Powder, Lead azide and RDX. **[14Hours]**

REFERENCES:

1. Roger's Manual of Industrial Chemistry, C.C. Furnas (Edition), 6th edition, Vol.I, D. Van Nostrand Company, Inc.
2. Industrial Chemistry by B.K. Sharma.
3. Chemistry in Engineering and Technology, J.C. Kuriacose and J. Rajaram Vol.-II, Tata Mc. Graw Hill Publishing Company Ltd., New Delhi.
4. Engineering Chemistry, 4th Edition, V.P. Mehta, Jain Brothers, New Delhi.
5. Engineering Chemistry, by P.C. Jain and M. Jain.
6. Industrial Microbiology – L.E. Casida Jr.

7. Dryden's Outlines of Chemical Technology – Gopal Rao and Marshal Sitting.
8. Alcohols, their chemistry, properties and manufacture – John A Monick.
9. Theory and Practice of Industrial Pharmacy – Lachmann et., al.
10. Pharmaceutics-I & II – Mehata, Asgar Ali and Mahamuni
11. Shreve's Chemical Process Industries, George T Austin, 5th Ed., McGraw-Hill,

Code : **ICS HCT: 4.3** Univ Code :403
Contact Hours : 56 Work load : 4hours per week
Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICS HCT: 4.3 Spectroscopy and Chromatography

56 Hrs

UNIT – I

Gas Liquid Chromatography:

Principle, apparatus-columns, sample application, mobile phase, stationary phase, detectors, applications.

HPLC Principles:

Instrumentation-columns, stationary phase and matrices, sample application, mobile phases, pumps, detectors

Mass Spectroscopy:

Introduction – Basic theory, ionsation, types of ions – molecular ion, fragment ion, meta stable ion, base peak, instrumentation, factors affecting fragmentation, intensity of M^+ peaks of alkanes, alkenes, alkynes, alcohols, amines, aldehydes and other compounds, Mc Laffarty rearrangement nitrogen rule, some simple examples of fragmentations, applications of mass spectrometry. GC-MS and LC-MS. **[14 Hours]**

UNIT-II

Molecular Luminescence:

Principles of Fluorescence and Phosphorescence - Fluorimetry in Chemical Analysis - Instrumentation in Fluorimetry - Fluorescence and Chemical Structure and - Fluorescence in quenching and inner filter effect - Phosphorescence Spectroscopy – Jablonski diagram- Phosphorescence and Chemical Structure - Phosphorimetry in Quantitative Analysis.

Chemiluminescence:

Principles, measurement of Chemiluminescence - Quantitative Analysis - Titrations - Electrochemiluminescence.

Polarimetry and Related Methods :

Polarized light - Applications of Polarimetry - Optical Rotatory Dispersion and Circular Dichroism – cotton effect, Instrumentation in ORD and CD. **[14 hrs]**

UNIT – III

Electron Spin Resonance Spectroscopy:

Introduction - Presentation of spectrum – ESR transitions and selection rules Hyperfine splitting in various structures – Factors affecting "g" values. Zero field splitting and Kramer's degeneracy Anisotropy in Hyperfine coupling constant – Nuclear Quadrupole interactions – Spin Hamiltonian – Electron delocalization instrumentations and applications

Mössbauer Spectroscopy

Introduction – Mössbauer effect – Resonance absorption of gamma rays conditions for Mössbauer spectroscopy – Mössbauer parameters – Isomer shift – electric quadruple interaction – Magnetic interactions – Instrumentation & applications to $Fe_3(CO)_{12}$, Prussian blue, Oxyhemerythrin, Hexacyano ferrates, Netroprusside and Tin halides.

Nuclear Quadruple Resonance Spectroscopy:

Introduction – Nuclear Quadruple Moment – Electric field gradient – Asymmetry parameter – Nuclear Quadruple transition – Effect of external magnetic field – Applications. **[14 hrs]**

UNIT-IV

Electroseparation techniques:

Supercritical fluid chromatography: Introduction, Properties of supercritical fluids, Instrumentation, and applications.

Electrophoresis: Principle, classification, capillary electrophoresis, , Instrumentation, Application to capillary zone electrophoresis, gel electrophoresis.

Electroosmosis: Principles, Instrumentation and applications.

Field flow fractionation: Separation mechanisms, Methodology, Advantages over chromatographic methods.

[14 hrs]

REFERENCES:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi
4. Spectroscopy of Organic compounds – P.S. Kalsi, Wiley Eastern Ltd. (India) / New Age International Publications, New Delhi (4th Edn.)
5. Organic Spectroscopy – William Kemp 3rd Edn. ELBS
6. Application of obsorption spectroscopy of organic compound – John R Dyer, Prentice Horll India, EEE, Recent Edn.
7. Instrumentation Method of Chemical analysis – G.R. Chatwal and S.K. Anand, Himalaya Publication House, Delhi (Recent Edn.)
8. Instrumentation method of chemical analysis. – B.K. Sharma – Goel Publishing House – Meerut.
9. Molecular structures and Spectroscopy – G. Aruldas, Prentice Hall India, New Delhi.
10. Spectroscopic methods in organic chemistry – D.H. Williams, I. Fleming – Tata McGraw Hill.

Code : **ICP SCT: 4.4** Univ Code :404

Contact Hours : 56 Work load : 4hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICP SCT: 4.4-Polymer Science and Technology

56 Hrs

UNIT- I

Importance of polymers. Basic Concepts:

Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: Condensation, addition, radical chain-ionic and co-ordination and co-polymerization. Polymerization conditions and polymer reactions. Polymerization in homogenous and heterogeneous systems, Polymerization Techniques.

Polydispersion-average molecular weight concept.

Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance molecular weight. Measurement of molecular weights. End-group, viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact. Tear resistance. Hardness and abrasion resistance. **[14 Hours]**

UNIT- II

Morphology and order in crystalline polymers - configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting poit Tm-melting points of homogenous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature,

Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization. **[14 Hours]**

UNIT- III

Testing of Polymers: Need for testing-specifications and standards, mechanical-short term (tensile, fluxural, impact, tear resistance, abrasion resistance etc.,) long term (creep and fitigue). Electrical-conductivity, volume resistivity, surface, breakdown voltage, dielectric constant, loss factor, thermal coefficient of thermal expnasion, heat distortion temperature, vicat softening point, low temperature, properties, thermal conductivity.

Solution properties of polymers:

Polymer dissolution, criteria, thermodynamics, Floury-Huggins theory, nature of polymer molecules in solution, their size and shape, theta solvent, theta temperature, thermodynamics of mixing, solution viscosities. **[14 Hours]**

UNIT- IV

Polymer processing: Plastics, electomers and fibres, compounding. Processing techniques; calendaring, die casting, rotational casting, film casting, injection molding, blow molding extrusion molding, thermoforming, foaming reinforcing and fiber spinning.

Properties of commercial polymers: Polyethylene, polyvinyl chloride, polyamides, polyester, phenolic resins, epoxy resins and silicon polymers. Functional polymers- fire retarding polymers and electrically conduction polymers, Biomedical polymers: contact lens, dental polymers, artificial heart, kidney skin and blood cells. **[14 Hours]**

REFERENCES:

1. Text book of Polymer Science (3rd edition) F.W.Billmayer, A Wiley-Interscience, 1984
2. Contemporary Polymer Chemistry (2nd edition), H.R.Allcock and F.W.Lampe, Prentice Hall, Englewood Cliff's, NewJersy 1981
3. Polymer Science, V.R.Gowswamy424784ariker, N.V.Viswanathan and Jayadev Sreedhar, New Age International (P) Limited, August 1996.
4. Introductory Polymer Chemistry, G.S.Misra, Wiley Eastern Limited, 1993
5. Polymer Science and Technology of Plastics and Rubbers, Premamoy Ghosh, Tata McGraw Hill, 1990
6. Polymer characterisation, Physical Techniques, D.Campbell and J.R. White, Chaopman and Hall, 1989.
7. Principles of Polymer Science Systems, F.Rodriguez, McGraw Hill Book co., 1970.

Code : **ICA SCT: 4.5** Univ Code :405

Contact Hours : 56 Work load : 4hours per week

Credit Points : 4

Evaluation: Continuous Internal Assessment - 30 marks

Semester and Examination - 70 marks

ICA SCT: 4.5 ADVANCED SELECTED TOPICS IN CHEMISTRY

56 Hrs

UNIT – I

PRINCIPLES & CONCEPT OF GREEN CHEMISTRY

Introduction –Concept and Principles-development of Green Chemistry- Atom economy reactions – Selection of starting materials, Designing biodegradable products, Green reaction conditions, Green catalysis, Ionic liquids, Supercritical fluids, Flourous phase reactions, Heterogeneous catalysis: Biocatalysis: -toxicity measures- Need of Green Chemistry in our day to day life.

RENEWABLE RESOURCES

Biomass –Renewable energy – Fossil fuels-Energy from Biomass-Solar Power- Other forms of renewable energy-Fuel Cells-Alternative economics-Syngas economy- hydrogen economy-Bio refinery chemicals from fatty acids-Polymer from Renewable Resources –Some other natural chemical resources. **[14 Hours]**

UNIT – II

MEASURING AND CONTROLLING ENVIRONMENTAL PERFORMANCE

Importance of measurement – lactic acid production-safer Gasoline – introduction to life cycle assessment-four stages of Life Cycle Assessment (LCA) –Carbon foot printing-green process, Matrics-eco labels - Integrated Pollution and Prevention and Control(IPPC)-REACH (Registration, Evaluation, Authorization of Chemicals)

EMERGING GREEN TECHNOLOGY AND ALTERNATIVE ENERGY SOURCES

Design for Energy efficiency-Photochemical reactions- Advantages-Challenge faced by photochemical process. Microwave technology on Chemistry- Microwave heating –Microwave assisted reactions-Sono chemistry and Green Chemistry –Electrochemical Synthesis-Examples of Electrochemical synthesis.

[14 Hours]

UNIT – III

SUPRAMOLECULAR CHEMISTRY

Supramolecular Chemistry, Classification, Thermodynamic and Kinetic selectivity, Supramolecular interactions, Supramolecular host design, Macrocyclic versus acyclic hosts, High dilution synthesis,Template synthesis, Cation binding, cryptaspherands, heterocrowns, hetero-cryptands, selectivity of cation complexation, anion binding hosts, concepts in anion host design, cation hosts to anion hosts, pH effect, Self assembly-basic concepts, Template effect on self assembly, Kinetic and Thermodynamic considerations, Self assembly of coordination complexes. Solid state supramolecular chemistry, Supramolecular Photochemistry.

[14 Hours]

UNIT – IV

CHEMISTRY OF NANOMATERIALS

Introduction: Scope and importance of nanoscience and nanotechnology. Synthetic Methods: Chemical Routes : Physical methods, Techniques for characterization:, BET method for surface area analysis, dynamic light scattering for particle size determination. Studies of Nano-structured Materials: Synthesis, properties and applications of the following nanomaterials, fullerenes, carbon nanotubes, core-shell nanoparticles, self-assembled monolayers, nanocrystalline materials, magnetic nanoparticles thermoelectric materials, non-linear optical materials, liquid crystals. **[14 Hours]**

References:

1. T. Pradeep, NANO: The Essentials, McGraw-Hill, 2007.
2. B S Murty, P Shankar, Baldev Rai, BB Rath and James Murday, Textbook of Nanoscience and Nanotechnology, Univ. Press, 2012.
3. V. K. Ahluwalia, M. Kidwai, New trends in Green Chemistry, New Age Publications, 2004.
4. P.T. Anastas and J.C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, 2000.
5. Jonathan W. Steed, David R. Turner, Karl J. Wallace, Core Concepts in Supramolecular Chemistry and Nanochemistry, John Wiley & Sons, 2007.
6. Jonathan W. Steed, Jerry. L. Atwood, Supramolecular Chemistry, John Wiley & Sons, 2002
7. Alfred Burger, Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery: Chemotherapeutic Agents, 6th Edition, Wiley Inter Science, 2003.
8. N. K. Jain, Advances in Controlled and Novel Drug Delivery, CBS, 2001.
9. Mike Lancaster , Green Chemistry and Introductory text, II Edition

10. P.T.Anastas and J.C Warner,Green Chemistry theory and Practice, Oxford University press, Oxford (1988).
11. P.Tundo*et. al.*, Green Chemistry, Wiley –Blackwell, London (2007).
12. Protti D.Dondi *et.al.*,Green Chemistry
13. T.E Graedel, Streamlined Life cycle Assessment, Prentice Hall, NewJersey (1998).
14. V.K. Ahluwalia,Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry. www.clri.org

---

Code : **ICI HCP: 4.6** Univ Code :406
Contact Hours : 64 Work load : 4 hours per week
Credit Points : 2
Evaluation: Continuous Internal Assessment - 15 marks
Semester and Examination - 35 marks

ICI HCP- 4.6 Industrial Chemistry Practicals

a. Preparation and Spectral analysis of few complexes and organic compounds (UV- Visible, IR).
b. Interpretation of Spectral data (NMR,& Mass)

Code : **ICI HCP: 4.7** Univ Code :407
Contact Hours : 64 Work load : 4 hours per week
Credit Points : 4
Evaluation: Continuous Internal Assessment - 30 marks
Semester and Examination - 70 marks

ICI HCP: 4.7-PROJECT WORK/ IN-PLANT TRAINING
