VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI

INDUSTRIAL CHEMISTRY (PG)

(2022-23)

Approved by BOS on (DD/MM/YYYY)

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VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) for PG Programs

With Practicals

I-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FIRST	DSC1	21ICH1C1L	**Concepts in Inorganic chemistry**	30	70	100	4	-	-	4	3
	DSC2	21 ICH 1C2L	**Theoretical Organic chemistry**	30	70	100	4	-	-	4	3
	DSC3	21 ICH 1C3L	**Thermodynamics, Chemical kinetics and Electrochemistry**	30	70	100	4	-	-	4	3
	DSC4	21 ICH 1C4L	**Analytical Chemistry**	30	70	100	4	-	-	4	3
	SEC1	211CH1S1 LP	**Computational Chemistry**	20	30	50	P-4			2	2
	DSC1P	21 ICH 1C1P	**Inorganic Chemistry Practicals**	20	30	50	-	-	4	2	4
	DSC2P	21 ICH 1C2P	**Organic Chemistry Practicals**	20	30	50	-	-	4	2	4
	DSC4P	21 ICH 1C3P	**Analytical Chemistry Practicals**	20	30	50	-	P-4		2	4/2
Total Marks for I Semester						**600**				**24**	

II-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
SECOND	DSC5	21 ICH 2C5L	**Coordination Chemistry**	30	70	100	4	-	-	4	3
	DSC6	21 ICH 2C6L	Chemistry of Natural products, Reagents in Organic synthesis and Heterocyclic Compounds	30	70	100	4	-	-	4	3
	DSC7	21 ICH 2C7L	**Electro and Photochemistry**	30	70	100	4	-	-	4	3
	DSC8	21 ICH 2C8L	**Instrumental methods of analysis**	30	70	100	4	-	-	4	3
	SEC2	21 ICH 2S2 P	Research Methodology	20	30	50	L-1 & P-2/			2	2
	DSC 5P	21ICH 2C4P	**Synthesis of Coordination compounds**	20	30	50	-	-	4	2	4
	DSC6P	21ICH 2C5P	**Organic synthesis**	20	30	50	-	-	4	2	4
	DSC8P	21ICH 2C6P	**Instrumental methods of analysis**	20	30	50	-	P-4		2	4/2
Total Marks for II Semester						**600**				**24**	

III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
THIRD	DSC9	21 ICH 3C9L	**Spectroscopy**	30	70	100	4	-	-	4	3
	DSC10	21 ICH3C10L	**Unit Operations**	30	70	100	4	-	-	4	3
	DSE1	21 ICH 3E1L	**DSE 1/1 : Polymer Chemistry** **DSE 1/2 Water Management in Industries** **DSE 1/3 : Quality control and environment, health and safety measures**	30	70	100	4	-	-	4	3
	DSE2	21 ICH 3E2L	**DSE 2/1 : Industrial materials** DSE 2/2 : Industrial Management and Pollution monitoring and control DSE 2/3 : Chemical Analysis in Agro, Food and Pharmaceutical Industries	30	70	100	4	-	-	4	3
	GEC1	21 ICH 3G1L	**GEC 1/1 : Green chemistry** **GEC 1/2 : Bio Inorganic Chemistry** **GEC 1/3 : Adsorption and Surface Phenomena**	15	35	50	2	-	-	2	2
	SEC3	21 ICH 3S3 LP	**Instrumental methods of Analysis (1L + 1P)**	20	30	50	L-1 & P-2/			2	2
	DSC9P	21 ICH 3C7P	Interpretation of Spectra of the compounds	20	30	50	-	-	4	2	4
	DSE2/1P	21 ICH 3C8P	Analysis of Industrial Materials	20	30	50	-	-	4	2	4
Total Marks for III Semester						**600**				**24**	

IV-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	21 ICH 4C11L	**Inorganic Industrial materials**	30	70	100	4	-	-	4	3
	DSC12	21 ICH 4C12L	**Unit Processes**	30	70	100	4	-	-	4	3
	DSE3	21 ICH 4E3L	**DSE 3/1:Pharmaceutical Industrial Chemistry** **DSE 3/2 : Advanced Topics in Chemistry** **DSE 3/3 : Manufacturing of Common Materials**	30	70	100	4	-	-	4	3
	DSE4	21 ICH 4E4L	**DSE 4/1 : Environmental Impact Assessment** **DSE 4/2 : Food Industry and Agrochemicals** **DSE 4/3 : Chemistry in Biology**	30	70	100	4	-	-	4	3
	GEC2	21 ICH 4G2L	**GEC 2/1 : Water Harvesting and Renewable Energy Sources** **GEC 2/2 : Basics of Chemistry** **GEC 2/3 : Impact of Chemical Fertilizers and Pesticides on Agriculture**	15	35	50	2	-	-	2	2
	DSC11P	21 ICH 4C9P	Analysis of Inorganic Materials	20	30	50	-	-	4	2	4
	Project	21 ICH 4C1R	Research Project /In-Plant Training	40	60	100		-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester) **Total Marks: 2400** **Total credits: 96**

Note: Course = paper; L= Lecture; T= Tutorial; P=Practical; DSC= Discipline Specific Core Course; DSE= Discipline Specific Elective; SEC= Skill Enhancement Course; GEC1 = General Elective Course to be taken from within Faculty from other department, GEC2= General Elective Course to be taken outside Faculty.

A credit is a unit of study of a fixed duration. For the purpose of computation of workload as per UGC norms the following is mechanism be adopted in the university:One credit (01) = One Theory Lecture (L) period of one hour; One credit (01) = One Tutorial (T) period of one hour; One credit (01) = One practical (P) period of two hours.

A Tutorial is supplementary practice to any teaching –learning process that may consist of participatory discussion/self study,desk work, seminar presentations by students and such other novel methods that help a student to absorb and assimilate more effectively the contents delivered in the Lecture Sessions/ Class, Seminars, Case study, Discussion Session etc.

Subject Code Description:

21 – Year of Establishment
ICH – Program Code
1/2/3/4 – Semester
C1/S1/G1/E1 – Course subject 1/SEC1/GEC1/DSE1
L –Lecture
T – Tutorial
P –Practical
R – Research Project

Title of the Program: M.Sc. Industrial Chemistry

I SEMESTER

DSC1: Concepts in Inorganic chemistry

Course Code: 21ICH1C1L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam: 70 Marks**

Course objective: The objective of this course is to refresh the chemistry knowledge learnt in earlier programs and to introduce advanced concepts on related topics.

Course Outcomes: After the completion of this course, the student would be able to;

1. Relate the quantum numbers and atomic orbitals and their shapes.
2. Evaluate and relate the periodic properties of elements based on electronic configuration.
3. Explain selected crystal structures and the parameters that affect the crystal structure of a compound and perform calculations of the lattice enthalpy of ionic compounds.
4. Differentiate bonding in metals from their compounds..
5. Explain the definitions of acids / bases based on different theories and predict the reactions between acids and bases.
6. Identify the difference between a coordination and organometallic compound based on the nature of bonding and chemical properties.
7. Explain different types of reactions of organometallic compounds with their mechanisms.

Course outlines

Unit I : Review of periodic properties and theories of Bonding

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

Ionic Bond: Radius ratio rules, types and structures of simple ionic compounds, lattice energy, Born-Lande equation, Kapustinskii equation, Size effects, polarizing power and polarizability of ions, Fajan's rules, solubility of ionic solids and hydration energy.

Covalent Bond and Metallic Bond: VSEPR theory shapes of molecules-ClF_3, ICl_4^-, TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6, $SbCl_6^{3-}$, IF_7, XeF_8^{2-}, TaF_8^{3-};

Concepts of hybridization, Energetics of hybridization, Bent rules and 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. Hydrogen Bonding

[13 hrs]

UNIT II: Band theory of Solids

Semiconductors – Bonding and conductivity, mechanism of conductivity, energy bands in semi-conductors, impurity conductors, p-n and n-p-n junctions. Importance of semiconductors. Super

conductors – occurrence of super conductivity, its destruction by magnetic fields, effect of IR and isotope effect, BCS theory of super conductivity, applications.
Defects in solids – Frenkel and Schotky defects and chemical reaction of solids.

[10 hrs]

Unit III : Concepts of Acids and Bases

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, N2O4, super acids and molten salts. HSAB-classification & strength of hardness and softness. Irving-William's series. Theoretical bases of hardness and softness. **[10 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 and bonding in alkyls of Li, Mg, & Al.
Transition Metal alkyls (synthesis and stability), Synthesis structure and bonding in metal olefins, carbonyls, nitrosyls, carbenes and metallocenes. Isobolality and Fluxionality

[10 hrs]

Unit V : Reactions and Catalytic applications of Organometallic Compounds

Fundamental reactions: Substitution in carbonyl complexes, Mechanisms, Insertion reactions, CO, SO_2, olefin insertions, oxidative additions, one electron, addition of oxygen, reductive elimination, CH activation, Use of Organometallic Compounds as catalysts – Catalytic behaviour – Homo catalysis –. Anchoring of Catalysts
Hydrogenation. Hydrogenation of olefins (oxo reaction-cobalt and rhodium oxo catalysts), carbonylation of alcohols – Monsanto acetic acid process, Wacker process.
Polymerization of olefins and acetylenes: Ziegler – Natta catalysis systems.
Fischer – Tropsch reaction, Water Gas Shift reactions.

[10 hrs]

References:

1. J. E. Huheey, E. A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, Pearson Education, 2004.
2. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, John Wiley & Sons, Inc., New York, 2009.
3. J. D. Lee, *Concise Inorganic Chemistry*, Blackwell Science, Oxford, 2000.
4. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, *Shriver & Atkins:Inorganic Chemistry*, Fourth edition, Oxford University Press, Oxford, 2000.
5. F. A. Carey G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, Wiley Interscience, 2003.
6. C. E. Housecroft and A. G. Sharpe, *Inorganic Chemistry*, Prentice Hall, 2005
7. Chemistry of Elements – N.N. Greenwood and A.Earnshaw, Pergaman (2000).
8. Inorganic Chemistry – 2nd edition, C.E Housecraft and A.G Sharpe, Pearson Education Ltd. (2005).

9. Inorganic Chemistry – 2nd edition, D.F Shriver, P.W.Atkins and C.H.Langtore Oxford University Press (1994).
10. Concepts and Models of Inorganic Chemistry – 3rd edition, B.E Douglas, D.H. Mc Daniel and Alexander, Wiley (2001)

DSC 2: Theoretical Organic chemistry

Course Code: 21ICH1C2L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam: 70 Marks**

Course objective: The objective ofthis course is to make the students to be acquainted with new concepts and topics in organic chemistry.

Course Outcomes: After the completion of this course, the student would be able to;

1. Explain the importance of resonance concept amongst organic compounds and depict the resonating structures.
2. Figure out the differences among antiaromaticity, nonaromaticity and homoaromaticity.
3. Explain hypercojugation and tautomerism.
4. Classify molecules as chiral or achiral; identify chiral carbons as (R) or (S),
5. Identify relationships between pairs of molecules as enantiomers, diastereomers, or equivalent, and identify when a solution is racemic versus optically active.
6. Recognize and classify fundamental organic reactions such as SN^1, SN^2, E2, E1, alkene addition, electrophilic aromatic substitution, 1,2/1,4-additions, ring-opening, and radical halogenation.
7. Write logical and detailed mechanisms for various fundamental reactions of alkanes, halocarbons, alkenes, dienes, and arenes.

Course outlines

Unit I: Concept of Resonance and Aromaticity

Concept of resonance, Delocalized chemical bonding: Conjugation, cross conjugation,.
Aromaticity. Huckel's rule of aromaticity.Aromatic systems with electron numbers other than six (including azulene, tropone, tropolone and annulenes). Antiaromaticity. Aromaticity in benzenoids, meso-ionic compounds. Nonaromaticity of organic systems (3-7 membered rings & ring ions). Homo-aromaticity. Alternant and nonalternant hydrocarbons, Energy levels in odd and even-alternant hydrocarbons, energy levels for the benzyl cation, benzyl free radical and benzyl carbanion. Hyperconjugation. Tautomerism **[11 hrs]**

Unit II: Stereochemistry of Organic compounds

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 isomers, 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.

[11 hrs]

Unit III: Reaction mechanisms, and Reaction intermediates

Generation, structure, stability and reactivity of carbocations, carbanions, carbon free radicals,carbenes and nitrenes.
Classification of reactions and mechanisms. Thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates.
Methods of determining mechanisms: Based on the structure of products, determination of the presence of intermediates, isotopic labeling, isotope effects, from stereochemical evidence.
Effect of structure on reactivity:- Resonance and field effects; steric effects. Nucleophilic substitution reaction at a saturated carbon: SN^1, SN^2, and SET mechanisms. Effect of substrate structure, attacking nucleophile, leaving group.Ambident nucleophiles and substrates

[11 hrs]

Unit IV: Named Reactions

1 Acetoacetic ester synthesis 2 Aldol condensation 3 Alkene metathesis 4 Bayer-Villiger oxidation 5 Birch reduction 6 Claisen condensation 7 Claisen rearrangement 8 Clemmensen reduction 9 Cope rearrangement 10 Dieckmann condensation 11 Diels-Alder reaction 12 Friedel-Crafts reaction 13 Gabriel synthesis 14 Grignard reaction 15 Heck coupling 16 Hydroboration reaction 17 Malonic ester synthesis 18 Mannich reaction 19 Michael addition 20 Ozonolysis 21 Sharpless Dihydroxylation 22 Sharpless Epoxidation 23 Simmons-Smith reaction 24 Sonogashira coupling 25 Stille coupling 26 Strecker synthesis of amino acids 27 Suzuki coupling 28 Wadsworth-Emmons reaction 29 Williamson ether synthesis 30 Wittig reaction

[11 hrs]

Unit V: 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.

[11 hrs]

References:

1. F. A. Carey and R. A. Sundberg, Advanced Organic Chemistry, Part A: Structure and Mechanisms, Fifth edition, Springer, New York, 2007
2. T. H. Lowry and K. S. Richardson, Mechanism and Theory in Organic Chemistry, Second edition, Harper & Row, New York, 1981

3. N. S. Isaacs, Physical Organic Chemistry, ELBS, Longman, UK, 1987.
4. D. Nasipuri, Stereochemistry of Organic Compounds. Principles and Applications, Second edition, Wiley Eastern Limited, New Delhi, 1994.
5. D. G. Morris, Stereochemistry, RSC Tutorial Chemistry Text 1, 2001
6. E. L. Eliel and S. H. Wilen, Stereochemistry of Organic Compounds, John Wiley & Sons, New York, 1994.
7. P. Sykes, Advanced Organic Chemistry; Reaction Mechanisms**,** Longman and Scientific Technical, New York, 1985
8. R. Brukner,Advanced Organic Chemistry, Reaction Mechanisms, Academic Press, 2002.
9. R. O. C. Norman and J.M. Coxon, Principles of Organic Synthesis, CRC Press, UK, 1993.
10. J. M. Berg, J. L. Tymoczko and L. Stryer, Principles of Biochemistry, 6th edition, W.H. Freeman & Co, 2006.
11. D. L. Nelson and M. M. Cox. Lehninger Principles of Biochemistry, 5th edition, W.H. Freeman & Co, 2008.
12. R. K. Murray, D. K. Granner, P. A. Mayes and V. W. Rodwell, Eds. Harper's Illustrated Biochemistry 26th edition, McGraw Hill, 2003

DSC 3: Advanced Physical Chemistry

Course Code: 21ICH1C3L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course Objective: The objective of studying advanced physical chemistry in the first semester of postgraduate programme is to give a essential knowledge of physical chemistry to the students with respect to chemical thermodynamics, reactions in solutions, chemical kinetics, catalysis, electrochemistry and phase rule.

Course outcomes; at the end of the advanced physical chemistry course, student should be able to

1. Solve the problems related to laws of thermodynamics.
2. Illustrate the partial molar quantities and free energy change in the mixing of two solutions and chemical potential.
3. Predict the effect of substituents, salt and solvent on reaction rates.
4. Recognize the cause and consequences of electrical double layer
5. Predict the energetics of cell reactions
6. Construct a phase diagram for three-component system.

Course outlines

Unit I: Chemical Thermodynamics

A brief resume of laws of thermodynamics (combined form of 1^{st} and 2^{nd} 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 Heat 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. **[12 hrs]**

Unit II: Chemical Kinetics

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: Substituent effects on the rates of reactions, linear free energy relationships - Hammett and Taft equations.

[15 hrs]

Unit III: Electrochemistry

Electrochemistryof 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. 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)

[10 hrs]

Unit IV: 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.

[10 Hours]

Unit V: Phase Equilibria

Introduction and definitions, derivation of phase rule, one component system, two component system, the Nernst distribution law, solid- liquid systems-condensed systems, Alloys, three component systems **[07 Hours]**

References:

1. An Introduction to Electrochemistry, S. Glasstone, Van Nostrand, East-West 1965.
2. Modern Electrochemistry, Vol. I and II, 2nd Edition, J. O'M Bockris and A. K. N. Reddy, Plenum, 1977.
3. Electrolytic Solutions, R. A. Robinson and R. H. Stokes, Butterworths, London, 1959.
4. Physical Chemistry, P. W. Atkins, ELBS, 1986.
5. Physical Chemistry, 4 th Edition, Silbey, Alberty, Bawendi, Wiley, India, 2007.
6. Chemical Kinetics, 2nd Edition, K. J. Laidler, TMH.
7. Kinetics and Mechanism, 2nd Edition, A. A. Frost and R. G. Pearson.
8. Physical Chemistry, P. W. Atkins, ELBS, 3rd Edition, 1986.
9. Physical Chemistry, G. M. Barrow, 5th Edition, 2007.
10. Basic Physical Chemistry by W. J. Moore, Prentice Hall, 1986.

DSC4: Analytical Chemistry

Course Code: 21ICH1C4L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: The objective ofthis course is to make the students to get familiarized with various analytical techniques and their importance in all the fields of chemistry.

Course outcomes: After the completion of this course, the student would be able to ;

1. Explain the fundamentals of analytical chemistry and differentiate between qualitative and quantitative analyses.
2. Evaluate the analytical data in terms of statistics.
3. Estimate the sources and types errors in chemical analysis.
4. Explain the terms such as standard solution, titration, back titration, equivalence point, end point, primary and secondary standard and can carry out the calculations
5. Select suitable gravimetric analysis method for determining the quantity of the substance.
6. Compare the efficacy of solvent extraction and chromatographic methods for adopting suitable method for separation.
7. Describe TGA, DTA and DSC, their principles and applications.

Course outlines

Unit I: Sampling, Errors, and statistical analysis

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 **[11 Hours]**

Unit II: Titrimetry and Gravimetry

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

[13 Hours]

UNIT III: Characteriztion of Electromagnetic radiations,Colorimetry and Spectrophotometry

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.

Colorimetry and Spectrometry :

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,

Turbidimetry and Nephelometry
Tyndall, Rayleigh and Raman Scattering - Principles, Instrumentation and Applications of Turbidimetry and Nephelometry **[10 Hours]**

Unit IV: 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.
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
Paper and thin layer Chromatography:
General principles and classification of chromatographic methods-paper, thin layer, column and liquid chromatography.

[10 Hours]

Unit V: Thermal Methods of Analysis

Thermo Gravimetric Analysis:
Introduction, thermo gravimetric analysis(TGA) – types of thermo gravimetric analysis, principles, factors affecting the results – heating rate, thermobalance, 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.

[10 Hours]

References:

1. Vogel's Text book of Quantitative Chemical Analysis, J. Bassett, G. H. Jeffery and J.Mendham, Pearson, 7th edition, (2009).
2. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co.(1974).
3. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co.,London (1972).
4. Principles of Instrumental Analysis - Skoog, Holler, Nieman, 5th ed., Harcourt CollegePublishers, 1998.
5. Analytical Chemistry – Gary D. Christian, 6th ed., John Wiley and sons. Inc., New York1994.

6. Instrumental methods of Analysis - Willard, Merit, Dean, 6th ed., CBS Publishers &distributors, 1986.
7. Hand Book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle,Prentice Hall, New Jersey, USA, 1997.
8. Principles and practice of Analytical Chemistry, F.W.Fifield & D Kealey, 5th Ed.Blackwell Science, 2000.
9. Quantitative Chemical Analysis, Daniel C. Harris, 6th Ed. WH Freeman & Co. NewYork,2003.
10. Analytical Chemistry An Introduction, Crouch, 7th Ed. Saunders CollegePublishing,2000.
11. Organic Analytical Chemistry theory and practice, Jag Mohan, Narosa Publications,2003.

SEC-1 Computational Chemistry

Course code: 211CH1S1 LP **No: Credits :02**

Internal Assessments: 20 Marks **Semester end examination: 30 Marks**

Teaching Hours/Week (L-T-P): 1-0-2

Course Objective:
The Goal of this course is to cover the fundamental mathematical approaches utilized by chemists in Industries

Course out comes: After the completion of the course students will be able to

1. Address complex issues in chemical kinetics and adsorption material characteristics
2. Able to use computational tools

Course outlines:

Unit 1: Introduction to mathematics for Chemists with MATLAB

Theory: 1. Chemists in industries.- an intro to what computational skills are relevant in industries

2. Introduction to vectors and Matrix calculation

3.Introduction to calculus for chemists 07Hours

Practicals: 1. Introduction to MATLAB-Matrics Calculation with Matlab

3. Symbolic calculation with MATLAB
4. Symbolic integration and differentiation
5. Data analysis using MATLAB(working with potentiometric data

14 Hours

UNIT 2: Analysis of Chemical Reaction Kinetics

Theory: 1. Analysis of effects of process parameters on Chemical Kinetics

1. Introduction to adsorption-equilibrium models, BET surface area analysis.
2. Reaction Kinetics with heterogeneous catalysis 07 Hours

Practicals: 1. Analysis of fundamental chemical kinetics-1st , 2nd and 3rd order reactions

2. Effect of feed concentration ratio and temperature on yield of series parallel reactions

3. Computing adsorption isotherm from experimental data

4.Calculating the adsorption BET surface area from adsorption-desorption data

5. Case study: Effect of rate of adsorption and rate of surface reaction on overall reaction rate in heterogeneous catalysis **14 Hours**

DSC 1P: Inorganic Chemistry Practicals

Course Code: 21ICH1C1P **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam :30 Marks**

Course Objective: The objective ofthis course is to make the students to understand and perform both qualitative and quantitative analytical techniques for detection and determination.
Course Outcomes: After the completion of this course, the student would be able to ;

1. Explain the systematic methodology used in qualitative analysis of inorganic substances and implement the same wherever required.
2. Carryout the preparation of standard solutions accurately to minimise errors.
3. Enhance the skill to do titrations and identify the end point accurately.
4. Determine the quantity of unknown substances accurately.

EXPERIMENTS

1. Semi-micro qualitative Analysis:

Semi-micro qualitative Analysis of Inorganic mixture containing 2 anions (one interfering anion) and 2 cations
(one rare cation). Minimum number of mixtures to be analysed – 5

2. Quantitative Inorganic Analysis: Titrimetry

i. Determination of calcium using $KMnO_4$
ii. Determination of copper using KIO_3
iii. Determination of Iron using ceric ammonium sulphate
iv. Determination of Aluminium using EDTA

3. Quantitative Inorganic Analysis: Gravimetry

i. Determination of sulphate as Barium sulphate.

ii. Determination of Nickel as NiDMG.

Suggested Books:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J.Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co.(1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co.,London (1972).

DSC 2P: Organic Chemistry Practicals

Course Code: 21ICH1C2P **Course Credits: 02**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 20 Marks **End semester exam: 30 Marks**

Course objective: The objective ofthis course is to make the students to understand and perform quantitative analysis of different organic compounds

Course Outcomes: After the completion of this course, the student would be able to ;

1. Analyse amino acid content in different pharmaceutical samples
2. Estimate saponification and iodine values of oil samples.
3. Determine phenol content in different samples.
4. Find out glucose content in a given sample.

EXPERIMENTS

1. Quantitative analysis

i. Titrimetric estimation of amino acids.

ii. Saponification value of oil.

iii. Estimation of glucose by Fehling's method.

iv. Estimation of keto group.

v. Estimation of phenols.

vi. Iodine value of oil (chloramine-T method).

2. Qualitative analysis

i. Systematic analysis and identification of organic compounds

References

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T RGovindachari, Allied Publishers, New Delhi, (1996).
2. Practical Organic Chemistry – Mann and Saunders, (1980).
3. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996).
4. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).
5. A Handbook of Organic Analysis – Clarke and Hayes, (1964).
6. Comprehensive practical organic chemistry : Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
7. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S.Dhingra, Universities Press (India), 2000.
8. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.
9. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
10. Practical organic chemistry (Quantitative analysis), B. B. Dey, M. V. Sitaraman and T. R. Govindachari, Allied Publishers, New Delhi, 1992.

DSC 3P: Analytical Chemistry Practicals

Course Code: 21ICH1C2P **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam :30 Marks**

Course learning objectives:

In the first semester laboratory, students will gain the hands on skill of handling the P^H meter, potentiometer, skill on preparation of solutions with known concentrations. conductometer. complementary to the learning objective of discipline specific course, student should carry out the experiments related to determination of rate constants, energy of activation and adsorption phenomenon

Course learning outcome:

At the end of the practical physical chemistry course, student should acquire a skill to;

1. Read the proper end points in titrations.
2. Plot the graphs of potentiometric behaviour of redox titration
3. Reproduce the value of rate constants
4. Predict the energy of activation
5. Verify the Raoults law on colligative properties
6. Observe the change in the P^H and conductance behaviour of the reaction

Experiments

1. Determination of molal boiling point elevation constant of water using (1) NaCl (2) Urea and (3)Oxalic acid as solutes
2. p^H titration of HCl with NaOH
3. Determination of Equivalent Conductance at infinite dilution of a strong electrolyte
4. Determination of pK_{a1} and pK_{a2} of Oxalic acid by P^H titration
5. Conductometric titration of a mixture of strong and weak acid with strong base
6. Estimation of Iron using Potassium dichromate by potentiometric titration
7. Kinetics of hydrolysis of ester using HCl and H_2SO_4 at two different temperatures and determination of rate constants and energy of activation
8. Study of kinetic reactions between K2S2O8 and KI determination of rate constants and energy of activation
9. Conductometric titration of a mixture of H_2SO_4, acetic acid and cupper sulphate penta hydrate using a strong base
10. Phase diagram of three component system. Acetic acid, Benzene and water
11. Adsorption of acetic acid on Charcoal
12. Adsorption of oxalic acid on charcoal

References

1. Findlays Practical physical chemisty revised by P. B. Levitt, Longman's London (1966).
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill International Edn. (1966)
3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
5. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
6. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
7. Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press, NewYork (1962)
8. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi(1983)
9. Experimental Physical Chemistry by V. D. Atavale and Parul Mathur, New Age International,New York (2001)
10. Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow,S. R. Cohen and M. E. Green Macmillan publishing Co .New York.
11. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan Publishers Delhi (2006).

II SEMESTER

DSC 5: Coordination Chemistry

Course Code: 21ICH2C5L **Course Credits: 04**
Total Contact hours: 58 **4Hours/week**
Internal assessments: 30 Marks **End semester Marks: 70**

Course Objective: The objective of this course is to prepare the students to get acquainted with horough knowledge in coordination chemistry and bioinorganic chemistry. The students will also get information about the usefulness of nuclear chemistry in various fields.

Course Outcomes: At the end of the course the student would be able to,

1. Describe the bonding in transition metal complexes using crystal field, ligand field theories and the 18 electron rule.
2. Describe various metal-ligand interactions in terms of sigma- and pi-bonding interactions.
3. Explain magnetic susceptibility and its importance in predicting the geometry of the complexes..
4. Characterize the complexes using Orgel and TS diagrams.
5. Compare the penetrating power of alpha, beta, neutron, and gamma radiation.
6. Understand and calculate the mass defect for a nuclear reaction use Einstein's relation, $E = (\Delta m)c^{2.}$.
7. Explain the analytical applications and the biological effects of radiation:

Course outlines

Unit I: Bonding in Metal complexes

Metal-Ligand Bonding:

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 planar fields 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 coordination compounds involving σ and π bonding. **[13 hours]**

Unit II: Magnetic and Spectral Properties of Coordination Compounds

Magnetic properties of coordination compounds-Types of magnetic behaviour, magnetic susceptibility and its determination- Gouy, Faraday, VSM method. Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro- and antiferromagnetic coupling, spincrossover.

Magnetic properties of Lanthanide and Actinide metal complexes.

Electronic spectra of coordination compounds-Spectroscopic ground states, selection rules, term symbols for d^n ions, Racah parameters, Orgel, Correlation and Tanaube-Sugano diagrams,

spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $[CoCl_4]^{2-}$ calculation of Dq, B and β parameters, CT spectra.
Spectral properties of Lanthanide and Actinide metal complexes.

[13 hours]

Unit III: Reaction mechanism of Transition Metal Complexes

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,.
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**.** **[10 hours]**

Unit IV: Bio-inorganic Chemistry

Metal Ions in Biological Systems Essential and types metals
Na+/K+ transport across cell membranes, ionophores, crown ethers, Na+/K+ pump. Iron storage and transfer- ferritin, transferrin and siderophores.
Oxygen transport and oxygen uptake proteins- transport and storage of dioxygen; Heme proteins and oxygen uptake, structure and functions of haemoglobin and myoglobin, dioxygen binding,
Bohr effect, Hill equation, role of distal and proximal histidine; Model complexes for dioxygen binding, non- porphyrin systems- hemerythrin and hemocyanin.
Photosynthesis and nitrogen fixation: Nitrogenase: structural aspects and functions, abiological nitrogen fixation. Photosynthesis: Chlorophyll- structural features, role of Mg2+- Z scheme of photosynthesis-PSI and PSII

[10 hours]

Unit V: Nuclear Chemistry

Nuclear Stability – Mass Defect and Binding Energy..
Radioactivity: Radioactive elements, general characteristics of radioactive decay, interaction of α, β and γ – rays with matter. Nuclear reactions Types of nuclear reactions, Nuclear fission
Applications of Radioactivity: Synthesis of various useful isotopes, use of isotopes in the elucidation of reaction mechanism, structure determination, kinetics of exchange reactions, measurement of physical constants including the diffusion constants, isotope dilution techniques, NAA, PGNAA, neutron absoptiometry and age determination, radio isotopes in field of medicine

[12 hours]

References:

1. J. E. Huheey, E. A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, Pearson Education, 2004.

2. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, John Wiley & Sons, Inc., New York, 2009.
3. J. D. Lee, *Concise Inorganic Chemistry*, Blackwell Science, Oxford, 2000.
4. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, *Shriver & Atkins:Inorganic Chemistry*, Fourth edition, Oxford University Press, Oxford, 2000.
5. F. A. Carey G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, Wiley Interscience, 2003. 11
6. C. E. Housecroft and A. G. Sharpe, *Inorganic Chemistry*, Prentice Hall, 2005.
7. R. M. Roat-Malone, *Bioinorganic Chemistry – A Short Course*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.
8. S. J. Lippard, and J. M. Berg, *Principles of Bioinorganic Chemistry*, Univ. Science Books, 1994.
9. W. Kaim and B. Schwederski, *Bioinorganic chemistry: Inorganic Elements in the Chemistry of Life – An Introduction and Guide*, John Wiley & Sons, 1994.
10. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1stEdn.
11. G. Choppin, J. Rydberg and J. O. Liljenzin, Radiochemistry and Nuclear Chemistry, Butterworth-Heinemann, 3rd Edition, 2002.
12. W. D. Loveland, D. Morrissey and G. T. Seaborg, Modern Nuclear Chemistry, John Wiley & Sons, 2006.
13. Irving Kaplan, Nuclear Physics 2nd Edition Addison-Wesley Publishing Company
14. Inorganic Electronic spectroscopy, A. B. P. Lever, Elsevier. (1968).
15. Magnetochemistry, R.L. Carlin, Springer Verlag.
16. Electronic Absorption Spectroscopy and related Techniques, D. N. Sathyanarayana, University Press (2001).
17. Inorganic Chemistry A Unified Approach by W. W. Porterfield, Elsevier 2005 2nd edition.

DSC 6: Chemistry of Natural products, Reagents in Organic synthesis and Heterocyclic compounds

Course Code: 21ICH2C6L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course Objective: The objective of this course is to make the students to acquire important information regarding various organic compounds in nature which are part of our daily lives. Also, this course would impart knowledge about importance of heterocyclic compounds. Various reagents used in organic synthesis and applications of photochemistry to it.

Course Outcomes: At the end of the course the student would be able to,

1. Explain different types of alkaloids, glycosides & terpenes and their chemistry
2. Identify the structure of aminoacids
3. Classify proteins with functionsillustrating the structures.
4. Describe the structure and functions of RNA and DNA
5. Describe the classification of heterocyclic compounds according to their different types Showing the multiple methods of preparation of heterocyclic compounds

6. Recognize the chemical properties of heterocyclic compounds and their reaction mechanisms.
7. Demonstrate an understanding of excited states and apply group theory to photochemical problems

Course outlines

Unit I: 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, ergo sterol-structure and synthesis

[11 Hours]

Unit II : Carbohydrates, Proteins and Nucleic acids

Carbohydrates-Determination of ring structures of monosaccharide 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.

[11 Hours]

Unit III : Heterocyclic Compounds

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

[11 Hours]

Unit IV: Reagents in Organic synthesis and their uses

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

[12 hours]

UNIT V: Organic Photochemistry

Concepts in Organic photochemistry- forbidden transitions, excited states, types of excitations, Frank-Condon principle. Chemical processes in excited molecules, hydrogen abstraction, cleavage of radicals, intra-molecular rearrangements, photo-isomerisation, photo-dimerisation and photo-sensitisation. Determination of reaction mechanisms. Photochemistry of Alkenes, Carbonyls and Aromatic compounds. Miscellaneous photochemical reactions.

[11 hours]

References:

1. Natural Products Vol.I & II by O.P. Agarwal Goel publications – Meerut.
2. Burger's Medicinal Chemistry, M.E. – Wolff, Ed., John Wiley & Sons, New York
3. Chemistry of Natural Products, 1st Edition, S. V. Bhat, B. A. Nagasampagi and M. Sivakumar, 2008, Narosa Publishing House
4. Organic Chemistry, Vol.II by I.L. Finar, The English Language Book Society, London
5. Organic Chemistry-P.Y.Bruice (Pearson Education Pvt. Ltd., New Delhi),2002.
6. Organic Chemistry-Vol. -1,2&3- Mukherji, Singh and Kapoor. (Wiley Eastern,) 1994.
7. Organic Chemistry-3rd Edn- F.A. Carey (Tata McGraw Hill, New Delhi) 1996
8. Organic Chemistry-R.T. Morrison and R.N. Boyd (Prentice Hall, New Delhi) 1994.
9. Organic Chemistry 4th Edn.–S.H. Pine et al (McGraw-Hill, London) 1987.
10. Advanced Organic Chemistry- R.A. Carey and R.J. Sundberg (Plenum, New York)1990.
11. Modern Concepts of Advanced Organic Chemistry-R.P. Narein (Vikas, Delhi) 1997.
12. A Text book of Organic Chemistry-Tewari, Vishnoi and Mehrotra (Vikas, New Delhi)1998.
13. A Text book of Organic Chemistry-3rd Edn.-R.K. Bansal, (New Age, New Delhi) 1997.
14. R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Interscience NY
15. Chemistry of Natural Products: A Unified Approach, N.R. Krishnaswamy, University Press (India) Ltd., Orient Longman Limited, Hyderabad, 1999. (Overall and for certain aspects of, azadirachtin, morphine, reserpine,).
16. Introduction to Organic Chemistry, A Streitweiser, CH Heathcock and E.M/ Kosover IV Eeition, Me.Milan, 1992
17. Molecular reactions and Photochemistry by Charles Dupey and O. Chapman, Prentice Hall

DSC 7: Electro, Quantum and Photochemistry

Course Code: 21ICH2C7L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course Objective: A study of physical chemistry aspects related to the electrochemistry, quantum chemistry and photochemistry in the second semester should give the essential information on the topics of reversible and irreversible electrode process, electro analytical techniques, aspects on quantum chemistry, photochemistry, symmetry and group theory.

Course outcomes:

At the end of the advanced physical chemistry course, student should be able to

1. Differentiate between reversible and irreversible electrochemical process.
2. List the types of overvoltage and determine the overvoltage
3. Explain the theory and principles of polarography
4. Predict entropy of translational function.
5. Understand the statistical theories of thermodynamics
6. Demonstrate symmetry operations

Course outlines

Unit I: Electrokinetic Phenomena

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 **[12 Hours]**

Unit II : 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_3CHO, 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

[10 Hours]

Unit III: Quantum Chemistry

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 hours]

Unit lV: Statistical Thermodynamics-II

Sackur-Tetrode equation for entropy of translation function. Relation between equilibriumconstant and partition function.
Different Distribution Laws:Types of Statistics : Maxwell – Boltzmann , Bose-Einstein andFermi-Dirac statistics. Derivation of the equations for above three distribution Laws.Comparision of Bose-Einstein and Fermi-Dirac statistics with Maxwell – Boltzmann statistics.Problems and their Solutions.
Non-equillbrium Thermodynamics:
Thermodynamic criteria for non-equillibrium states-Phenomenological Laws and Onsager'sreciprocity relations, Coupled and Non-coupled reactions, Entropy production and entropy flow.Postulates and methodologies: Uncompensated heat and thermodynamics function production. de-Donder's inequality. Rate of entropy production. Transformations of the generalized fluxes andforces : eg., Chemical reaction, heat flow, Diffusion or material flow, flow of electric current. **[11 hours]**

Unit V: Symmetry and Group Theory

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 [**11 hours]**

References:

1. Modern Electrochemistry, Vol I, IIA & IIB J.O.M. Bockries and A.K.N.Reddy(1998)
2. Electrochemistry,, Samuel Glasstone, East-West, New Delhi
3. Principles & Applications of Electrochemistry, D R Crow, 3rd Edn., Chapman & Hall,1987
4. Photochemistry, Carol E Wayne and Richard P Wayne, Oxford University Press, (1996)
5. Molecular Reactions and Photochemistry, C H Deputy and D S Chapman, Prentice Hall India, New Delhi (1st Edition) , 1972.
6. Concepts of Inorganic photochemistry, A. W. Adamson and P D Fleischaves Wiley

7. Quantum Chemistry, Ira N. Levine, 5th Edn., Prentice Hall of India Pvt. Ltd., 2006
8. Quantum Chemistry, A. B. Sannigrahi, 2nd Edn., Arunabha Sen Books and Allied Pvt. Ltd.,
1. 2010
9. Molecular Quantum Mechanics, P. W. Atkins, , Oxford University Press, New York, 2005.
10. Quantum Chemistry, Donald A McQuanie, Viva Books Pvt. Ltd., 2013
11. Thermodynamics for Chemists, S Glasstone, East-west Editon, New Delhi, 2003.
12. Chemical Thermodynamics-Basic Theory and Methods, 4th Edn., Klotz, Rosenbeg, Benjamin,1986
13. F. A. Cotton, *Chemical Applications of Group Theory*, Wiley Interscience, New York,2006.
14. P. H. Walton, *Beginning Group Theory for Chemistry*, Oxford University Press Inc., New York, 1998.
15. L. H. Hall, *Group Theory and Symmetry in Chemistry*, Mc Graw Hill, New York, 1969.
16. R. Mc Weeny, *Symmetry: An Introduction to Group Theory and its Applications,* Pergamon Press, London, 1963.

DSC 8: Instrumental methods of analysis

Course Code: 21ICH2C8L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course Objective: A study of analytical chemistry aspects related to the chromatography, Electroanalytical and separation techniques ans X-Ray diffraction shall impart essential information on the topics which are very important and relevant.

Course outcomes:

At the end of the this course, students should be able to

1. Explain the basic principles of chromatography.
2. Categorize the types, basic components and properties of liquid chromatography.
3. Describe the principles and working of GLC and HPLC along with their applications in pharmaceutical industries.
4. Decide about the suitable light source for the analysis.
5. Comprehend the factors that must be controlled to obtain reliable and reproducible data from electroanalytical experiments.
6. Identify the most appropriate electroanalytical technique for a specific analysis
7. Describe the electrode reaction mechanism from data obtained using several electroanalytical techniques

Course outlines

Unit I: 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.

Gas Liquid Chromatography:

Principle, apparatus, columns, simple application, mobile phase, stationary phases, detectorsApplications.

HPLC Principles:

Instrumentation-columns, stationary phase and matrices, simple applications, mobile phase pumps, detectors.

[10 hours]

Unit II: AAS, Flame photometry and FES

Flame Photometry and Atomic Absorption Spectrometry:

Principles and Theory - Instrumentation - Flames - Burners - Non-flame 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

[12 hours]

Unit III: Electro-analytical Techniques

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 : Principles, amperometric titrations with examples.

Elecrogravimetry: Theory, completeness and nature of the deposit, instrumentation, electrolytic separation of metals and applications **[13 hours]**

Unit IV: Electro separation 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.

[10 hours]

Unit V: XRD, and Photoelectron Spectroscopy

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 ESC

[11 hours]

References:

1. D. A. Skoog and D. M. West, F. J. Holler and S. R. Crouch, *Fundamentals of Analytical Chemistry*, Brooks/Cole, Florence, 2004.
2. G. D. Christian, *Analytical Chemistry*, 6th edition, John Wiley & Sons, Singapore, 2008.
3. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, *Vogel's Textbook of Quantitative Chemical Analysis*, Pearson Education Ltd., New Delhi, 2000
4. H. H. Williard, L. L. Merrit, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis*, Wadsworth Publishing Company, Belmont, California, 1986.
5. D. Harvey, *Modern Analytical Chemistry*, McGraw Hill Higher Education, New York, 2000
6. Modern methods of Chemical analysis-Pecsok, Shields, Cairns and McWilliams (2^{nd}edition), John Wiley and Sons (1976).
7. Vogel's Textbook of Quantitative Inorganic Analysis, Bassett, Denney, Jeffery andMendham, (4th edition) ELBS (1989).
8. Treatise on analytical Chemistry-Kolthoff, Elving and Krivan (2nd edition) John Wiley &Sons (1986).
9. Commercial methods of analysis-Snell and Biffen, McGraw Hill, (1944)
10. Hand Book Of Instrumental Techniques For Analytical Chemistry, Frank Settle, PrenticeHall PTR (1997)
11. Instrumental methods of Chemical Analysis, G. W. Ewing, 5th edition, McGraw-Hill,New York, 1988.
12. Electrochemical methods: A.J. Bard & l. R. Faulkner, 2nd edition, Wiley, New York,2000.
13. An Introduction to X-ray Crystallography, M. M. Woolfson, CambridgeUniversity Press-Vikas Publishing House, New Delhi (1980).
14. Principles of the solid State, H.V.kheere, Wiley Eastern Ltd., New Delhi (1993).
15. X-Ray structure determination: A practical guide, George H Sout and Lyle HJenson, Macmillan Publishing Co.Inc and Collier Macmillan Publishers.

SEC-2 Research Methodology

Course code: 21 ICH 2S2P: Credits: 02 Contact hours per week-02
Internal Assessment: 20: Final Exam 30 Marks

Course Objective: The objective of this course is to make the students to know about the basics of the research activities, formulation of research and interpretation of report. Also to have a knowledge on protection of intellectual properties.

Course outcomes:

At the end of the course students should be able to

1. Collect the information about the current research activities and their applications
2. Carry out the literature survey on the relavant topics
3. Formulate the research problem
4. Design the methodology of working
5. Explain the outcome of the research work through report writing
6. Follow the ethics of research to avoid scientific misconduct
7. Should be able to ascertain intellectual property rights.

Course contents

Unit I Research formulation and design:

Motivation and objectives-research methods vs methodology, quantitative vs qualitative, conceptual vs empirical. Concept of applied and basic research process. Criteria for good research. Defining and formulating the research problems, selecting the problems, necessity oof defining the problems, importance of literature review in defining a problem, litarure review, primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying the gap areas from literature and research data base. Development of working hypothesis. **[10 Hrs]**

Unit II: Interpretation and report writing

Meaning of interpretation, techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of the research reports, types of reports, oral presentation, mechanics of writing a research report. Precautions for writing research reports, conclusions. **[8 Hrs]**

Unit III: Intellectual property rights(IPR)-

Patents, trademarks and copyrights Industrial design, geographical indication. Ethics of research . scientific misconduct- forms of scientific misconduct, plagiarism, unscientific

practices in thesis work, Ethics in science. **[10 Hrs]**

References:

1. Garg, B.L, Karadia, R. Agarwal. U.K., 2002. An introduction to research methodology. RBSA publishers
2. 2.Kothari C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418 P
3. Sinha, S.C and Dhiman, A.K., 2002. Research Methodology, ESS, ESS publications. 2 volumes
4. Trochim, W. M.K 2005 Research methods: the concise knowledge base, Atomic Dog Publishing.
5. Wadhera, B.L. 2000. Law relating to patents, trademarks, copyright design and geographical indications. Universal Law Publishing.

DSC 5P: Synthesis of Coordination Compounds

Course Code: 21ICH2C5P **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam: 30 Marks**

Course Objective: The objective of this course is to make the students to familiarize with the synthesis of complexes followed by analysis for its metal content and recording electronic spectrrum.

Course Outcomes:

After learning, this course the student would be able to,

1. Prepare and analyze the complexes.
2. Record the electronic spectrum
3. Correlate the spectral data to account for its colour and structure.

Experiments

Preparation and quantitative analysis of inorganic complexes:

1. Cis- and trans- potassium dioxalatodiaquachromium(III) complex [analysis of oxalate and chromium]
2. Hexamminecobalt(III)chloride [analysis of cobalt]
3. Preparation of pentamminechloro cobalt(III)chloride.

Preparation of selective inorganic compounds (any four). Record the electronic spectra of any three complexes and identify transitions.

a) $VO(acac)_2$,
b) $Na[Cr(NH_3)_2(SCN)_4]$
c) $K_3[Fe(C_2O_4)_3]$
d) Prussian Blue
e) $[Co(Py)_2Cl_2]$
f) $[Cu(NH_3)_4]SO_4.H_2O$

References:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J.Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jefferyand J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co.(1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co.,London (1972).

DSC 6P: Organic Synthesis

Course Code: 21ICH2C6P **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam:30 Marks**

Course Objective: The objective of this course is to make the students to acquire expertise in preparing the organic compounds followed re-crystallization and recording of IR spectrum of any two compounds.

Course Outcomes:

After learning, this course the student would be able to,

1. Synthesize organic compounds and acquire the skill of purifying.
2. Explain the mechanism involved in the reaction.
3. Interpret the functional groups using IR spectra

Experiments

Organic Synthesis:

i. Eosin from phthalic anhydride.
ii. Benzene azo-β-naphthol(Dye)
iii. Bakelite (Polymer).
iv. Acetyl salicylic acid (Aspirin).
v. Synthesis of p-hydroxyacetanilide (Paracetamol).
vi. Oil of wintergreen (Methyl Salicylate)

Quantitative Analysis (Any two):

i. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.
ii. Estimation of amine/phenols using bromate bromide solution or acetylation method.

DSC 7P: Instrumental methods of analysis

Course Code: 21ICH2C7P **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam :30 Marks**

Course objectives:

In the second semester laboratory, students are expected to gain the hands on skill for handling spectrometer, potentiometer, skill on preparation of solutions with known concentrations. conductometer. complementary to the learning objective of discipline specific course, student should carry out the experiments related to determination of PKa Value of different chemical compounds. Students will also trained on determination of acid strengths, determination of Standard electrode potentials. Quantification of metal ions.

Course outcome:

At the end of the practical physical chemistry course, student should acquire a skill to

1. Handling of spectrometer
2. Determine the PKa values for phosphoric acid and acetic acid
3. Construct and verify the Beer's law
4. Acquire a skill on measurement of standard electrode potentials
5. Observe the rate of corrosion in acid medium
6. Demonstrate the extraction process.

Experiments

1. Potentiometric titration of KI versus $KMnO_4$
2. Potentiometric Titrations of Fe(II) versus Ceric ammonium sulphate and determination of amount of Iron present in a solution
3. Spectrometric titration of Fe(II) Ions versus Potassium dichromate
4. Potentiometric titrations of available Chlorine in a bleaching powder
5. Determination of Dissociation constant of a weak acid conductometrically
6. Determination of pK_{a1} and pK_{a2} of Oxalic acid by potentometric titration
7. Determination of pK_{a1} and pK_{a2} andpK_{a3} of phosphoric acid by potentometric titration
8. Determination of standard electrode potentials-Measurements of potentials-Danial cell
9. Determination of distribution coefficient using distribution of acetic acid and benzoic acid in water
10. Determination of distribution coefficient using distribution of acetic acid and benzoic acid in chloroform
11. Comparison of the strengths of HCl and H2SO4 by studying the kinetics of hydrolysis of methyl acetate
12. Corrosion studies on a metal in acid medium

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.

III SEMESTER

DSC 9: Spectroscopy

Course Code: 21ICH3C9L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: Students to get the in depth knowledge on the interaction of molecules and atoms with the light. Behaviour of the atoms and molecules, energy levels of molecules and to characterize the molecules based on their electromagnetic interactions with light.
Students also should understand the Mossbauer and spin resonance effects of the compounds

Course outcomes:
Students should be able to differentiate between various spectroscopic principles

1. Able to characterize the molecule by identifying the absorption mode in the infra-red region
2. Understand the principles of various spectroscopic techniques
3. Have a clarity on interpretation of the spectra of the compound
4. Understand the factors affecting the spectra of the compounds
5. Understand the NMR appearance of organic compounds
6. Able to Explain the Mossbauer principles and ESR principles
7. Know the instrumentation of various spectroscopic techniques

Course outlines

Unit I: Rotational, Vibrational and Raman Spectroscopy

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 – Breakdown of Born – Oppenheiner approximation

Raman Spectroscopy:

Classical theory of Raman Effect – rotational Raman spectra – Linear – Vibrational Raman Spectra – Instrumentation

[12 Hours]

Unit II: Infrared 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 spectra of coordination modes of ligands like nitrate, thiocynate, sulphate, carbonate(bridging, bidentate etc.,), and water.

[12 Hours]

Unit III: Electronic Spectroscopy and Mass Spectrometry

Electronic Spectroscopy

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

Mass Spectrometry:

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

[12 Hours]

Unit IV: NMR Spectroscopy

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, phosphor halides, fluoro acetic acid, SF_4, P_4S_4, HPF_2.

[10 Hours]

Unit V: ESR and Mossbauer spectroscopy

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

[10 Hours]

DSC 10: Unit Operations

Course Code: 21ICH3C10L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objectives: Students should learn the engineering and industrial aspects of chemistry. Acquire a knowledge on industrial measurement systems. Understand the basic reactions principles. Different methods employed in the industrial production, construction materials and designing of industrial equipments

Course outcomes: students will be able to

1. Gain a knowledge on material balance equation and solve the problems related to material balance and energy balance
2. Know about the different types of thermometers and the measurements systems
3. Know the principle and types of extractions. Able to solve the problems related to extractions
4. able to understand the evaporation process in industries
5. Explain the evaporation process, types and equipments for evaporation
6. should be able to understand the drying process and different types of dryers used in industries

7 Able to understand the crystallization and filtration process

Course outlines

Unit I: Material and energy balance and Industrial Measurements

Material balance: Process classification, Choice of system and basis of molecular processes with chemical reactions, Material balance calculations, Multiple unit processes, Recycle and bypass
Energy balance: Forms of energy, Energy balance, Energy changes in physical processes, Energy changes in reactions, Energy balance Calculations
Measurement of temperature, Thermo couples and pyrometers, High temperature thermometers, Optical pyrometers
Measurement of pressure and vacuum, Manometric and Bourdon gauges, Vacuum gauges, Ionization and pirani gauges. Flow measurement, Pitot tube, Rotameters
Liquid level indicators. Hook Type, Sight glass, Float type, Capacitance level indicator, Radiation level indicator

[10 hours]

Unit II: Extraction, Evaporation, and Drying

Extractions:
Liquid equilibria, Extraction with reflux, Extraction with agitation equipment, it's use and performance, continuous contact equipment, agitator extractors, packed spray extractors, Leaching, flow sheets of solid-liquid extraction,
continuous leaching, counter current extraction
Evaporation;

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

Drying:

General Principles (Significance, moisture content), Rate of drying (Constant & falling rate period, factors affecting drying), Drying equipments, Tray dryers, Rotary dryers, Single Drum dryer & Spray dryers.

[12 hours]

Unit III : Filtration, Distillation and Crystallization

Filtration:

Classification of filters, Sand filters, filter press, plates & frame press, filter aids, principles of leaf filters

Distillation:

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

Crystallization:

Growth of Crystal, saturation, nucleation supersaturation, (Mier's theory), Caking of crystals, effect of impurities, Classification of crystallizers, Agitated tank, Swenson walkers, Krystal, Oslo, continuous vaccum crystallizers

[10 hours]

Unit IV: Equipment design: Materials of construction and design of vessels

Material of constructions: Mechanical properties, Corrosion resistance. Plastics, Ceramics. Metals and alloys, Stainless steel, Special material for food and pharmaceutical equipment. Protective coatings, Surface treatment to metals for corrosion resistance

Design of Vessels: Classification of chemical reactors, pressure vessels for internal or external pressure, Maintenance, Storage vessels for liquids and gases.

Design of chemical reactors, Reactors with chemical addition, agitation, heating, removal of vapours, gas addition

[12 hours]

Unit V: Heat and mass Transfer

Flow of Heat:

Introduction, Conduction (Fourier law, Thermal conductivity, thermal insulation & problems), Convection (rate of heat transfer and heat transfer coefficients), Radiation (Absorptive, Reflectivity, & Transmissivity, Kirchoff's law concept of
black body & examples)

Heat Exchange Equipments:

Introduction, Double Pipe, Shell& tube, Fixed tube, U tube heat exchangers

[12 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.

DSE 1: A: Polymer Chemistry

Course Code: 21ICH3E1L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: student should learn about polymers and polymer processing techniques. Basic concepts, types of polymers and polymer characterization.

Course outcome:

Students should be able to explain

1. Polymerizations, types of polymerizations and meaning of different terminologies of polymers
2. Testing of polymers
3. Characterize the polymers
4. Different polymers production (commercial polymers)
5. Morphology and order in crystalline polymers
6. Properties of commercial polymers
7. Solution properties of polymers

Course outlines

Unit I: Importance of polymers. Basic Concepts

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 of 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.

[12 Hours]

Unit II: Morphology and order in crystalline polymers

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

[12 Hours]

Unit III: Testing of Polymers

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

[12 Hours]

Unit IV: Polymer production

a. Polyethylene (HDPE, MDPE, LDPE, LLDPE, UHMWPE, chlorinated PE),
b. Polypropylene (PP),
c. Polyisobutylene (PIB)),
d. Acrylics (PMMA & PAN)
e. Polyvinyles (PVC, PVDC & CPVC),
f. Polystyrene & copolymer (HIPS, SBR, SAN & ABS)
g. Poly(vinyl acetate)
   i. Phenol formaldehyde (PF- Novolak and resol)
   ii. Urea formaldehyde (UF)
   iii. Melamine formaldehyde(MF)
   iv. Polyamides:- Nylon-6, Nylon-6, 6 & Kevlar.

[10 Hours]

Unit V: Polymer processing and Properties of commercial polymers

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.

[10 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.

DSE 1: B: Water Management in Industries

Course Code: 21ICH3E1L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: water is the important solvent used in the industries for the various purposes. Hence quality of the water and purification and recycling are of paramount important. This paper focus on giving the detailed knowledge to students on properties and quality of water, water management, purification of water, water pollution and treatment of effluents.

Course outcomes:

Students should

1. Know the sources, industrial uses of water
2. Aware the water pollution and causes of pollution
3. Know the different water polluting chemicals
4. Able to manage the effective use of water
5. Able to understand the different water purification techniques
6. Able to analyse the water pollution and gain a knowledge on prevention of pollution

Course outlines

Unit I: Properties and Quality of water:

Properties of water:Introduction, chemistry, uses, sources and quality of water, water for industry, water in human body, effect of water on rocks and minerals, organic, humic and colloidal matter in water. Water pollution: Definition, types of water pollution (Physical, Chemical, biological and physiological), water pollutants. Ground water pollution and its protection, Surface, river, sea and lake water pollution, effect of excess nutrients and oil on water pollution,

Marine pollution and episodes, measures against oil spills, Sewage, domestic, agricultural thermal, radioactive, industrial pollutants and siltation, Effect of toxic metals, fertilizers and detergents on water pollution, Inorganic and organic pollutants and their effects on pollution, eutrophication and pesticide pollution.

[10 Hours]

Unit II: Water Management

Water Management: Introduction, use and conservation of water resources, water quality management, rainwater harvesting, water management in agriculture rain fed systems, irrigated systems, industries, Sea water for agriculture, remedial measures for water pollution.

Industrial waste treatment: Characteristics and types of industrial waste, principles of industrial waste treatment and disposal, protection of biosphere and surface water form industrial pollution.

[10 Hours]

Unit III: Purification of water

Purification of water: portability of water, removal of coarse, dispersed and colloidal impurities, clarification and coagulation (Contact and electrochemical) of water, determination of hardness, Flocculants, Sterlization (Chemical and physical methods) fluoridation, defluoridation and disinfection of water, softening of water (Clark's, lime soda, modified lime soda, Permutit and ion exchange process)

Demineralization, desalting (electro dialysis and reverse osmosis methods) and deoxygenation of water, removal of slime, algae, smack, iron, manganese, silicic acid and odour from water, Magnetic treatment of water.

[12 Hours]

Unit IV: Prevention and analysis of water pollution

Prevention, control of water pollution and its best use, Chemical and physical examination and measurement of quality of water, chemical substances affecting potability, odour, taste, temperature and electrical conductivity of water,suspended and dissolved solids, acidity and alkalinity of water, free carbon dioxide and chlorine. Chlorine demand. Analysis of calcium, magnesium, iron, manganese, silver and zinc in water. Determination of ammonia, nitrate, nitrite, cyanide, sulphate, sulphide, chloride and fluride. Determination of arsenic, beryllium, chromium, copper, lead, selenium and mercury

[12 Hours]

Unit V: Treatment of Industrial Effluents

Pollutants from industrial effluents –sources, effects on streams, sewers, land – organic load on rivers. Basic theories of Industrial waste water management. Inplant survey– composite sampling

– Tolerance limits for effluents discharges into inland surface water's public sewers, and on land for irrigation – standards.
Volume and strength reduction, neutralization, equalization and proportioning, recovery and recyle of waste products and bye products – joint treatment of Industrial wastes and domestic sewage – discharge into water bodies, consequent problems.
Treatment of Industrial waste from distilleries, dairy, fertilizer plant, steel plant. Oil refiners, pharmaceutical plants, Thermal Power Plants, and radioactive wastes. Treatment units for the above industrial effluents.

[12 Hours]

References:

1. Wastewater Treatment by M. N. Rao and A. K. Datta–Oxford I. B. H publishers
2. Handbook of Industrial Waste Disposal by Richard A. Conway Richard Ross– Van Nostrand publisher (1980)
3. Industrial Waste Treatment: Contemporary Practice and Vision for the Future by Nelson Leonard Nemerow, Nemerow – Butterworth Weinemann publisher (2006)

DSE 1: C: Quality control, environment, health and safety measures

Course Code: 21ICH3E1L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objectives: students should learn about various quality management systems and their importance. Students should know about the essential practice of a laboratory and safety measurements. Students should also learn about air pollution

Course outcomes:

1. Students should be able to adhere a strict safety rules in the laboratories
2. Should be able to perform the error free preparation of different chemicals of varying concentration
3. Gain the knowledge quality control aspects of industries
4. Gain a knowledge on air pollution analysis and control of air pollution
5. Understand the concepts of soil pollution
6. Understand the causes of soil pollution

Course outlines

Unit I : Quality Control and Quality Assurance

Statistical Quality Control Techniques: Statistical treatment of data. Control charts, Performance Evaluation uncertainties in measurement. Validation of analytical methods. Quality Assurance: Elements of quality Assurance, Quality Management System Quality management concepts and principles: ISO 9001:2000 QMS Case studies on ISO 9001: 2000 in chemical industries. ISO 14000 Series of Standards. TQM in Chemical Industry. Six Sigma Approach to Quality: Applying Six Sigma to chemical Industries. Good Laboratory Practices: Principles of GLP, GMP

in Drugs and Pharmaceutical Industries Accreditation of QC laboratories: Tools and Mechanisms ICH Guidelines on Drug substances and Products.

[12 Hours]

Unit II: Good Laboratory Practices

Good lab practices, lab safety, waste disposal and managements, method of storing chemicals, solvents and glassware, procedures and maintenance of stock, purchase and distribution registers;

: Introduction of non instrumental basic laboratory techniques such as sample preparation, stoichiometric calculations, solution preparation, method selections, gravimetric, volumetric techniques, standardization methods and analysis of samples by various procedures and the use of glassware. R

Introduction of instrumental basic laboratory techniques such as the use and maintenance of analytical balance, potentiometers, pH meters, conductivity meters, mechanical shakers, melting point apparatus, water heaters, water deionisers, magnetic stirrers and hot plates etc

[12 Hours]

Unit III: Air Pollution, Analysis & Control Methods

Definition, Sources, classification and characterization of air pollutants. Effects of air pollution on health, vegetation & materials. Types of inversion, photochemical smog.

Sampling of particulate and gaseous pollutants (Stack, Ambient & indoor air pollution), Monitoring and analysis of air pollutants (PM2.5, PM10, SOX, NOX, CO, NH3)

Particulate matter and gaseous pollutants- settling chambers, cyclone separators, scrubbers, filters & ESP.

[12 Hours]

Unit IV: Safety measures in Industries

Review of Industry Accidents Major Oil Industry Accidents Major Chemical Industry Accidents : Flixborough Disaster, Seveso Disaster, The Mexico LPG Disaster, Mexico Bhopal Disaster,Phillips Disaster

Risk, Hazard, Chemical Hazard Symbols, Incompatible chemicals, Fire Classification; Occupational Health and Safety Administration, The Factories Act, Personal Protective Equipment (PPE)

Toxic Substances Definition, Classes of Toxicity,Entry Points for Toxic Agents, Effects of Toxic Substance, Relationship of Doses and Responses, Threshold Limiting Values,Exposure Thresholds,Airborne Contaminants, Confined Spaces Hazards, Respiratory Protection,Prevention and Control

Decomposition & Runaway Reactions, Initiating factors Reactive Chemical Hazard, Case Studies: T2 Laboratories, Florida, Synthron, North Carolina,PhenolFormaldehyde Reaction. Assessing Reaction Hazard; Tools for evaluating thermal explosion,Steps to Reduce Reactive Hazards. Process Plant Design: Flow Diagrams; Piping and Instrumentation Diagram, Control System,Alarms,

[10 Hours]

Unit V: Soil Pollution

Basic concepts related to soil pollution: The soil and its constitution. Functions and land uses. Main causes and the processes that contribute to the degradation of soil quality (erosion, chemical degradation and physical degradation). Sources of pollution (e.g. urban areas, industrial

areas, agriculture and livestock, landfills, sewage sludge, municipal solid waste dumps and hazardous waste) and types of contaminants expected. Soil quality.
Irrigation water as a source of soil contamination.
Applying fertilizer to the soil: The case of phosphorus, nitrogen and nitrates. Typical dose-response curve for the macro, meso and micro-nutrients and toxic trace elements. Risks of soil contamination. Risk of groundwater contamination. Eutrophication. Good Agricultural Practices

[10 Hours]

References

1. M. N. Rao and H V N Rao, "Air pollution", Tata Mc-G raw Hill Publication.
2. H. C. Perkins, "Air pollution". Tata McGraw Hill Publication
3. Mackenzie Davis and David Cornwell, "Introduction t o Environmental Engineering" McGraw-Hill Co.
4. S Banerjee, Industrial Hazard and Plant Safety, Tayor & Francis, 2003.
5. DanielA. Crowl, Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications - Prentice Hall, 2002.
6. David.L. Goetsch,"The Safety and Health Handbook" Prentice Hall, 2000.
7. F P Lees, Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control,ButterworthHeinemann, 1996
8. McBride, M.B. (1994). Environmental Chemistry of Soils. Oxford University Press. International Edition.
9. Kearney, P.C., Roberts, T. (Editors) (1998). Pesticide Remediation in Soils and Water. John Wiley and Sons. International Edition.

DSE 2: A: Industrial materials

Course Code: 21 ICH3 E2L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: students to learn on common and special industrial materials namely Drugs, Dyes and detergents, Rubber and Rubber like products, leather chemistry, fertilizers, paints and emulsions, explosives and adhesives.

Course outcomes:

1. Students must be able to know the chemistry of different dyes, their constituents and classification
2. Students should be able to know important drugs, their production and uses
3. Students should be able to classify the detergents and manufacturing
4. Student able to write the chemical equations for the production of various types of rubber
5. Students able to work in leather industries
6. Able to know the production of nitrogen, phosphorous and potassium containing fertilizers
7. Students gain a knowledge on different types of explosive and their production and use
8. Able to produce and use the adhesives

Course outlines

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.

[10 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.

[12 Hours]

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

[12 Hours]

Unit IV: Paints and Emulsions

Paints – Introduction and Definitions of paints, pigments, varnishes, lacquers, Anatomy of paints, functions & requirements of constituents of paints, classification of paints on the basis of order of application/ methods of curing / nature of solvent/ uses etc.

Paint Properties - color, tinting strength, reducing power, pigments classification of pigments, pigments properties-oil absorption, refractive index, particle size shape, bleeding, resistance to light and heat.

Manufacture of Paints

Ball mill, triple roll mill, bead mill, titrator, high speed and heavy-duty disperser.

[12 Hours]

Unit V: Adhesives and Explosives

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:
Classification, characteristics, preparation of explosives, nitro cellulose, TNT, Dynamite, Cardite, Gun Powder, Lead azide and RDX.

[10 Hours]

References

1. Outlines of Paint Technology, W. M Morgan 3rd edn CBS Publishers.
2. Paints, Coatings and solvents, Dieter Stoye, Werner Freitag, Wiley VCH Pub

DSE 2: B: Industrial Management and Pollutionmonitoring and control

Course Code: 21 ICH3 E2L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: students should have the awareness of industrial management and environmental policy that helps for a start ups in chemical industries and for establishment of small scale industries. Students should also aware of removal of health hazardous and prohibited chemicals from the mother products.

Course outcomes: after the completion of course, students should be able to

1. Have a clarity on the governmental policy pertaining to environmental protection
2. Get an idea of establishing the industries
3. Able to solve the management problems while setting up of industries
4. Able to solve the management problems in established industries.
5. Able to identify the sourses of sulphur contaminants and their removal techniques
6. Knowledge on removal of phenolic residues and analytical methods for quantification of phenolic residue
7. Able to analyze and quantify the heavy metals

Course outlines

Unit I*:* 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]

Unit II: National environmental policy

The environment protection act 1986. Objectives of anti-pollution acts. National policy on EIA and regulatory frame work. Rules, regulations of central and state government. Central and state pollution control boards for safeguardingthe environment. Rules, regulations and guidelines

given for disposal of hazardous waste, municipal solid waste and biomedical waste. Case study of current issuerequirements of rule 14 for environmental audit under environmental protection act 1986.

[12 hours]

Unit III: Removal of Phenolic residue

Sources of Phenolic residues, Analytical methods, treatment by using stream gasstripping, ion – exchange, solvent extraction, oxidation methods, Microbiological treatment General nature of organic residue not mentioned so far. Role of vapor pressure, role of solubility, effect of pH on solubility extractive methods of recovery and recycle, Chemical methods of conversion to less soluble nontoxic or biodegradable products, carcinogens,Economics of recovery and recycle methods. Incineration of nonrecyclable concentrates and residues.

[10 hours]

Unit IV: Removal of sulphur dioxide and Nitrogeneous pollutants

Origin of SO2 and its hazard, Analysis of SO2, SO2 control methods, desulphurization of fuels, Indian cola and Indian Crude oil. Economics of SO2 control measures NOx, dissolved NOx, nitrites, ammonia, Urea and other nitrogene containing compounds in the effluents ,fertilizer and explosive, industrial effluents, effluents from nitro aromatic industries, analytical methodology, Photochemistry of air pollution.

[10 hours]

Unit-V: Removal of heavy toxic metals

Metallic and non-metallic pollutants, Cr,Hg,Pb,Cd,Cu,As etc. Their physiological manifistation, source, analysis and control of inorganic compounds. Effect of heavy toxic metals on living organisms, Chromium, Merqury, Lead, Cadmium, Arsenic analytical methods of determination of small amounts of the metal pollutants, copper recovery,treatment of waste to remove heavy metals, recovery techniques.

[10 hours]

Reference:

1. S.P. Mahajan: Pollution control in processes iIndustries (J.W)
2. P.N.Chennsioff and R. A Young: Air Pollution control and design Hand Book and recovery (J.W)
3. J.R. Holmes: Refuse recycling and recovering (J.W)
4. M. Sitting: Resources recovery and recycling Hand Book and Industrial Wastes (NDS)
5. J.O. Niagh: Sulphur in the Environment Vol. I & II (J.W)
6. P.S.Minor: The Industry/EPA controntation (MGH)
7. R.B.Pojaselc: Toxic and Hazardous waste disposal Vol. I &II (AAS)
8. S.M.Khopkar: environmental pollution analysis
9. A.K.Dey: Environmental Chemistry
10. W.Handley: Industrial safety Handbook
11. J.E.Huneey etal. (1993) Inorganic Chemistry.
12. Principles of Management, R.C. Tripathi and P.N. Reddy

DSE 2: C: Chemical Analysis in Agro, Food and Pharmaceutical Industries

Course Code: 21 ICH3 E2L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: students should learn on various analytical aspects of food, pharmaceuticals, fuel, biological samples, assay of nuclear wastages, instrumentation and labelling.

Course outcomes:

1. Students are able to analyze the drugs and pharmaceutical ingradients
2. Students are able to analyse the polymers for weight determination
3. Students can identify the pesticide residues and also adultration in food
4. students are able to analyze the dfferent parameters for soil and fuel
5. Students are able to work in clinical laboratories
6. students are able to anlyse the biological samples by fluroscence spectroscopy
7. students learn on radioisotope tracer methodology
8. students get a knowledge on radiometric analysis.

Course outlines

Unit I : Chemical analysis in Industries

Parameters of analysis of the end products in the pharmaceutical industries, Different experimental methods used in the analysis of following drugs: aspirin, nimesulide, metformin, and glimepride.

Analysis of polymers: weigh average molecular weight determination, end group analysis;

Analysis of pesticide residues in the food products; adultration identification methods in food products.

[10 Hours]

Unit II : Analysis of soil & Fuel

Analysis of soil: Moister, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur & alkali salts.

Fuel analysis: Solid, liquid and Gas , ultimate and proximate analysis heating values , grading of cool , liquid fuels , flasks points , aniline point , octane number and carbon residue , gaseous fuels – producer gas and water gas – calorific value

[10 Hours]

Unit III : Clinical Chemistry and drug analysis:

Composition of blood collection, and preparation of samples, clinical analysis – serum electrolytes, blood glucose, blood urea nitrogen , uric acid , albumin , globulin , barbiturates , acidic and alkaline phosphates , Immunoassay , principles ofradiimmunoassy and applications . Blood analysis – trace elements in the body.

Drug analysis: Narcotics and dangerous drugs, classification of drugs, screening by gas m thin layer chromatography and spectrophotometric analysis.

[12 Hours]

Unit IV: Food analysis

Moister, ash, crude protein, fat, crud fiber, carbohydrate, calcium, potassium, sodium, and phosphates, food adulteration – common adulteration in food, contamination of food stuffs,

microscopic examination of foods for adulterants, Pesticide analysis in food products, extractionand purification of sample, HPLC, gas chromatography for organo– phosphates, thin layer chromatography for identification of chlorinated pesticides in food products

[12 Hours]

Unit V:Fluorescence in Biological, Medical and Drug Development

Fluorescence instrumentation for analysis, flurophors and their modification , pH –indicators , membrane potential probes , lipid membrane protein, labeling of protein and DNA.

Analytical Applications of Nuclear Chemistry

Radioisotope tracer methodology – problems of experimental design – radio analytical techniques – radiometric analysis – solubility measurements – various types of isotope dilution techniques – radio activation analysis including non-destructive analysis

[12 Hours]

References:

1. Fundamentals of analytical chemistry by D. A. Skuog , D. M. West and F. J. Honer, W. B. Saunders.
2. Chromic phenomenon , The Technological application of color chemistry Peter Bamfield .

GEC 1: A: Green chemistry

Course Code: 21 ICH3 G1L **Course Credits: 02**

Total Contact hours: 56 **2Hours/week**

Internal assessments: 15 Marks **End semester exam Marks: 35**

Objectives: To learn about the environmental status, public awareness in evolution, principles involved in green chemistry, bio-catalytic reactions, global warming and its control measures, availability of green analytical methods.

Course outcomes:

1. A functional understanding of the field of green chemistry.
2. A working understanding of the 12 principles of green chemistry.
3. An understanding of several real world examples where organizations used green chemistry to improve the sustainability performance of their products.
4. An appreciation of how the practice of green chemistry enhances competitiveness, innovation and faster time to market.

Course outlines

Unit I:

Introduction-Current status of chemistry and the Environment-Evolution of the Environmental movement: Public awareness - Dilution is the solution to pollutionPollution prevention

[10 Hours]

Unit II:

Principles of Green Chemistry – Definition – 12 Principles of Green Chemistry - Why is this new area of Chemistry getting to much attention - Why should chemist pursue the Goals of Green Chemistry - The roots of innovation – Limitations

[10 Hours]

Unit III:

Bio Catalytic Reactions Green Chemistry Using Bio Catalytic Reactions – Introduction - Fermentation and Bio transformations - Production of Bulk and fine chemicals by microbial fermentationAntibiotics – Vitamins - Bio catalyses synthesis of industrial chemicals by bacterial constructs - Future Tends.

[12 Hours]

Unit IV:

Green House Effect Green house effect and Global Warming – Introduction - How the green house effect is produced - Major sources of green house gases - Emissions of CO2 - Impact of green house effect on global climate - Control and remedial measures of green house effect - Global warming a serious threat - Important points.

[12 Hours]

Unit V:

Green Analytical Methods Future trends in Green Chemistry - Green analytical methods, Redox reagents, Green catalysts; Green nano-synthesis, Green polymer chemistry, Exploring nature, Biomimetic, Proliferation of solvent-less reactions; Non-covalent derivatization, Biomass conversion, emission control

[12 Hours]

References:

1. V. Kumar, "An Introduction to Green Chemistry" Vishal publishing Co. Reprint Edition 2010
2. Rashmi Sanghi, M.M Srivastava "Green Chemistry" Fourth Reprint - 2009
3. Anastas & Warner, Green Chemistry: Theory & Practice ,Oxford Univ. Press,New York,1998

GEC 1: B: Bio-Inorganic Chemistry

Course Code: 21 ICH3 G1L **Course Credits: 02**

Total Contact hours: 23 **2Hours/week**

Internal assessments: 15 Marks **End semester exam Marks: 35**

Course objectives: The objective of this course is student to expose the essential elements of bio inorganic chemistry. Trace elements in biological system and their functions. Photosynthesis in plants and metal deficiency dieses.

Course outcomes: After the completion of the course

1. Students should be able to draw the structure and define the functions of various biological cycles
2. Students are able to explain the metal deficiency health issues
3. Students are able to solve the competitive exam questions related to bio inorganic chemistry
4. Know the nitrogen fixation mechanism
5. Knowledge on the structures of various metallo proteins in body

Course outlines

Unit I:

Periodic survey of essential and trace elements, biological importance and relative abundance, Na+ / K+ ion pump and its mechanism. Porphyrine and metalloporphyrins, Oxygen carriers/storage-Hb and Mb: Structure and mechanism of their function, cooperativity and Bohr effect. Synthetic models of Hb, Cyanide, phosphine and carbon monoxide poisoning. Inhibition and poisoning by ligand and metal ions, hemocyanin and hemerythrin, models of iron, coalt and copper. Bioenergetic and ATP cycle process coupled to phosphate hydrolysis, Nucleotide transfer-DNA polymerase, phosphate transfer pyruvate kinase, phosphoglucomutase, creatin kinase, ATPase.

[07 hours]

Unit II:

Photosynthesis and respiration - chlorophyll : structure, function and its synthetic model. Xanthine oxidase, Gout Disease and its remedy. Enzymes and their functioning, Bioredox agents, Zn-enzymes carboxy peptidase, carbonic anhydrase, superoxide dismutase, peroxidases and catalases, Vitamin B12 coenzyme, structure, function and "Mn" mechanism and its application in organic synthesis, intake of alcohol and its remedy. Cytochromes-structure and function, Cytochrome P450 enzymes. Ferrodoxins and rubredoxins their structure and function. Abiological and biological N2fixation and mechanism.

[10 hours]

Unit III:

Ferritin, transferring and siderophores and their structure and function. Availability, competition, toxicity and nutrition of Iron, metal deficiency and diseases, toxic effects of antibiotics, chealte therapy, synthetic metal chelates as antimicrobial agents. Calcium in living cell, transport and regulation and its mechanism. Molecular aspects of intramolecular processes and their mechanisms. 2. Metal Clusters (a)Reaction at Coordinated ligands The role of metal ions in the hydrolysis of amino acid esters, peptides, and amides Molecular orbital concept of role of metal ions participation, Modified aldol condensation, Imine formation, Template and Macrocyclic effect in detail.

[06 hours]

References:

1. Principles of Bioinorganic Chemistry, S. J. Lippard and Berg, University Science Books.
2. J.E. Huheey : Inorganic Chemistry III & IV Ed. Pearson Education Asia – (2002).
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
4. Purcell and Kotz: Inorganic chemistry. W. B. Saunders and Co., London
5. Bioinorganic Chemistry by D. Banergia

GEC 1: C: Absorption and surface phenomenon

Course Code: 21 ICH3 G1L **Course Credits: 02**

Total Contact hours: 23 **02Hours/week**

Internal assessments: 15 Marks **End semester exam Marks: 35**

Objectives: Students should have the understanding on basic physical chemistry related to adsorption phenomenon, phase rule and polymers

Course outcomes: After the completion of the course students are able to

1. Draw the phase diagram
2. Able to derive the phase rule
3. Able to understand the natural phenomenons like capillary action
4. Able to understand the various types of adsorption phenomenon
5. Describe the polymerization process

Course outlines

Unit-I:

Phase Rule Concept of Equilibrium between phases, Derivation of phase rule, Ideal Solution, Liver Rule, Brief concept on one and two component system, Application of phase rule to three component systems of both solids and liquids.

[07 Hours]

Unit II:

Adsorption Surface tension, Capillary action, Adsorption, types of adsorption, Gibbs adsorption isotherm, Freundlich's adsorption isotherm, Langmuir's adsorption isotherm and its limitations, BET adsorption isotherm and its applications, Heat of adsorption, estimation of surface areas of solids from solution adsorption studies.

[10 Hhours]

Unit III:

Macromolecules Polymer-definition, Classification of polymer, Polymer structure, Number average and molecular weight average, Step growth & chain growth polymerization, Kinetics of polymerization, Stereochemistry of polymerization.

[06 Hours]

References:

1. Text Book of Physical Chemistry Vol-1-4 by K.L. Kapoor
2. Physical Chemistry by D.N. Bajpai
3. Physical Chemistry by A.W. Atkins
4. Introductory Quantum Chemistry by A.K. Chandra
5. Polymer Science by Gowariker, Viswanathan & Sreedhar
6. Polymer Science & Technology by J. R. Fried C

SEC: Industrial Methods of Analysis (1L+1P)

Course Code: 21 ICH3 S3LP **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam Marks: 30**

Objectives: Students to have a skill and knowledge on the important methods of analysis in the industries

Course outcomes: Students are able to

1. Use the chromatographic technique
2. Identify the impurities and determine the percentage purity of the compound
3. Perform the experiments using UV-Vis spectrometer

4. Able to determine the assay of drug samples by wet chemistry

Course outlines

Theory: Instrumental methods of Analysis:

Unit-I: Chromatography:

Principles, Instrumentation, theory, and types of chromatography. Determination of purity of the samples.

[08 Hours]

Unit-II: UV-Visible spectroscopy and NMR spectroscopy.

Utilization of these techniques for qualitative and quantitative analysis.

[08 Hours]

Practicals:

Standardization of solutions, Determination of assay of organic compounds. Aspirin, salysilic acid, ascorbic acid

[16 Hours]

References:

1. Analytical Chemistry – Gary D. Christian, 6th ed., John Wiley and sons. Inc., New York1994.
2. Instrumental methods of Analysis - Willard, Merit, Dean, 6th ed., CBS Publishers &distributors, 1986.
3. Vogel's Text book of Quantitative Chemical Analysis, J. Bassett, G. H. Jeffery and J.Mendham, Pearson, 7th edition, (2009).

DSC 9P Interpretation of Spectra of the organic molecules

Course Code: 21 ICH3 C7P **Course Credits: 02**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 20 Marks **End semester exam Marks: 30**

Course objective: Student should have the analytical ability to determine the structure of the compound from the given physical and spectroscopic data and also should predict the possible spectra of the molecule based on the structure

Course outcome: after the completion of this practical students should be able to

1. Draw a structure of the molecule based on the physical and spectral data
2. Able to understand the spectral signals appearance in the different electromagnetic region based on the absorption or emission
3. Able to predict the spectral appearance for the particular structure and explain
4. Able to remember all theoretical spectroscopic instrumentation principles studied in discipline specific course

Course contents

1. Draw the structure of the compound using the Given Elemental composition, Mass, FTIR, NMR, Uv-Vis spectral Data (for any TEN organic molecule)
2. Predict the NMR, FTIR, UV-Vis, Mass and elemental composition of the Organic compounds (for any TEN simple organic structures)

DSC10 P Analysis of Organic Industrial Materials

Course Code: 21 ICH3 C8P **Course Credits: 02**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 20 Marks **End semester exam Marks: 30**

Course Objective: Students should be familiar with the quality control aspects of important organic industrial products **.**

Course outcome: 1. Students are able to perform the wet analysis

2. Students are able to perform the wet analysis of different products by knowing the techniques of wet analysis

Course contents:

Analysis of the following materials by wet analysis method(Any Six)

a. Acid value, Iodine value and Saponification value of oil ,
b. Assay of Aspirin,
c. Assay of Ascorbic acid
d. Ash and moisture contents in the coal sample
e. Estimation of citric acid
f. Analysis of ester by saponification method
G. Analysis of Pulp for copper number and moisture

IV SEMESTER

DSC 11: Inorganic Industrial materials

Course Code: 21ICH4C11L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Course objective: To expose the students on the theory and principles of important industrial material production. Process of refining of metals and petrochemical industries.
Course outcome: students should be able to

1. Classify the ceramics and have a knowledge on manufacturing process of ceramics.
2. Should be able to describe the industrial carbon and its manufacturing
3. Should have a knowledge on refractories
4. Should be able to write the different forms, properties and manufacturing of glass
5. Gain a knowledge on chemistry of cement, manufacturing and setting
6. Able to explain the metallurgical process of Cu, Fe and Steel

Course outlines

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.

[12 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.

[12 Hours]

Unit III:Metallurgy of Cu, Fe 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.

[10 Hours]

Unit IV: Refining of Metals

Definition, procedures for purification of metals-Liquation, distillation, vapour phase refining, chromatographic methods, zone refining, electrolytic refining. Electrolytic refining of Copper. Zone refining of Bismuth.

[12 Hours]

Unit V: 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.

[10 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,

DSC 12: Unit Processes

Course Code: 21ICH4C12L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam 70 Marks:**

Course objective: students should know the basics of unit process used in the industries. It is important to learn the various methods for the manufacturing of chemicals via different reaction pathways. Student should also gain the knowledge on modern material production industries.

Course outcome

After the completion of the course students should be able to

1. Explain the basics of organic unit processes
2. Able to perform nitration process
3. Able to perform sulphonation process
4. Carry out the Esterification, Halogenation and Oxidation
5. Carry out manufacturing process of liquid crystals and soft materials
6. Able to differentiate different types of liquid crystals
7. Understanding and applications of thin films

Course outlines

Unit I: Unit Processes:

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.,

Introduction to unit processes in pharmaceutical industries: preparations of formulations from bulk drugs. Parameters involved in formulation process.

[10 Hours]

Unit II: Nitration and Sulfonation,

Nitration: Introduction, nitrating agents, aromatic nitration, nitration of organic solvents, effect of HNO_2 on nitration, Gas phase and liquid phase nitration, thermodynamics of nitration, Batch and continuous nitration, manufacture of nitrobenzene, m-dinitrobenzene, p-nitroacetanilide.

Sulfonation: Introduction, classification of sulfonates,

General procedures for preparation of sulfonates, sulfonating agents, manufacture of benzene sulfonic acid, naphthalene-β-sulfonic acid.

[10 Hours]

Unit III: Esterification, Halogenation and oxidation

Esterification: Kinetics and mechanism. Esterification of carboxylic acid derivatives, Esters by addition to unsaturated systems, Industrial esterifications, Ethyl acetate, butyl acetate, Vinyl acetate, methyl methacrylate, Cellulose acetate, xanhate and nitroglycerin.

Halogenation: Kinetics and mechanism, Survey of methods, Catalytic chlorination, photohalogenation, Manufacturing processes for chlorohenzene, BHC, Chlorinated methanes, monochloroacetic acid, chloral, vinyl chloride.

Oxidation: Oxidising agents with typical applications of each, Liquid phase oxidation with oxidising compounds, Typical manufacturing processes.

[12 Hours]

Unit IV: Soft Materials and liquid crystals

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&smecticmesophases, 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.

[12 Hours]

Unit V: Electrolysis

Definition, electrolytic process, cell potential, Faraday's law of electrolysis, products of electrolysis, factors affect for electrolysis, Electrolysis of water: high-pressure electrolysis, low-pressure electrolysis, high-temperature electrolysis, Electrolyzers, High-temperature electrolysis, Hydrogen energy-electrolysis, applications-metallurgy of alkali and alkaline earth metals, manufacture of pure gases, electroplating for corrosion resistance, ornaments etc., simple problem solving of electrolysis.

[12 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, 4thEdition, 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

DSE 3: A: Pharmaceutical industrial chemistry

Course Code: 21ICH4E3L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Objectives: In this course students have to learn about the involvement of chemistry/chemicals in the pharmaceutical industries. Also should have a knowledge on therapeutic techniques and important drug catagories.

Course outcomes: 1. Able to identify and quantify the impurities in pharmaceuticals and gain a knowledge on various testing parameters

2. Aware of chemical reactions involved in the synthesis of drug molecule
3. Able to optimize the conditions of production of drugs in good yield
4. Able to determine the structure activity relationships
5. Able to recognize the important drug categories

Course outlines

Unit I: Basic pharmaceutical chemistry:

Introduction, Accuracy, precision, significant figures, Impurities in Pharmaceuticals: Source and effect of impurities in Pharmacopoeial substances, importance of limit test, Principle and procedures of Limit tests for chlorides, sulphates, iron, heavy metals and arsenic**.**

[12 Hours]

Unit II: synthesis of drugs and testing techniques

Synthesis of drugs: 1,3-pyrazole, 1,3-oxazole, Benzimidazole, Benztriazole, 2,3-diphenyl quinoxaline, Benzocaine, Phenytoin, Phenothiazine, Barbiturate

Testing techniques: Impurity and Stability Studies, Stability Testing Protocols, Impurity Profiling and Degradent Characterization, Stability testing of Phytopharmaceuticals, Biological Tests and Assays- Adsorbed Tetanus vaccine, Adsorbed Diphtheria vaccine, Human anti

haemophilic vaccine, Rabies vaccine, Tetanus Anti toxin, Tetanus Anti serum, Oxytocin, Heparin sodium IP, Antivenom. PCR, Immunoassays (IA).

[12 Hours]

Unit III: Structure-activity relation, Docking studies

Introduction, Discovery of Mycobacterium tuberculosis InhA Inhibitors Using structure based virtual screening, (SBVS) andPharmacophore Modeling, Discovery of Proteasome Inhibitors by SBVS, Identification of a New Series of STAT3 Inhibitors by virtual screening(VS), Discovery of Pim-1 Kinase Inhibitors by a Hierarchical Multistage VS, Identification of Aldose Reductase Inhibitors by MD and SBVS, Design of Selective Cyclooxygenase-2 Inhibitors.

[12 Hours]

Unit IV: Advanced therapeutic techniques

Sacroiliac Dysfunctions and Muscle Energy, Sacroiliac and Spinal Stabilization Exercise Programs Temporomandibular Joint and Thoracic Outlet Soft Tissue, Neural and Joint Mobilization Proprioceptive Neuromuscular Facilitation Neurodynamics Proprioceptive and Vestibular Balance, Upper Extremity Therapeutic Exercise, Lower Extremity Therapeutic Exercise.

[10 Hours]

Unit V: Important drug categories

Introduction to medicinal chemistry historyand development ofmedicinal chemistry Physicochemicalproperties inrelationtobiological action, Drugmetabolism, Drugs acting on Autonomic Nervous System, Cholinergic neuro transmitters, Drugs acting onCentral NervousSystem-Morphine andrelated drugs, Narcotic antagonists, Anti-inflammatoryagents:

[10 Hours]

References

1. A Textbook of Pharmaceutical ChemistryTextbook by Jayashree Ghosh
2. The art of drug synthesis Douglas S. JohnsonJie Jack LiPfizer Global Research and Development
3. Molecules 2015, 20, 13384-13421; doi:10.3390/molecules200713384

DSE 3: B: Advanced topics in chemistry

Course Code: 21ICH4E3L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Objectives: Students to have a knowledge on current progress in chemistry that will help the students to face the competitive examinations and make them eligible to teach chemistry and industrial chemistry subjects at college and university level.

Course outcomes: 1.students are able to know the pollution and toxic free synthesis
2. Able to make hazard assessment
3. Understand the action of organocatalysis
4. Able to construct the solar cells from different materials
5. Able to draw the various structures of solar cell materials
6. Understanding the working principles electrochemical energy devices

Course outlines

Unit I: Concepts of green chemistry:

Introduction, Atom Economy, Principles of Green Chemistry, Alternative Solvents/Energy Effici ency, Catalysis, Abiotic Depletion of Elements, Renewable Feed stocks, Biodegradation, Introduction to Toxicology, Toxicology, Designing Safer Chemicals, Risk vs. Hazard Assessment, Chemical Alternatives Assessment, Environmental Laws, Policies, Regulations

[10 Hours]

Unit II: Supramolecular chemistry

Fundamentals of Supramolecular Chemistry-Terminology and definitions in supramolecular chemistry. Intermolecular forces: Ion pairing, ion-dipole and dipole-dipole interactions;

Molecular Recognition-Principle of molecular recognition, host-guest complementarity, preorganisation, chelate effect, cooperativity. Synthesis and applications of supramolecular host (crown ethers, lariat ethers, podands, cryptands) as cation and anion binding receptors and receptors for ion-pair recognition.

Supramolecular Reactivity and Catalysis-Organocatalysis mediated through hydrogen bonding, preconcentration, self-assembly of catalysts and preorganisation of catalyst-substrate systems.

[10 Hours]

Unit III: Chemistry of nanomaterials

Introduction, synthesis of nanoparticles, size effects on structure and morphology of nanoparticles- Fundamental Properties - Size Effects on Structure and Morphology of Free or Supported Nanoparticles - Size and Confinement Effects - Fraction of Surface Atoms - Specific Surface Energy and Surface Stress - Effect on the Lattice Parameter - Effect on the Phonon Density of States- Nanoparticle Morphology - Equilibrium Shape of a Macroscopic Crystal – Equilibrium Shape of Nanometric Crystals - Morphology of Supported Particles.

[12 Hours]

Unit IV: High energy materials

High efficiency solar cells, PERL Si solar cell, high efficiency solar cells, GaAs solar cells, tandem and multi-junction solar cells, solar PV concentrator cells and systems, III-V, II-VI thin-film solar cells (GaAs, Cu(In,Ga)Se2, CdTe) Nano-, micro- and poly-crystalline Si for solar cells, mono-micro silicon composite structure, crystalline silicon deposition techniques, material and solar cell characterization, advanced solar cell concepts and technologies (Porous Si layer transfer, Metal induced crystallization, etc.).

Basic of electrochemical energy devices; mechanism and materials for different types of batteries, supercapacitor and hybrid; fuel cells (Polymer membranes for fuel cells, PEM fuel cell, Acid/alkaline fuel cells.), electrochemical and photoelectrochemical water splitting. Details of Pb-acid Nickel-metal hydride (Ni-MH), NiCd-alkaline battery, Ni-iron, Li/Na-ion, Mg-ion, Li/Na-S batteries.

[12 Hours]

Unit V: Electrometallurgy

Introduction to Electrometallurgy, Electrochemical principles and basic concepts,Important milestones in the development of electrometallurgy, Conductivity,Electrolytic conduction, Molar conductivity, Transport numbers, Chemical changesin electrolysis, Examples of electrolysis, Electrode reactions, Stoichiometry ofelectrolysis (Faraday's Laws), Technological applications;

Leaching,Precipitation, Metal extraction and refining, Electrorefining and Electrowinning ofmetals, Fused salt electrolysis of aluminium and magnesium, Electroplating,Electroforming, Electrochemical polishing, Batteries, Fuel cells.

[12 Hours]

References

1. Lancaster, M. Green Chemistry: An Introductory Text, Third Edition; RSC Publishing; 2 016. ISBN: 978-1-78262-294-9
2. Supramolecular Chemistry: from Molecules to Nanomaterials Eds. by P.A. Gale and J.W. Steed (2012).
3. Modern Supramolecular Chemistry by F. Diederich, P. J. Stang, R. T. Tykwinski (2008). . Page 20 of 21
4. Core Concepts in Supramolecular Chemistry and Nanochemistry by J. W. Steed, D. R. Turner, K. J. Wallace (2007).
5. Supramolecular Chemistry by J.W. Steed and J.L. Atwood (2011).
6. Supramolecular Chemistry: Concepts and Perspectives by J.-M. Lehn, Wiley VCH, Weinheim (1995).
7. Supramolecular Chemistry by V. Balzani (Editor), L. De Cola, Kluwer, Dordrecht (1992).
8. Introduction to Supramolecular Chemistry by H. Dodziuk, Kluwer Academic Publishers, The Netherlands (2002).
9. Supramolecular Assemblies Y. Murakami (Editor), Mita Press, Tokyo, (1990).
10. Advances in Supramolecular Chemistry, Vol 1 (1990), Vol 2 (1992), Vol 3 (1993) by G. W. Gokel (Editor), JAI Press, Greenwich.
11. Supramolecular Chemistry – Fundamentals and Applications. Advanced Textbook by T. Kunitake, K Ariga, Berlin: Springer-Verlag Heidelberg, 2006. 208 p. ISBN 978-3-54001298-6.
12. C. Brechignac, P. Houdy, M. Lahmani, “Nanomaterials and Nanochemistry”, Springer publication 2007.
13. Kenneth J. Klabunde, “Nanscale materials in chemistry”, Wiley Interscience Publications 2001.
14. C. N. Rao, A. Muller, A. K. Cheetham ,“Nanomaterials chemistry”, Wiley-VCH 2007.
15. Solar cells: Operating principles, technology and system applications, by Martin A. Green, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981.
16. Adrian Kitai, Principles of Solar Cells, Leds And Related Devices: The Role Of The Pn Junction, 2nd Edition. John Wiley
17. JOHN WILEY, Vasilis M. Fthenakis, Paul A. Lynn, Electricity From Sunlight: Photovoltaic-Systems Integration And Sustainability, 2nd Edition
18. Juan Bisquert, Physics Of Solar Cells : Perovskites, Organics, And Photovoltaic Fundamentals, T&F/Crc Press
19. Fundamental Aspects of Electrometallurgy, 2002, Popov K.I.,DjokićS.S., GrgurB.N., Kluwer Academic/Plenum Publishers, New York

DSE 3: C: Manufacturing of common materials

Course Code: 21ICH4E3L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Objectives: Students should know the chemistry and techniques of manufacturing of common materials using simple raw materials and technology

Course outcomes: 1. Course enable students to start their own small scale or home industries of common chemicals

2. Gain knowledge on various guidelines and regulatory aspects for starting the small scale industries
4. Students are also able to work in the large scale industries like paper and leather industries
5. Students know the process of production of fertilizers

Course outlines

Unit I: History and general introduction

Oils, fats, waxes, mineral oils, essential oils, their sources, composition and structures. Constituents of natural fats Glycerides and fatty acids, their nomenclature, classification and principle sources; theories of glyceride structure.Production and consumption pattern of various Oils & Fats in the Country vis-à-vis world.Non–glyceride components, important minor constituents and contaminants Phosphatides, sterols, gossypol, carotenoids, hydrocarbons, coloring matter, natural pigments, vitamins, antioxidants, Fatty Alcohols, Sterols, Tocopherols, Tocotrinols, Oryzanols, Triterpine Alcohols Waxes etc. Gossypol, Sesamol and Sesamoline, Flavoring compounds. Some minor important constituents of oilseeds: ricin, sinigrin, linamarine, saponin, allylisothiocyanate, gossypol, sesamol and sesamoline; environmental contaminants.
Detergents – Introduction, classification-anionic, cationic, non-ionic and amphoteric detergents, biodegradability of surfactants and manufacture of shampoos.

[12 Hours]

Unit II: Cosmetic Industries

Classification of raw materials and raw materials used in the cosmetic industry for the manufacture of finished products. Method of sampling, Indian Standard specification laid down for sampling and testing of various cosmetics in finished form by the bureau of Indian standards. Factors affecting stability of a formulation, ICH guidelines, Methods of stabilizations and Methods of stability testing.Concept of development of stability indicating analytical methods.
Determination of Physical and chemical constants such as extractive values, moisture content, alcohol content, volatile oil content, ash values, bitterness values, foreign matters, and physical constants applicable to the lipid containing drugs. Microbial counts, bioburden and Pharmacopoeial microbial assays.

[12 Hours]

Unit III: Rubber and Leather Industries

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

[12 Hours]

Unit IV: Fertilizer 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.

[10 Hours]

Unit V: Paper Industries

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.

[10 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,

DSE 4: A: Environmental Impact assessments

Course Code: 21ICH4E4L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam Marks: 70**

Objectives: Students should aware of current environmental problems and the rules, regulations and other measures to control the impact of environmental problems

Course outcomes: After the completion of the course, students should be able to

1. Understand the objectives of environmental policy
2. Able to guide on the disposal of Hazardous wastes
3. Able to appreciate the sustainable development
4. Well versed with the Impact assessment methodologies
5. Gain a knowledge on pollution controlling method

Course outlines

Unit I: National environmental policy

The environmental policy act 1986. Objectives of anti-pollution acts

National policy on EIA and regulatory framework: Rule, regulations of central and state government. Central and State pollution control boards for safeguard for environmental protection. Rules, regulations and guidelines given for disposal of hazardous waste, municipal solid waste and biomedical waste. Case study of current issue requirements of rule 14 for environmental audit under environmental policy act 1986

[10 Hours]

Unit II: sustainable Developments:

Definition and concepts of sustainable development. Integration of (a) economic, social and environmental sustainability (b) Biodiversity and(c) Availability of natural resources in development. Critical review of drawbacks in traditional(based on economics) evaluation of development. Cost benefit analysis. Introduction of ecological growth factor for sustainable developments.

[12 Hours]

Unit III: Methodologies of Impact assessments

Baseline collection of data, significant impacts. Assessment of impacts of physical biological and socio economic environment. Impact prediction. Tootls and techniques such as adhoc method, checklist method etc. Deevelopment of environment manage plans-post project monitoring.EIA report and EIS, Review process, EIA case studies/histories for industrial projects. Water resources and irrigation projects, ports and harbours, mining, transportation and other project sectors.

[10 Hours]

Unit-IV- Pollution monitoring and control

Definition, Sources, classification and characterization of air pollutants. Effects of air pollution on health, vegetation & materials. Types of inversion, photochemical smog.

Sampling of particulate and gaseous pollutants (Stack, Ambient & indoor air pollution), Monitoring and analysis of air pollutants (PM2.5, PM10, SOX, NOX, CO, NH3)

Particulate matter and gaseous pollutants- settling chambers, cyclone separators, scrubbers, filters & ESP.

[12 Hours]

Unit V: Report Writing and case studies

Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Convention on Biological Diversity, Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits. 19 Role of Ministry of Environment, Forests & Climate; role of central and state pollution control boards. National Green Tribunal: Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988.

[12 Hours]

References:

1. Larry W. Carter," Environmental Impact Assessment" Tata-Mc Grow Hill Co. Singapore
2. Suresh. K "Environment engineering and management" S,K Kotharia and sons, New Delhi-2004
3. Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.
4. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.
5. Divan, S. & Rosencranz, A. 2002. Environmental Law and Policy in India: Cases, Materials and Statues (2nd edition). Oxford University Press.
6. Gupta, K.R. 2006. Environmental Legislation in India. Atlantic Publishers and Distributors.
7. Leelakrishnan, P. 2008. Environmental Law in India (3rd edition). LexisNexis India.
8. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International

DSE 4: B: Food industries and agrochemicals

Course Code: 21ICH4E4L **Course Credits: 04**

Total Contact hours: 56 **4Hours/week**

Internal assessments: 30 Marks **End semester exam Marks: 70**

Course Objectives:

1.To understand the basic principles involved in food process engineering.

2.To apply the principles in food processing.

3.To perform calculations for basic operations in food processing.

Course Outcomes:

The students will be able to

1. Enumerate the units and dimensions of various physical quantities.
2. Express the laws and theory of gases and vapours.
3. Describe the types and properties of fluid flow.
4. Calculate the material balance in food processing units.

5. Appraise the performance of processing units

Course outlines

Unit I:

Carbohydrates- composition, classification, sources, functions, structure, physical & chemical properties. Other sweetening agents, functions of sugar in food (Browning reaction), changes during cooking and processing. Lipids – composition, nomenclature, saturated, unsaturated fatty acids, classification, food sources, functions of fats. Physical and chemical properties, emulsions, chemistry & technology of fat and oil processing. Role of food lipids in flavor Proteins – composition, classification sources, functions, denaturation, and protein deficiency, determination of protein quality. Amino acids – classification, Physio-chemical properties, modification of food protein through processing and storage.

[12 Hours]

Unit II:

Foods as ecological niches, relevant microbial groups, Microbes found in raw materials and foods that are detrimental to quality, Factors that influence the development of microbes in food, newer and rapid methods for qualitative and quantitative assay demonstrating the presence and characterization of microbes, Stress, damage, adaptation, reparation, death. Microbial growth in food: intrinsic, extrinsic and implicit factors, Microbial interactions, Inorganic, organic and antibiotic additives. Effects of enzymes and other proteins, Combination systems, Adaptation phenomena and stress phenomena, Effect of injury on growth or survival, Commercial available databases.

[12 Hours]

Unit III: Food Analysis

a) Iodine value
b) Saponification number
c) Acid value
d) Free fatty acids value
e) Peroxide value
f) Estimation of thiamin content of foods by Fluorimetric method.
g) Estimation of riboflavin content of foods by Fluorimetric method.
h) Estimation of ascorbic acid content of different foods by 2,6 dichloro indophenol method

[12 Hours]

Unit IV: Principles of Food Preservation

1. Meaning, mode of action and changes in foods
2. Use of High temperature (Heat preservation)
    a) Moist and Dry heat methods
    b) Blanching
    c) Dehydration
    d) Concentration
    e) Canning
    f) Commercial sterilization
    g) Pasteurization
3. Use of Low Temperatures
    a) Cold Preservation: Freezing and Refrigeration- Air freezing

b) Indirect contact freezing
c) Immersion freezing
d) Dehydro-freezing
e) Cryo-freezing
f) Changes in foods during refrigeration and frozen storage

4. Use of dehydration and Concentration
   a) Benefits and factors affecting heat and mass transfer
   b) Physical and chemical changes during dehydration and concentration
   c) Methods and techniques used (Air convection, drum driers and vacuum driers)
   d) Use of various evapourators for concentration of foods

[10 Hours]

Unit V: Agrochemicals

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.

[10 Hours]

References:

1. Agrochemicals Desk Reference" by John H Montgomery
2. Agrochemicals: Composition, Production, Toxicology, Applications" by Franz Müller
3. Agrochemicals: Preparation and Mode of Action" by R J Cremlyn
4. A first course on Food Analysis: A.Y Sathe, 1999, New age international publishers
5. Food Industries: Food processing and Management: Lisa Jordon (editor) Callisto Reference; Illustrated edition (20 March 2015)

DSE 4: C: Chemical Biology

Course Code: 21ICH4E4L **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 30 Marks **End semester exam: 70 Marks**

Objectives: Students should learn the various chemicals involved in the biological system and their importance in biology.

Course outcomes: After the completion of the course, students are able to

1. Understand the basic chemicals structure and their importance in biology
2. Able to draw different biological cycles involving the chemical transformation and energy release
3. Understand the metabolism process
4. Able to understand the importance of Vitamins
5. Able to identify the vitamin deficiency diceses
6. Able to appreciate the importance of enzymes in metabolism
7. Able to evaluate the quality of protein

Course outlines

Unit I: Amino acids and Nucleic acids

Amino acids

General reactions of amino acid metabolism - Transamination, decarboxylation,

Oxidative and non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation.

Overview of biosynthethic pathways of amino acids and thei regulation Assimilation of ammonia, biosynthesis of essential and non-essential amino acids, regulation of glutamine synthetase andaspartate family of amino acids.

Nucleic Acids

Purine and pyrimidine nucleotides: biosynthesis and it regulation Deoxyribo nucleotides: biosynthesis and regulation. Biosynthesis of nucleotide coenzymes. Catabolism of purine and pyrimidine nucleotides.

[12 Hours]

Unit II: Lipid metabolism Oxidation of fatty acids and its energetics:

oxidation of saturated and unsaturated (mono and poly unsaturated fatty acids (PUFA), Peroxisomal oxidation of fatty acids (Phytanic acid),

Refsum's disease, ketone body formation and their clinical significance, diabetic keto acidosis, Biosynthesis of fatty acids and regulation, Biosynthesis of triglycerides, cholesterol and phospholipids.

[10 Hours]

Unit III: Enzymetic Matabolism

Carbohydrate metabolism Regulatory mechanisms, bioenergetics and significance of central pathways of carbohydrate metabolism –

Glycolysis Citric acid cycle, Gluconeogenesis from TCA intermediates amino acids / acetyl-CoA.

Pentose phosphate pathway, glyoxalate cycle, glucuronic acid pathway, Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen. Biosynthesis of polysaccharides and sugar inter conversions.

[10 Hours]

Unit IV: Proteins and Peptides

Classification of protein, new discoveries in protein and their functions such as protein in Immune system, as lubricants, biological buffers and carriers, evaluation of protein quality: in vitro and in vivo methods, animal and human bioassays: amino acid pool, protein turnover in man with special reference to body size, age and various nutrition and pathological conditions, regulation of proteins, requirements; novel food sources of protein. Effect of insulin, corticosteroids, thyroids, androgen and growth hormone on protein metabolism, inheritable disorders of amino acid metabolism of protein; effect of dietary protein on cardiovascular disease and cholesterol metabolism, adaptation of body to low intake of energy and protein.

[12 Hours]

Unit V: Vitamins

General definition and history of vitamins and hormones; cause of vitamin deficiencies in India. Chronology, chemistry, distribution, functions, absorption, transport, metabolism, deficiency manifestations,

Nutritional requirements, methods of assay. Interaction with other nutrients, antagonists and analogues of vitamins Hyper vitaminosis of water and fat soluble vitamins; vitamin fortification and supplementation; endocrine and exocrine secretion of hormonesorgans of secretion, metabolism, mechanism of action, regulation and sites of action, biological effects and interaction. Assessments of vitamin status of population; antioxidants and their relationship with aging, cancer and other metabolic disorders.

[12 Hours]

References:

1. Basu TK & Dickerson JWT. 1996. Vitamins in Human Health and Disease. CABI.
2. Combs GF. 1992. The Vitamins, Fundamental Aspects in Nutrition and Health. Academic Press.
3. Kutsky RJ. 1981. Handbook of Vitamins and Minerals and Hormones. NRC.
4. Machlin LJ. 1991. Handbook of Vitamins. Marcel Dekker.
5. Nelson, D. L.; Cox, M. M.; Lehninger Principles of Biochemistry, W.H.Freeman; 2017, 7th Edition.
6. Voet, D.; Voet, J. G.; Pratt, C. W.; Fundamentals ofBiochemistry, John Wiley & Sons Inc., 2016, 5th Edition.
7. Berg, J. M.; Stryer, L.; Tymoczko, J. L.; Gatto, G. J.;Biochemistry; W.H Freeman; 2019, 9th Edition
8. Kuchel, P.; Easterbrook-Smith, S.; Gysbers, V.; Guss, J. M.;
9. Hancock, D.; Johnston, J.; Jones, A.; Matthews, J.; Schaum'sOutline of Biochemistry, McGraw-Hill Book Co., 2009, 3rd Edition.

GEC 2: A: Water Harvesting and renewable energy sources

Course Code: 21ICH4E4L **Course Credits: 02**

Total Contact hours: 56 **2Hours/week**

Internal assessments: 15 Marks **End semester exam: 35 Marks**

Course objective: students should learn the water saving methods and should know about the energy sources.

Course outcome:

1. Students are able to appreciate the water harvesting techniques.
2. Able to know the irrigation development methods
3. Able to understand the energy sources
4. Aware the methods of energy harvesting from solar energy

Course outlines

Unit I: Hydrology

Hydrologic cycle, definition, processes, and components of hydrologic cycle, precipitation, origin, process, forms and clouds and their formation. Air masses and stores. Measurement of rainfall, calculation of average rainfall in a field, water budget, surface and ground water hydrology and aquifers. Runoff types, factors affecting, method of computation, runoff hydrograph. Surface and ground water, factors affecting the shape of hydrograph, computation of runoff using unit hydrograph. Runoff computation by infiltration and imperial formulae.

Hydrograph and stream gauging. Use of remote sousing in data collection, water resource management

[10 Hours]

Unit II: Water resources and irrigation development in India

water convegance and control. hydraulics of open channels, design of farm channels, conveyance losses, lining of channels of water courses, hydroclic principle of water _measurement, of irrigation water velocity, area methods, water meter, weirs parshall flumes, orifices etc. water application methods irrigations system and their design pump and tube wells comparative efficiency and economics of different methods of irrigation. irrigability classification and its use in irrigation planning. Conservation drainage - Necessity, methods and design of surface and substance drainage, drainages of irrigated lands, interceptor relief drains and tile drains and their design, drainage requirements of crops, drainage in relation salinity control

[10 Hours]

Unit III: Renewable energy sources

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond.

[12 hours]

References:

1. Water Resources Engineeringby Larry Mays
2. Hydrology for Water Managementby Stephen A. Thompson
3. Water Resources Engineering: Handbook of Book by Anand Prakash
4. Renewable Energy Sources and Emerging Technologies by D.P. Kothari, K.C. Singal, Rakesh Ranjan

GEC 2: B: Basics of Chemistry

Course Code: 21ICH4E4L **Course Credits: 02**

Total Contact hours: 23 **2 Hours/week**

Internal assessments: 15 Marks **End semester exam: 35 Marks**

Course objective: in this course, students will learn about basics of chemistry, history of chemistry and atomic structure.

Course outcome:

1. Students are able to differentiate the atom, molecule, elements and compound
2. Students are able to understand the different states of matter

3. Able to differentiate between the solid, liquid and gases
4. Understand the origin of electrical and magnetic properties in the solids
5. Understand the elements of quantum mechanics
6. Understand the structure of atom based on orbital theory

Course outlines

Unit I: Some basic concepts of chemistry

Matter and its nature, Dalton's atomic theory; Concept of atom, molecule, element and compound; Physical quantities and their measurements in Chemistry, precision and accuracy, significant figures, S.I. Units, dimensional analysis; Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae; Chemical equations and stoichiometry.

[6 Hours]

Unit II: States of matter

Classification of matter into solid, liquid and gaseous states. Gaseous State: Measurable properties of gases; Gas laws - Boyle's law, Charle's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation; Kinetic theory of gases (only postulates); Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behaviour, compressibility factor, van der Waals equation, liquefaction of gases, critical constants. Liquid State: Properties of liquids - vapour pressure, viscosity and surface tension and effect of temperature on them (qualitative treatment only). Solid State: Classification of solids: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea); Electrical, magnetic properties.

[10 Hours]

Unit III: Atomic structure

Discovery of sub-atomic particles (electron, proton and neutron); Thomson and Rutherford atomic models and their limitations; Nature of electromagnetic radiation, photoelectric effect; Spectrum of hydrogen atom, Bohr model of hydrogen atom - its postulates, derivation of the relations for energy of the electron and radii of the different orbits, limitations of Bohr's model; Dual nature of matter, de-Broglie's relationship, Heisenberg uncertainty principle.Elementary ideas of quantum mechanics, quantum mechanical model of atom, its important features, and concept of atomic orbitals as one electron wave functions; various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance; shapes of s, p and d - orbitals, electron spin and spin quantum number; Rules for filling electrons in orbitals, aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half-filled and completely filled orbitals.

[7 hours]

References

1. Inorganic Chemistry – 2nd edition, D.F Shriver, P.W.Atkins and C.H.Langtore Oxford University Press (1994).
2. Concepts and Models of Inorganic Chemistry – 3rd edition, B.E Douglas, D.H. Mc Daniel and Alexander, Wiley (2001)

GEC 2: C: Impact of Chemical fertilizers and pesticides on agriculture

Course Code: 21ICH4E4L **Course Credits: 02**
Total Contact hours: 23 **2Hours/week**
Internal assessments: 15 Marks **End semester exam: 35 Marks**

Course objective: Students should learn the impact of chemicals and fertilizers used in agriculture .

Course outcome:

1. Students gain the knowledge on residues of agrochemicals
2. Learn about the impact of pesticide residue
3. Gain awareness of pesticide residue effects on human health

Unit I: Residues of Agrochemicals:

a) Pesticides Residues in the Atmosphere:
Pesticides into the atmosphere and their fate, Transport of vapours, Precipitation, effect of residues on human life,
b) Pesticides residues in Water system:
Nature and origin of pollution of aquatic systems, Point and Non-Point pollution. Dynamics of pesticides in aquatic environment.

[07 Hours]

Unit II: Pesticides residues in the Soil:

Absorption, Retention, Transport and Degradation of pesticides in the soil, Effect on microorganisms and Consequent effect on the soil condition, Fertility, Interaction in the soil

[10 Hours]

Unit III: Effect of pesticide residues on the quality of human life.

Model ecosystem, In general and consequent effect on human life. The Cases of & affectedsocieties and starving populations facing problems of health and nutrition, Traditional wisdom and Food security.

[06 Hours]

References

1. Progress in pesticides biochemistry and Toxicology V. I, II, III by D. H. Hutson and T. R.Robert.
2. Evaluation of pesticides in ground water by W. Y. Garnett, R. C. Honeycatt and others

DSC 11P: Analysis of Inorganic Materials

Course Code: 21ICH4C9P **Course Credits: 02**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 20 Marks **End semester exam: 30 Marks**

Course objective: Students should have hands on experience on analysis of important Inorganic materials

Course outcome: After the completion of practical course, students should be able to

1. Analyse the contents of Cement
2. Analyse the contents of Heamatite by different methods

3. Analyze the Dolamite ore by using complex metric titration
4. Analyse the contents and percentage of Fe, Ni, Co in steel
5. Able to analyze the composition of fertilizers
6. Able to carry out the soil analysis

Course outlines

1. Analysis of Cement
2. Analysis of Heamatite
3. Analysis of Dolamite by EDTA
4. Analysis of Steel
5. Determination of Percentage composition of N, P, K in fertilizers
6. Soil analysis

21 ICH 4C1R Project work Or In-plant training

Course Code: 21ICH4C1R **Course Credits: 04**
Total Contact hours: 56 **4Hours/week**
Internal assessments: 40 Marks **End semester exam: 60 Marks**

Course objective: Students should expose to the real industrial working atmosphere by carrying the small project work in the industries or should be able to carry a independent research after the completion of the course.

Course outcome:

1. After the completion of in plant training, students should be able to get a job in industries
2. Students should be able to secure a research position in any research and development organization or institutions.

Students are expected to get hands on experience in synthesis or analysis in a reputed industries for the period of one month **OR** should carry out the relevant research project under the supervision of Faculty of the department.