DEPARTMENT OF CHEMISTRY
JAHANGIRNAGAR UNIVERSITY
SAVAR, DHAKA-1342

Syllabus for Weekend Masters in Chemistry for Industry and Environment

(WMCIE)

Academic Year: 2021, 2022

Course of study for a Weekend Masters in Chemistry for Industry and Environment degree shall have a duration of 3 semesters in one academic year. A candidate for Weekend Masters in Chemistry for Industry and Environment degree will have to take up courses in Physical, Inorganic and Organic branches. Students shall have to take 12 theoretical courses, each course carrying 50 marks (0.5 units). A 0.5 unit (2 credits) theoretical course will involve 2 lecture hours per week. A student shall have to take 4 courses in each semester. The courses offered by a particular branch will be decided by that branch. The total marks for the practical courses will be 150 (1.5 unit) taking 50 marks (0.5 unit) in each semester. A 0.5 unit (2 credits) practical course will spread over 6 weeks with minimum of 6 hours per week. Students will have a viva voce examination of 50 marks (0.5 unit) at the end of 3rd semester. Assessment of a student in each theoretical and practical course shall be based on marks obtained in the examinations (written, practical), class works and class attendance. Marks allotted for class work, termed as tutorial mark, shall be 20% of the total marks and marks for attendance shall be 10% of the total marks earmarked for each of the theoretical and practical courses. For assessment of class works (tutorial) a minimum of 2 tests for a 0.5 unit course will be taken. Thus the Weekend Masters in Chemistry for Industry and Environment examination shall consist of the following:

		No. of courses	Units	Marks	Credits
1.	Theoretical courses	12	6	600	24
2.	Practical courses	3	1.5	150	6
3.	Viva voce	1	0.5	50	2
	Grand total:	16	8	800	32

1st Semester

		No. of courses	Units	Marks	Credits
1.	Theoretical courses	4	2	200	8
2.	Practical courses	1	0.5	50	2
	Total:	5	2.5	250	10

2nd Semester

		No. of courses	Units	Marks	Credits
1.	Theoretical courses	4	2	200	8
2.	Practical courses	1	0.5	50	2
	Total:	5	2.5	250	10

3rd Semester

		No. of courses	Units	Marks	Credits
1.	Theoretical courses	4	2	200	8
2.	Practical courses	1	0.5	50	2
3.	Viva voce	1	0.5	50	2
	Total :	6	3	300	12

The following courses will be offered for the degree of Weekend Masters in Chemistry for Industry and Environment (WMCIE):

A. Physical Chemistry branch

Theoretical

Course No.	Title of the course	Units	Marks	Credits
WMCIE 810	Concepts of Physical Chemistry	0.5	50	2
WMCIE 812	Polymer Science and Technology	0.5	50	2
WMCIE 814	Industrial Chemistry	0.5	50	2
WMCIE 816	Analytical Techniques, Quality Control and Assurance	0.5	50	2

Practical

WMCIE 815	Experiments in Physical Chemistry	0.5	50	2

B. Inorganic Chemistry branch

Theoretical

Course No.	Title of the course	Units	Marks	Credits
WMCIE 820	Concepts in Inorganic Chemistry	0.5	50	2
WMCIE 822	Instrumental Methods in Chemical Analysis	0.5	50	2
WMCIE 824	Material Science and Nano technology	0.5	50	2
WMCIE 826	Environmental Pollution & Industrial Waste Management	0.5	50	2

Practical

WMCIE 825	Selected Experiments in Inorganic Chemistry	0.5	50	2

C. Organic Chemistry branch

Theoretical

Course No.	Title of the course	Units	Marks	Credits
WMCIE 830	Functional Group Chemistry	0.5	50	2
WMCIE 832	Application of Spectroscopic Methods in Chemical Analysis	0.5	50	2
WMCIE 834	Chemistry in Textile and Dyeing Industry	0.5	50	2
WMCIE 836	Bio and Pharmaceutical Chemistry	0.5	50	2

Practical

WMCIE 835	Organo-applied Experiments	0.5	50	2

D. Viva voce

WMCIE 880	Viva voce	0.5	50	2

Academic Year: 2021, 2022

Course No. WMCIE 810 0.5 Unit, 2 Credit
Concepts of Physical Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives:
The learning objectives of this course are to

- Familiarize the students with concepts of thermodynamics, reaction rates, molecularity and order of a reaction, colloidal systems and adsorption
- Understand and explain different laws of physical chemistry
- Impart knowledge on entropy, and Gibbs and Helmholtz free energy changes for different physical processes
- Increase knowledge on the application of colloids, surface active agents and photochemical processes
- Impart knowledge on thermodynamic parameters, critical micelle concentration, rate constants, kinetics of different reactions

Course Content

1. **First law of thermodynamics:** System and surroundings, state and path functions, work, heat and energy, exact and inexact differentials, changes in internal energy, statement of first law, expansion work, enthalpy, variation of enthalpy with temperature, molar heat capacities, relation between C_p and C_v, adiabatic changes; changes in enthalpy at constant volume, Joule-Thomson effect.
2. **Second and third** laws **of thermodynamics:** Statement of second law, entropy, physical significance of entropy, Carnot cycle, efficiency of heat engine, entropy changes accompanying specific processes, Gibbs and Helmholtz free energies, Gibbs-Helmholtz equation; relations between entropy and probability, statement of the third law.
3. **Kinetics of Empirical and complex reactions:** Rates of reactions, rate laws and rate constants, reaction order; first-order, second-order and zero-order reactions; molecularity of a reaction; types of complex reactions and rate laws, preliminary concepts of collision theory, Arrhenius equation, activated complex theory of reaction rates, Catalysis and enzyme catalysis; Michaelis-Menten kinetics, effect of pH & temperature on enzyme catalysis.
4. **Photochemistry:** Laws of photochemistry; primary and secondary photochemical processes; quantum efficiency; fluorescence; phosphorescence; chemiluminescence; photosensitization; photochemical equilibrium; photochemical chain reactions: hydrogen-chlorine and hydrogen-bromine reactions, lasers and applications of lasers in chemistry.
5. **Surface chemistry:** Adsorption, absorption and sorption; physisorption and chemisorption; adsorption isotherms: Freundlich, Langmuir and BET isotherms; estimation of surface area, surface active agents, micelles and critical micelle concentration (CMC), factors affecting the CMC of surfactants, solubilization.
6. **Colloids:** Definition and classification of colloids; preparation and purification of sols; properties of colloids: optical properties; Tyndall effect; electrical properties: electrophoresis, electrical double layer, zeta potential; stability and coagulation of sols; gels; emulsions, importance of colloids.

Learning Outcomes

Upon successful completion of this course, the students should be able to

- understand the basic laws of thermodynamics & kinetics
- estimate thermodynamic parameters of different reactions and physical processes.
- apply colloids, surfactants, photoactive materials in different industries.
- estimate the parameters of different reactions and physical processes
- solve numerous problems related to thermodynamics, kinetics, and adsorption processes.

Suggested Readings

1. General Chemistry, Raymond Chang, 9th edition, Tata McGraw Hill
2. General Chemistry, D. Ebbing, Houghton Mifflin Company, Boston, New York.
3. Physical Chemistry for the Chemical Sciences, Raymond Chang, University Science Books.
4. Physical Chemistry, P. W. Atkins, W. H. Freeman & Co.
5. Principles of Physical Chemistry; M.M. Huque and M.Y. A. Mollah, Brother's publications.
6. Chemical Kinetics 3rd edition, K. J. Laidler, McGraw-Hill, New Delhi.

Academic Year: 2021, 2022

Course No. WMCIE 812 0.5 Unit, 2 Credit
Polymer Science and Technology 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objective of this course is to

- provides the students with basic concepts in polymer chemistry. Particular emphasis is placed on polymerization reactions-mechanisms and kinetics and methods for molecular characterization of polymers. In addition, polymer degradation, its impact on environment, and natural and biopolymer systems are discussed.
- general understanding of the advanced topics in polymer chemistry and how to apply the concepts in polymer industries.

Course Content

1. **Polymer Structure**: Definition of polymer, difference between polymers and macromolecule. classification of polymers; degree of polymerization, nomenclature and tacticity; basic structure of polymers (linear and branched polymers; moderately cross linked polymer); molecular forces and chemical bonding in polymers.

2. **Molecular weight and size of polymers**: Number average, molecular weight average, Z-average and viscosity, average molecular weight; distribution of molecular weight; determination of molecular weight by end group analysis, osmotic pressure measurement, light scattering, viscosity measurement and ultra-centrifugation.

3. **Polymer synthesis:** (a) step-reaction (condensation) polymerization: mechanism and kinetics of stepwise polymerization, statistics and molecular weight control; (b) Radical chain (addition) polymerization: mechanism-initiation, propagation, termination, kinetics and thermodynamics of radical polymerization, degree of polymerization and chain transfer, ceiling temperature; (c) Ionic polymerization: Similarities and contrasts in ionic polymerization, mechanism and kinetics of cationic and anionic polymerization.

4. **Polymer degradation and the environment**: Polymer degradation and stability: thermal degradation, oxidative and UV stability, chemical and hydrolytic stability, effects of radiation, mechanodegradation; management of plastics in the environment: recycling, incineration, biodegradation.

5. **Biopolymers, natural polymers, and fibers**: Biopolymers and other naturally occurring polymers: protiens, polynucleotides, polysaccharides, naturally occurring elastomers; fibers: natural and synthetic fibers, cellulosics, noncellulosics; fiber-spinning operations.

6. **Rheology of polymer solution:** Rheology and mechanical properties of polymers: Flow behavior of polymers: Newtonian and non-Newtonian flow; Elasticity, viscoelasticity.

Learning Outcomes

Upon completion of this course, the student will be able to

- describe the definition, classification, configuration and conformation, nomenclature of polymers
- explain the molecular weight and distribution of molecular weight
- measure molecular weight by different methods
- understand the different polymerization processes, and kinetics
- discuss the degradation of polymers and its effects on environment
- describe bio and natural polymers, there structures and uses.
- explain types of fibre and there spinning operation.
- understand the rheology of polymer solution

Suggested Readings

1. Polymer Science and Technology, Joel R. Fried
2. Polymer Chemistry, An Introduction, Malcolm Stevents
3. Introduction to Polymer Chemistry (International Student Editions), R. B. Seymour.
4. Polymer Chemistry, M. G. Arora, M. Singh.
5. Principle of Polymerization, Gorge Odian
6. Text Book of Polymer Science (Willey), Fred W. Billmeyer.
7. Introductory Polymer Chemistry, G. S. Misra, Wiley Eastern Limited, India.

Academic Year: 2021, 2022

Course No. WMCIE 814 0.5 Unit, 2 Credit
Industrial Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

- The learning objectives of this course are to give a general understanding of classification, properties, uses and industrial manufacturing process of few important industries in Bangladesh

Course Content

1. **Introduction to Industrial Chemistry:** Types of chemical industries, unit operations and unit processes; evaporation, distillation, crystallization, and their applications in common industries, evaporators and their classification.

2. **Fertilizer industries:** Role of fertilizer in agriculture; classification of fertilizers, manufacture of normal superphosphate, T.S.P. and urea, sources of potash fertilizers, NPK fertilizer, organic fertilizer and their uses.

3. **Sugar and starch industries:** Manufacture of cane sugar and beet sugar, refining of sugar, utilization of by-products; manufacture of starch, dextrin and their uses.

4. **Cement and lime industries:** Chemical composition and classification of cements, cement rock beneficiations, manufacture of Portland cement by wet and dry processes, reactions in kiln, mixing of additive to cement, setting and hardening of cement, testing of cement, types of lime and uses of lime.

5. **Soaps and detergents:** Soap and detergents and their differences, classification of surfactants, biodegradability of surfactants, manufacture of soap and detergent; builders, additives, different types of oils and fats.

6. **Pulp and paper industries:** Types of pulping, Manufacture of (sulphate pulp, sulphite pulp, mechanical pulp), chemicals recovery system, bleaching of pulp, manufacture of paper and paper board.

7. **Glass and ceramics industries:** Raw materials, classification of glass, method of manufacture, basic ceramic chemistry, whitewares.

8. **Leather industries:** Hides and skins, chemical theory of the tanning process, physical characteristics of different types of leather, different parts and their properties of leather.

Learning Outcomes

- Upon completion of this course, the student will be able to describe the properties, classification, uses and the industrial manufacturing methods of fertilizers, sugar and starch, cement and lime, soap and detergent, pulp and paper, glass and ceramic.

Suggested Readings

1. The Chemical Process Industries, R. Norris Shreve, McGraw-Hill, International Book Company.
2. Industrial Chemistry, Emil Raymond Riegel, Reinhold publishing Co.
3. Outlines of Chemical Technology, M. Gopala Rao and Marshall Sittig.
4. Industrial Chemistry, B. K. Sharma, Goel Publishing House, Meerut.
5. A Text Book of Chemical Technology, Vol.-I and Vol.-II, G. N. Pandey, Vikas publishing House Pvt. Ltd.
6. Industrial Chemistry and Chemical Technology, A. S. M. N. H. Bhuiyan, Dhaka University.
7. Industrial Chemistry, Part I and Part II, R. K. Das, Kalyani Publishers, New Delhi.
8. Industrial Chemistry, B. N. Chokraborty.
9. A Text book of Metallurgy, A. R. Bailey.

Academic Year: 2021, 2022

Course No. WMCIE 816 0.5 Unit, 2 Credit
Analytical Techniques, Quality Control and Assurance 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- promote knowledge of the students for application of statistical methods in chemical analysis
- enhance student knowledge in classical analytical techniques for quantitative measurements
- introduce the students with different electro-analytical techniques and their applications
- teach the students acquiring the knowledge of quality control and quality assurance activities in industry

Course Content

1. Application of Statistical Methods in Chemical Analysis: SI Units, significant figures; precision and accuracy; standard addition; internal standards; constructing a calibration curve; limit of detection (LOD), limit of quantification (LOQ).
2. Chemical Analysis by Titrimetric Methods: (a) Neutralization reactions and titrations: Introduction, theory, instrumentation, detection of end point, mixed acid–base titration, titration of polyprotic acid (H_3PO_4), titration of diprotic base (Na_2CO_3); (b) Complexometric reactions and titrations: Introduction, theory, complexes and formation constant, metal–EDTA titration curves, detection of end point, application of complexometric titration; (c) Precipitation reactions and titrations: Introduction, theory/principle, calculation of results from gravimetric data, application of gravimetric method.
3. Chemical Analysis by Electro-analytical Methods: Voltammetry and Polarography: Introduction, principle, apparatus, current voltage relationship, interpretation of polarographic wave, half wave potential, different kinds of currents contributing to the polarographic wave: charging/residual current, migration current, diffusion current; polarographic cells, the dropping mercury electrode (DME), advantage and limitations of DME, common voltammetric methods: linear sweep voltammetry, hydrodynamic voltammetry, normal pulse voltammetry, different pulse voltammetry, cyclic voltammetry, anodic stripping voltammetry, cathodic stripping voltammetry, Application of voltammetric methods for chemical analysis.

4. Analytical Quality Control (QC): Importance of quality control, possible sources & control of quality variation, set up of a quality control laboratory for certain industrial product analysis, expert laboratory personnel, equipment & environments, sample (raw materials/semi-finished products/finished products/packing materials) collection, choice of analytical method, equipment validation, process validation, method validation, calibration check, use of blanks, recovery checking, precision control using internal reference material, accuracy control using certified reference materials (CRM), concept of statistical quality control (SQC) - normal frequency distribution, quality control charts, etc.

5. Quality Assurance (QA): Concept of quality assurance, components of quality assurance - quality management system (QMS), quality motivation, training, standard operating procedures (SOP), laboratory facilities, equipment maintenance and calibration, good manufacturing practice (GMP), procurement, sampling, storage, analysis and disposal, reporting of results; implementation of quality assurance, audits and importance of accreditation.

Learning Outcomes

Upon successful completion of this course, students will be able to

- understand application of statistical methods in chemical analysis
- use of classical methods such as: titrimetric, complexometry, gravimetric, etc. for quantitative measurements
- understand modern electro-analytical methods such as: different types of voltammetry, polarography, their principles and applications in industries and environment
- understand quality control and quality assurance activities

Suggested Readings

1. Instrumental Analysis, D. A. Skoog, F. J. Holler and S. R. Crouch.
2. Analytical Chemistry, 7th edition, Gary D. Christian, Wiley
3. Electrochemistry, B. K. Sharma, 5Th Edition, GOEL Publishing House, India.
4. Electrochemistry: Fundamentals and Applications, A. J. Bard, John Wiley & Sons Inc
5. Electroanalytical Chemistry, J. Wang, 3rd Edition, John Wiley & Sons Inc., 2006
6. Quality Assurance in Analytical Chemistry, Elizabeth Prichard and Vicki Barwick, LGC, Teddington, UK
7. Quality Control in Analytical Chemistry, 2nd Edition, G. Kateman & L. Buydens, John Wiley & Sons Inc.

Academic Year: 2021, 2022

Course No. WMCIE 815 0.5 Unit, 2 Credit
Experiments in Physical Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- acquaint students with some experimental techniques
- impart students skill in using industry based laboratory equipments
- carry out industrial problem based experiment.

Course Content

1. To determine the equivalent conductance of the given strong electrolyte and hence examine the validity of Onsager equation.
2. Determination of the specific reaction rate of the hydrolysis of an ester by NaOH solution (conductometric method).
3. Potentiometric titration of phosphoric acid and calculation of the dissociation constant.
4. To determine thermodynamic quantity from e.m.f. measurement.
5. Influence of temperature on the viscosity of a pure liquid and determination of the activation energy of viscous flow.
6. To study the effect of concentration and ionic strength on the viscosity glycerol solution and determination of the radius of glycerol molecule.
7. Determination of molecular weight of a polymer from viscosity measurement.
8. To determine the critical Micelle concentration of sodium lauryl sulphate from conductivity measurement. Also determine thermodynamics of micellization.
9. To determine the binding constant of a dye molecule with polymer spectrophotometrically.

Learning Outcomes

Upon completion of this course, students will be able to

- handle the simple apparatus/equipments safely
- calculate molecular weight of polymer and dissociation constant of weak acid as well as pK_a values of polybasic acid
- determine equivalent conductivity at infinite dilution and verify onsager equation
- determine critical micelle concentration and thermodynamic parameters of surfactant micellization
- compute emf and thermodynamic parameters of a cell
- analyze and interpret tabulated experimental data.

N.B.: Experiments may be added to or omitted from the above list if necessary.

Suggested Readings

1. Practical Physical Chemistry, A. Findlay, Longmans, Green & Co. Ltd.
2. Practical Physical Chemistry, Palit, Science Book Agency.
3. Practical Physical Chemistry, Sharma, Vikas Publishing House, Calcutta.
4. Advanced Practical Physical Chemistry, J. B. Yadav.
5. Advanced Physical Chemistry Experiments, J. N. Gurtu & Amit Gurtu.

Academic Year: 2021, 2022

Course No. WMCIE 820 0.5 Unit, 2 Credit
Concepts in Inorganic Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- To provide knowledge on different type of bonds observed in inorganic compounds.
- To provide knowledge on valence shell electron pair repulsion theory (VSEPR) and its correlation with hybridization and molecular geometry.
- To impart knowledge about molecular orbital theory (MOT) with particular emphasis on the formation of molecular orbitals from constituents atomic orbitals and its application in determining the structure and stability of a molecule together with bond order and bond lengths.
- To give a comprehensive idea about the crystal field theory (CFT) with particular emphasis on understanding the splitting of d-orbitals in tetrahedral, octahedral and square planar systems.
- To understand the magnetic and electronic properties of coordination complexes using crystal field theory (CFT).
- To impart knowledge about metallic bonding and band theory as well as the importance of these concepts in understanding the basic principles of modern electronic devices.
- To provide a collective idea about different types of chemical reactions participated by inorganic molecules.

Course Content

1. Chemical Bonding and Molecular Geometry: (a) Ionic bonds: General description, lattice energy and Born-Haber cycle, electron configuration of ions. (b) Covalent bonds: General description, octet rule, exception to octet rule, bond polarity, resonance, hydrogen bonding. (c) Valence shell electron pair repulsion theory, hybridization.

2. Metallic Bonding: Theory of metallic bond formation, difference between free electron theory and band theory of solids, bonding in metals and semiconductors, Fermi level, doping, P-type and N-type semiconductor, depleting zone, importance of metallic bond theory in understanding the basic principles of diod, LED and solar cell.

3. Molecular Orbitals Theory (MOT): Characteristics of MOT, HOMO and LUMO (frontier orbitals), bond order, bond length and bond strength, MO potential energy diagram of homo (diatomic molecules and their ions) and hetero diatomic molecules: (HF, HCl, CO, NO etc.), formation of molecular orbital from atomic orbitals (only pictorial representations).

4. Bonding in coordination compounds: Introduction to crystal field theory, energy level splitting, octahedral complexes, tetrahedral complexes, square planar complexes, high-spin versus low-spin octahedral complexes, orgel diagrams, magnetic and electronic properties, spectrochemical series.

5. Selected topics: Acid-base reaction, self-ionization of water and pH, common ion effect, buffer, precipitation reaction, oxidation-reduction reaction, clathrate inclusion compounds, organometallic complexes.

Learning Outcomes

Upon completion of this course the students will be able to

- To understand chemical bonding found in different types of inorganic molecules/systems.
- To comprehend the concept of molecular orbital theory (MOT) and can use it to explain the structural, electronic and magnetic properties of different types of molecules.
- To comprehend the ideas of VSEPR theory and can use this theory to determine the shapes of different types of molecules.
- To understand the splitting of d-orbital in different types of coordination complexes as well as can explain the electronic and magnetic properties of such complexes.
- To understand the bonding in metals and semiconductor materials as well as why such materials are used modern electronic devices such as LED and solar cells.

Suggested Readings

1. Basic Inorganic Chemistry, F. A.Cotton and G. Wilkinson, John Wiley & Sons,Inc.New York.
2. Inorganic Chemistry, J. E. Huhee, E. A. Keiter, R. L. Keiter and O.K. Medhi, Pearson Pub.
3. Theoretical Inorganic Chemistry, M.C. Day and J. Selbin, East-west Press.
4. Atomic structure & Chemical bond including Molecular Spectroscopy, Manas Chanda, Tata McGraw-Hill Publishing Company Ltd.
5. Inorganic Chemistry, 3rd Ed., C. E. Housecroft and A. G. Sharpe, Pearson.
6. Inorganic Chemistry, 3rd Ed., G. L. Miessler and D. A. Tarr, Pearson, India.
7. Inorganic Chemistry, D. F. Shriver and P. W. Atkin, Oxford University Press.

Academic Year: 2021, 2022

Course No. WMCIE 822 0.5 Unit, 2 Credit
Instrumental methods in Chemical Analysis 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course is to

- understand the basis of instruments used in chemical analysis.
- gather knowledge on different sampling techniques
- enable students data processing and their analysis.
- be familiar with techniques of analysis using UV and atomic spectroscopy and their instrumentation.
- introduce students to different chromatographic techniques including TLC, paper, Gas and HPLC and Ion exchange chromatography.

Course Content

1. Introduction to instrumental methods: Types of instrumental methods, instruments for analysis, operational amplifiers, signal and noise, components of optical instruments, Radiation sources, wavelength selector, sample holder, detectors, signal processors and readout.

2. Sampling and Data processing: (a) Sampling procedure, sample preparation, representative sample, (b) accuracy, precision, mean, deviation, standard deviation, Errors: classification, sources and minimization; Tests for accuracy/precision: confidence level, t-test, F-test, Q-test, least square method.

3. UV-Visible spectroscopy: Principles of molecular absorption, instrumentation, quantitative estimation.

4. Atomic spectroscopy: Principle of atomic spectroscopy (AAS, AES, AFS): origin of spectra, line broadening & intensity, interference, quantitative estimation by AAS.

5. X-ray spectroscopy: Principle of X-ray spectroscopy, origin of spectra, quantitative estimation.

6. Chromatography: Basic principles, classification, paper chromatography, thin layer chromatography, column chromatography, gas chromatography, HPLC, ion-exchange chromatography, size exclusion chromatography.

Learning Outcomes

Upon completion of this course the students

- will understand the concepts of accuracy precision, mean deviation, standard deviation and different test methods such as Q,F tests and least square method.
- promote knowledge on different instrumental methods as well as chromatographic methods such as TLC, HPLC etc. and electro chemical methods.

Suggested Readings

1. Principles of Instrumental Analysis, Douglas A Skoog and James J Leary.
2. Fundamentals of Analytical Chemistry, D. A. Skoog & D. M. West, Saunders Publishing.
3. Atomic Absorption and Emission Spectroscopy, Ed Metcalfe, John Wiley & Sons.
4. Analytical Chemistry, G. D. Christian, Wiley.

Academic Year: 2021, 2022

Course No. WMCIE 824 0.5 Unit, 2 Credit
Material Science and Nanotechnology 35 + 10 + 5 = 50 Marks

Learning Objectives

The learning objectives of this course are to

- promote knowledge on synthesis and properties of semiconductors, superconductors and conducting polymers.
- impart knowledge on liquid crystals, LED/photovoltaic inorganic materials
- convey knowledge on nanomaterials, carbon based nanomaterials, ceramic materials with particular emphasis on metal oxide, silicon carbides and silicon nitrides.
- know the applications of nanomaterials

Course Content

1. **Electronic Materials:** (i) Semiconductors, (ii) Superconductors, (iii) Conducting polymers.
2. **Liquid Crystals:** Molecular structure and liquid crystallinity, types of liquid crystals, applications, design and synthesis of liquid crystals.
3. **LED/Photovoltaic Materials:** Principle and implication of photovoltaic materials, material design and device fabrication (LED, solar cell).
4. **Nano Materials:** (i) Overview, classification and characterization techniques, (ii) Metallic nanoparticles: structure and bonding, size-dependent properties, synthesis, (iii) Carbon based nano-systems: Fullerene, graphene and carbon nanotube: synthesis, properties, (iv) Ceramic nanoparticles based on metal oxides, SiC and SiN.
5. **Application of Nanomaterials:** Structural and mechanical applications, Colorants and pigments, Electronic and magnetic materials, Biomedical applications.

Learning Outcomes

Upon completion of this course the students will be able to

- understand the design, synthesis and preparation of semi- and superconducting materials with wide range of their applications.
- know the design and fabrication strategies of LED and photovoltaic materials
- gather knowledge on the preparation, properties and structures of nanomaterials, and their behavioral features at micro- and nanoscale levels.
- demonstrate various applications of nanomaterials

Suggested Readings

1. Inorganic Materials, Duncan W. Bruce and Dermot O′hare (Ed.), 2nd ed., John Wiley & Sons.
2. Nanoscale Materials in Chemistry, Kenneth J. Klabunde (Ed.), John Wiley & Sons.
3. Nanoscale Materials in Chemistry, K. J. Klabunde and R. M. Richards (2nd Ed.), John Wiley & Sons.
4. A Chemical Approach to Nanomaterials, G. A. Ozin & A. C. Apsenault, RSC Publishing.

Academic Year: 2021, 2022

Course No. WMCIE 826 0.5 Unit, 2 Credit
Environmental Pollution & Industrial Waste Management 35 + 10 + 5 = 50 Marks

Learning Objectives

- Introduce students to the greenhouse effect and the associated the environmental and ecological problems
- Introduce students to the fate and transport of major pollutants in various natural and perturbed environments
- Educate students on the principles of wastewater treatment and solid waste management strategies

Course Content

1. Atmospheric pollution: (a) Concepts of air pollution: composition of the atmosphere, types of pollutants and their sources, particulate matters in the atmosphere, the automobiles as a polluter, acid rain, biochemical effects of some air pollutants, major sources of air pollution in Bangladesh, Ozone layer depletion.

2. Green House Effect and Global Warming: Sources and sinks of greenhouse gases, Green House Potential of different gases, Sea level rise and other environmental impacts resulting from global warming.

3. Water and soil pollution: Nature and type of water pollution, inorganic and organic pollutants in aquatic environments, algal nutrient and eutrophication in surface waters, industrial water pollution, water quality parameters and standards, mobilization of arsenic in ground water, ground water arsenic pollution in Bangladesh, soil pollution by agrochemicals.

4. Noise Pollution: General consideration; Evaluation of industrial noise, Sources, Methods and techniques to control and reduce noise level.

5. Hazardous wastes: Introduction, classification of hazardous substances, sources, physical forms and segregation of wastes, physical and chemical properties of hazardous wastes, waste reduction and minimization, recycling, biodegradation.

6. Waste water treatment: Concept of Effluent Treatment Plant (ETP), Chemical and biological treatment technologies.

7. Solid waste Management: Incineration, composting, landfilling, pyrolysis, resource recovery, 5R's of waste management.

Learning Outcomes

Upon completion of this course, the students will be able to:

- know the compositions of earth's atmosphere, understand the chemistry of the atmosphere, sources and biochemical effects of air pollutants.
- understand the sources and effects of water and noise pollution, hazardous materials.
- know about the general characteristics of wastewater and solid waters, the general methods of waste treatment and management.

Suggested Readings

1. Fundamentals of Environmental Chemistry, S. E. Manahan, Lewis Publisher, NY.
2. Environmental Chemistry, R. W. Raiswell, Science.
3. Environmental Chemistry, Moore and Moore, Academic Press.
4. Handbook of solid waste management, Frank kreith, McGRAW-HILL.
5. Environmental Chemistry with green chemistry. Asim K. Das. Books and allied (p) Ltd. Kolkata, India.

Academic Year: 2021, 2022

Course No. WMCIE 825 0.5 Unit, 2 Credits
Selected Experiments in Inorganic Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

The objectives of this course are to provide knowledge about:-

- the preparation of coordination complexes.
- various types of titrations such as: acid-base, oxidation-reduction, and complexomatric titrations using EDTA.
- quantitative analysis of ions using volumetric and gravimetric methods.
- environmental water quality analysis.

Course Content

Experiments may be added to or omitted from the list depending on circumstances.

1. Inorganic Synthesis

1.1 The preparation of tris(thiourea)copper(I) sulfate.

1.2 The preparation of tris(acetylacetonato)manganese (III) and comparison of its IR spectra with that of ligand.

2. Neutralization Titration

2.1 Standardization of approximately 0.1M NaOH solution against succinic acid.

2.2 Standardization of approx. 0.1M HCl by titration with standard 0.1M NaOH (using both methyl orange and methyl red indicator).

3. Oxidation-Reduction Titrations

3.1 Determination of Ferrous iron by oxidation with standard $K_2Cr_2O_7$ solution;

3.2 Determination of Ferric iron with standard $K_2Cr_2O_7$ solution;

4. Complexometric Titrations Using EDTA.

4.1 Determination of zinc by direct titration using Eriochrome-Black T as indicator.

4.2 Determination of total hardness of water (temporary and permanent) using Eriochrome Black - T as indicator.

5. Quantitative Analysis.

5.1 Determination of lead as lead chromate.

5.2 Determination of sulfate as barium sulfate.

6. Water Quality Analysis

6.1 Determination of dissolve oxygen (DO).

6.2 Determination of chemical oxygen demand (COD) of a water sample.

Learning Outcomes

After completion of this course the students will be able to-

- synthesize coordination compounds.
- quantitatively analyze metal ions by complexometric titration.
- determine the amount of ions volumetrically and gravimetrically.
- analyze water quality by measuring DO and COD.

Suggested Readings

1. Vogel's Textbook of Quantitative Chemical Analysis, G.H. Jeffery, J. Bassett, J. Mendham & R.C. Denny, Longman and ELBS.
2. Practical Inorganic Chemistry, Preparations, reactions and instrumental methods, G. Pass and H. Sutcliffe, Chapman and Hall, New York.
3. Inorganic Experiments, Ed., J. D. Woollins, VCH Verlagsgesellschaft mbh, Weinheim.

Academic Year: 2021, 2022

Course No. WMCIE 830 0.5 Unit, 2 Credit
Functional Group Chemistry 35 + 10 + 5 = 50 Marks

Learning objectives

Learning objectives of this course are to

- understand fundamental ideas about the various classes of organic compounds, their preparations and their physical & chemical properties.
- be familiar with the mechanism of the reactions containing different functional groups.

Course Content

1. Alkene and Aromatic Hydrocarbons: (i) Structure and chemistry of alkene: Electrophilic and Radical addition reactions; (ii) The concept of aromaticity and Hückel's Rule; Reactions: Electrophilic aromatic substitution reactions with mechanism, effects of activating and deactivating groups.

2. Alkyl and Aryl Halides: (i) Structure, physical properties and preparation; (ii) Reactions: Nucleophilic substitution reactions (S_N1 and S_N2) and Elimination reactions (E1 and E2) with mechanism.

3. Alcohol and Phenol: (i) Structure and physical properties (acidity and basicity of alcohols and phenols); (ii) Important reactions of alcohols and phenols: Substitution, Esterification, Oxidations, Ring Substitution, Reimer-Tiemann reaction; Phenol-formaldehyde resin of phenol, the Pinacol-Pinacolone rearrangement, Periodic acid oxidation of glycols.

4. Carbonyl Compounds: Physical properties; Reactions: Nucleophilic addition to carbonyl group with mechanism, Cannizzaro reaction, Aldol condensation, Perkin reaction, Knoevenagel & Stobbe reaction, Benzoin condensation and Wittig reaction.

5. Carboxylic Acids and Their Derivatives: (i) Physical properties and synthetic methods; (ii) Reactions: Nucleophilic acyl substitution reaction, study of mechanism, reactivity and interconversion of acid derivatives.

6. Amines: Reactions of amines with nitrous acid, Replacement and Coupling reactions of arenediazonium salts; Synthesis of Drugs: Sulfanilamide, Sulfadiazine, Paracetamol and Aspirin.

7. Heterocyclic Compounds: (i) Chemistry and structure of five and six membered heterocyclic compounds containing hetero atom: Pyridine, Imidazole, Pyrimidine; (ii) Chemistry and structure of fused ring heterocyclic compounds: Indole, Quinoline and Isoquinoline.

Learning Outcomes

Upon completion of this course students will be able to

- understand the physical and chemical properties of the compounds containing different functional groups.
- know the preparation and derivatives of aldehydes, ketones, carboxylic acids, amines.
- analyze and compare the reactivity of various functional groups.

Suggested Readings

1. Organic Chemistry, R.T. Morrison & R. N. Boyd, 6th Edition, Prentice-Hall International, INC.
2. Organic Chemistry, W. H. Brown and C. S. Foote, 2nd Edition, Saunders College Publishing.
3. Organic Chemistry, I. L. Finar, Vol. I & II, Longman Group Ltd., Pearson.
4. A guide book to mechanism in organic Chemistry, Peter Sykes, 6th edition, Orient Longman Ltd.
5. Advanced Organic Chemistry, J. March, McGraw Hill.
6. An introduction to heterocyclic compounds, R. Morrin Acheson, Academic press.

Academic Year: 2021, 2022

Course No. WMCIE 832 0.5 Unit, 2 Credits
Application of Spectroscopic Methods in Chemical Analysis 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- develop the basic ideas of the effects of different types of electromagnetic radiations on molecules.
- analyze UV-Visible, IR and NMR spectral data to elucidate the structure of compounds
- use mass spectral data and fragmentation pattern to determine the molecular weight and structure.

Course Content

1. **Ultraviolet (UV) and Visible Spectroscopy:** Shifts of bands with solvents-the isolated double bond-conjugated dienes, Woodward-Fieser rule for calculating λ-max of alkenes, carbonyl compounds, benzene and its derivatives.

2. **Infrared Spectroscopy (IR) and Raman Spectroscopy:** FT-IR, applications of IR spectroscopy-interpretation of IR spectra-characterization of functional groups and frequency shifts associated with structural changes-structural elucidation. Raman spectroscopy & its application.

3. **Nuclear Magnetic Resonance (NMR) Spectroscopy:** Introduction-chemical shifts-theory of PMR spectroscopy-spin-spin splitting-complex spin-spin splitting-first order, non-first order spectra, vicinal coupling; proton exchange reactions; variable temperature spectra, simplification of complex spectra-LSR & spin decoupling-new techniques in FT-NMR-NOE- difference spectra; introduction to 2D techniques: COSY; **^{13}C NMR spectroscopy**: operating frequency-^{1}H decoupling; off resonance decoupling, broad band and gated-DEPT.

4. **Mass Spectroscopy:** Ionization of a molecule on electron impact, the mass spectrum-detection of the presence of the isotopes-recognition of molecular ion peak, meta-stable ions, fragmentations: McLafferty rearrangement, nitrogen rule, mass spectra of different classes of organic compounds.

5. Structure-elucidation of organic and inorganic compounds by combined UV, IR, NMR and Mass spectra.

Learning Outcomes

Upon completion of this course students will be able to

- interpret an IR spectrum to find the nature of bonds present in a molecule.
- use IR spectrum to identify geometric isomers and monitor chemical reactions.
- analyze the UV-Visible spectrum to find the type of chromophores and purity of drugs.
- interpret different types of NMR spectra specially ^{1}H, ^{13}C and 2D to determine the structure of a molecule.
- apply mass spectral data to find the molecular mass and structure.
- identify unknown molecules using a combination of all the spectroscopic techniques.

Suggested Readings

1. Spectroscopic methods in Organic Chemistry, Fourth Ed., D. H. Williams & Ian Fleming, Tata McGraw-Hill Publishing Company Ltd.
2. Spectroscopy, D. L. Pavia, G. M. Lampman, G. S. Kriz, Ceugage Learning India Private Ltd.
3. Spectroscopy of Organic Compounds, 6th edition, P. S. Kalsi, Wiley Eastern Limited.
4. NMR and Chemistry, J. W. Akitt, Springer.
5. Structure Elucidation, Modern NMR-H. Duddeck, W. Dietrich, Springer-Verlag New York.
6. Organic Spectroscopy, W. Kemp, ELBS with Macmillan.
7. Organic Spectroscopy, V. R. Dani, Tata McGraw-Hill Publishing Company Ltd.
8. Modern NMR Spectroscopy (in Bangla) by M. Rabiul Islam and Mirza Aminul Huq, Ashrafia Boighar, Dhaka.
9. Modern Mass Spectroscopy (in Bangla) by Mirza Aminul Huq and M. Rabiul Islam, Bangla Academy, Dhaka.
10. Spectroscopic Identification of Organic Compounds, 6th edition, Robert M. Silverstein and Francis X. Webster, John Wiley & Sons. Inc.

Academic Year: 2021, 2022

Course No. WMCIE 834 0.5 Unit, 2 Credits
Chemistry in Textile and Dyeing Industry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objective of this course is to provide in-depth understanding of chemistry about different aspects of textile industry such as fiber, washing, bleaching, dyeing, printing and finishing.

Course Content

1. Textile Fibers: Concepts of textile fiber and their raw materials. Classification and properties of textile fibers. Natural fibers: Sources and chemical composition of cotton, wool and silk. Synthetic fibers: Criteria of fiber forming polymer, use of nylon 6, nylon 6,6, polystyrene and polyester. Conversion of fiber to yarn and fabrics.

2. Dyeing and Printing: Introduction to dyes, requisites of true dye, Era of natural dyes, nomenclature of dyes, classification of dyes, dyeing, color fastness, synthesis of Vat dyes. Dyeing auxiliaries & their functions. Preparation of print paste, printing with disperse dye, printing with sulpher dye, printing with insoluble azoic colors, pigment printing.

3. Washing, Drying and Bleaching: Requirements of washing, different types of washing, caustic wash, pigment wash, silicon wash and acid wash. Drying process, whiskering and grinding. Bleaching, bleaching agents, properties and uses of hydrogen peroxide in bleaching.

4. Testing and Quality Control: Definition and purpose of QC, SQC, QA and TQM. Testing of physical parameters of fiber, yarn and fabrics. Testing the substance in dyestuffs; formaldehyde, phthalate, Azo-compounds in dye materials, heavy metals etc., testing methods. Use of BSTI, ISO, ASTM, British, and Indian standards.

5. Chemical Finishing: Different types of chemical finishing, chemistry of cross-linking agents and their effect on the properties of cotton, problems of formaldehyde based finishes, Application of different water repellents finishes, paraffin repellents, stearic acid-melamine repellents, and silicone repellents.

Learning Outcomes

Upon completion of this course students will be able to

- understand the chemistry in textile fibers.
- know the process, importance and application of washing and bleaching.
- acquire knowledge about the chemistry dyeing and printing in textile industries.
- understand the aspect of chemistry in textile finishing such as resin finishing, water repellency, etc.

Suggested Readings

1. Textile Chemistry by R. H. Peter, Vol – 1 & 2
2. Chemical Technology in the Pretreatment Process of Textiles by S. R. Karmakar
3. Textile Preparation and Dyeing by Asim Kumar Roy Chowdhury
4. Textile Scouring and Bleaching by E. R. Trotman
5. An Introduction to Textile Printing by Butterworth
6. Synthetic Dyes, Gurdeep R. Chatwa, Himalaya Publishing House
7. Modern Techniques of Textile Dyeing Bleaching and Finishing by S. M. Arora
8. Chemistry of Dyes and Principles of Dyeing, V. A. Shenai
9. Reactive Dyes for Textiles by A. Hunter M. Renfrew

Academic Year: 2021, 2022

Course No. WMCIE 836 0.5 Unit, 2 Credit
Bio and Pharmaceutical Chemistry 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- introduce students to general pharmaceutical process used for manufacturing drugs.
- understand function of drugs, their classifications, synthesis, routes of administration.
- describe the formulation of pharmaceutical products and advantages/disadvantages associated with the process.
- analyze drugs using different chemical, chromatographic and spectroscopic methods.
- introduce with the regulatory body and their principles.

Course Content

1. **Biochemical aspects of Enzymes**: Characterization and classification; coenzyme and prosthetic group; enzyme inhibition, enzyme specificity, brief treatment on enzymatic reaction mechanism and its regulation.

2. **Vitamins and Hormones**: (a) **Vitamins**: Definition and classification; source, dietary requirements, physiological action and deficiency symptoms of vitamin A & D, thiamine, riboflavin and ascorbic acid; (b) **Hormones**: Definition and classification; effects of insulin and thyroxine on cellular metabolism.

3. **Chemical technology of selected bulk drugs**: Case studies with emphasis on rationale for selection of routes, raw materials, process control methods, pollution control procedures etc. (examples depicting novel routes, ideal synthesis) for bulk drugs, Scale-up techniques for process optimization, maximization of productivity, in process control techniques with examples, typical standard operating procedures for different dosage forms.

4. **Molecular docking and structure activity relationships in drug design**: Concept of docking and its classification; advantages and disadvantages of flex-X, flex-S, Monte Carlo simulations. Qualitative versus quantitative approaches, advantages and disadvantages; random screening, nonrandom screening, structure based drug design, ligand based drug design, QSAR.

5**. Analytical Instruments used in Quality Control Department:** FT-IR, HPLC, Karl Fischer Titrators

Learning Outcomes

Upon completion of this course students will be able to

- acquire preliminary knowledge about the pharmaceutical process.
- realize the functions & way of drugs synthesis and the effects on living systems.
- formulate pharmaceutical products considering advantages and disadvantages associated with the process.
- analyze drugs by physical and chemical methods using modern instruments.
- learn how to proceed in pharmaceutical regulations.

Suggested Readings

1. Biochemistry, Lehninger, Kalyani Publishers.
2. Harper's Biochemistry, Robert K. Murray, Daryl K. Granner, Appleton & Lange.
3. Biochemistry, U. Satyanarayana, New Central Book Agency (p) Ltd.
4. Biochemistry, 6th ed., Denise R. Ferrier.
5. Good manufacturing practices for pharmaceuticals. Sidney H. Willing., Wiley Ltd. 2nd ed.
6. Introduction to pharmaceutical chemical analysis, Steen Honore and Hansen et al.
7. Environmental and Toxicological Chemistry, Stanley E. Manahan, Tailor and Francis, 4th ed.

Academic Year: 2021, 2022

Course No. WMCIE 835 0.5 Unit, 2 Credit
Organo-applied Experiments 35 + 10 + 5 = 50 Marks

Learning Objectives

Learning objectives of this course are to

- expose students to basic concepts and techniques related to quantitative chemical analysis.
- provide experimental knowledge on assay of tablets such as vitamin C and aspirin.
- lay foundation on quantitative analysis of different types of functional groups.
- give working experience to determine saponification number of oils.

Name of the experiments:

1. Assay of L-Ascorbic acid.
2. Assay of Vitamin C-tablets.
3. Assay of Aspirin.
4. Assay of Aspirin tablets.
5. Quantitative estimations of OH groups.
6. Quantitative estimations of NH_2 groups.
7. Quantitative estimations of an acid.
8. Determination of saponification number of soybean oils.

Learning Outcomes

Upon completion of this course students will be able to

- assay tablets like vitamin C, aspirin.
- demonstrate pharmaceutical and titrimetric methods for drug analysis.
- know the process how to estimate functional groups.
- determine and calculate saponification number for soybean oil.
- understand and apply various analytical techniques to chemical analysis.

Suggested Readings

1. Text Book of Practical Organic Chemistry, Vogel's, 5th edition, ELBs with Longman.
2. Elementary Practical Organic Chemistry, Part III, Quantitative Organic Analysis by Vogel's.
3. Laboratory Manual, Department of Chemistry, Jahangirnagar University.