Dhaka University Affiliated Colleges
Syllabus for M.Sc. (Final Year) in Chemistry
(Effective from Session: 2016-17)

Students willing to study M.Sc. in Chemistry must take six of the following theory courses and all practical courses.Each theory course carries 4 (four) credits and practical course carries 2 (two) credits. Two theory courses must be taken by the students from each group. The weightage of assessment for theory course will be of 100 marks.In which20% of the marks are allotted to class assessment, comprising arithmetical mean of two one hour in-course examinations of 15% marks and 5% marks are for class attendance. There will be a 4-hour course final examination of 80% marks.The allocation of marks to each practical course is 50. During practical examination a student has to perform three experiments one from each course. The duration of each experiment will be 6 hours. The students may accomplish a thesis work equivalent to 6 credits in lieu of practical. Each student has to appear in a viva-voce examination/thesis defense of 2 (two) credits.

Group 1

1. **MC 7541Chemical Bonding and Group Theory**
2. **MC 7542Chemistry of Solids**
3. **MC 7543 Analytical Chemistry**

Group 2

4. **MC 7544Organic Reaction Mechanism and Stereochemistry**
5. **MC 7545 Chemistry of Food and Drugs**
6. **MC 7546Environmental Pollution and Monitoring**

Group 3

7. **MC 7547Chemical Kinetics and Surface Chemistry**
8. **MC 7548Spectroscopy and Its Application**
9. **MC 7549Chemistry of Polymers and Biopolymers**

Group 4

Practical courses

10. **MC 7550Physical Chemistry Experiments**
11. **MC 7551 Organic Chemistry Experiments**
12. **MC 7552Inorganic and Analytical Chemistry Experiments**
13. **MC 7553 Viva voce**

MC 7541 Chemical Bonding and Group Theory (4 Credits, 100 marks)

1. **Electron Deficient Bonding:** Three-center-two-electron bond in boranes, polyhedral skeletal electron pair theory (PSEPT), calculation of the number of electron deficient bonds, structures of some higher boranes and the carboranes.

2. **Bonding in Coordination Complexes:** Structure of ML_6 and ML_4 complexes, complexes of high coordination numbers (higher than six) and their structural aspects, crystal field theory, splitting of d^n terms in various fields, spectrochemical series, crystal field stabilization energies (CFSE) for d^1 to d^{10} systems in octahedral and tetrahedral fields, Jahn-Teller distortion, Nephelauxetic effect, other evidences of metal and ligand orbital overlap, molecular orbital theory, molecular orbital model of ML_6 and ML_4 complexes, electronic spectra of metal complexes in solution, selection rules and intensities of UV-Vis absorption, microstates, term symbols, Orgel diagrams, strong field cases and correlation diagram, Tanabe-Sugano diagrams, spectra of distorted octahedral and square planar complexes, calculation of Dq, B and β, ligand to metal and metal to ligand charge transfer (LMCT and MLCT) transitions, spectral properties of lanthanide and actinide complexes, f-f transitions, f-d transitions and their sensitivity to ligand environment.

3. **Bonding in Organometallics:** 18-electron rule and its applicability, electron counting, synergic bonding, isoelectronic and isolobal analogy, σ-bonded alkyl organometallic compound, Ziegler Natta polymerization, bonding description and reactivity of π-bonded organometallic compounds including alkene, alkyne, arene compounds, Fischer vs. Schrock Carbenes, agostic interaction, fluxionality.

4. **Metal-Metal Bonds and Transition Metal Clusters:** Binuclear clusters, trinuclear clusters, octahedral clusters, chevrel phases, metal-only clusters - zintl cluster ions such as germides, stannides and plumbides, Wade's rule to elucidate the structure of zintl phases, metal-metal bonds in stacked polymeric structure.

5. **Molecular Symmetry, Group Theory and Applications:** Symmetry elements and operations, point groups, group multiplication tables, matrix representations for group elements, orthogonality theorem and its applications, character and character tables, interpretation of character tables of chemically important symmetry groups, symmetries of atomic orbitals, symmetry and molecular orbitals, molecular vibrations, other important aspects of molecular symmetry.

Books Recommended

1. Inorganic Chemistry, J. E. Huheey.
2. Inorganic Chemistry, G. L. Miessler and D. A. Tarr.
3. Fundamental Concepts of Inorganic Chemistry, A. K. Das, Vol. 3.
4. Organotransition Metal Chemistry: From Bonding to Catalysis, John Hartwig.
5. The Organometallic Chemistry of the Transition Metals, R. H. Crabtree.
6. Introduction to Metal π-Complex Chemistry, M. Tsutsui, M. N. Levy, A. Nakamura, M. Ichikawa, and K. Mori.
7. Basic Organometallic Chemistry, B. D. Gupta and A. J. Elias.
8. Organometallic Chemistry, R. C. Mehrotra and A. Singh.
9. Chemical Applications of Group Theory, F. A. Cotton.

MC 7542 Chemistry of Solids (4 Credits, 100 marks)

1. **Materials:** Basic concept of materials science, classification of materials, composite materials, smart and intelligent materials, nanomaterials, an overview of material science and engineering and its recent developments.

2. **Synthesis of Solid Materials:** Reaction types, quality criteria and assessments, thermodynamic of solid-state reactions, crystal growth, single crystal growth techniques – solution growth, Czochralski, chemical vapour transport, fused salt

electrolysis, hydrothermal method, flux growth, liquid crystals, classification of liquid crystals and their possible phase transition, chemical structure elements in liquid crystals, application of liquid crystals, solid solutions, requirements for solid solution formation type of solid solutions.

3. **Composite Materials:** Particle-reinforced composites: large-particle composites, dispersion-strengthened composites, fiber-reinforced composites, influence of fiber length, influence of fiber orientation and concentration, the fiber phase, the matrix phase, polymer-matrix composites, metal-matrix composites, ceramic-matrix composites, carbon-carbon composites, processing of fiber-reinforced composites, hybrid composites, structural composites - laminar composites, sandwich panels, materials of importance - biomaterials and advanced ceramics.

4. **Smart Materials:** Ceramics, alloys, gels and polymers, piezoelectric materials, electrostrictive and magnetostrictive materials, rheological, thermoresponve, pH sensitive halochromic materials, electrochromic materials and smart gels.

5. **Nanomaterials in Chemistry:** Introduction to nanomaterials and nanochemistry, classification of nanomaterials, general methods of preparation and applications. Chemical and catalytic aspects of nanocrystals – nanomaterials in catalysis, as adsorbents, as new chemical reagents.

6. **Properties of Solid Materials:** (a) Ideal and defect structures of MX, MX_2, M_2X, MX_3, M_2X_3, $A_mB_nX_p$ type solids. (b) Phase transitions, classifications of phase transition, stable and metastable phases, representations, on phase diagrams, (c) conductivity, band theory of inorganic solids, semiconductors - extrinsic and intrinsic, Hall effect, insulators - dielectric, ferroelectric, pyroelectric and piezoelectric properties, (d) Color of inorganic solids. (e) Structure and magnetic property relation of transition metal oxides, spinel, garnets and perovskites.

7. **Characterization of Solid Materials:** (a) X-ray diffraction - production of X-rays, Bragg's equation, Powder method – principles, instrumentation and application for structural studies. (b) Neutron diffraction: neutron diffraction, applications, merits and limitation. (c) Electron Microscopy: electron diffraction, principles and applications, transmission electron microscopy (TEM), Scanning electron microscopy (SEM), analytical electron microscopy (AEM).

Books Recommended

1. Materials Science and Engineering: An Introduction W. D. Callister.
2. The Science and Engineering of Materials, D. R. Askeland, P. Phulé,
3. Foundations of Materials Science and Engineering, W. F. Smith.
4. Solid State Chemistry and its Applications, A. R. West.
5. Solid State Chemistry-Techniques, A. K. Cheetham and P. Dey.
6. Introduction to Solid State Physics, C. Kittel.
7. Solid State Chemistry: An Introduction, L. E. Smart and E. A. Moore.
8. Basic Solid State Chemistry, A. R. West.

MC 7543 Analytical Chemistry **(4 Credits, 100 marks)**

1. **Liquid Chromatography Techniques:** Introduction, various forms of liquid chromatography,
   (i) Ion Exchange Chromatography: Principles, ion exchange resins, factors affecting separation factor, applications.
   (ii) High Performance Liquid Chromatography (HPLC): Principles, equipment, pumps, column efficiency, characteristics of detector, detectors used, advantages of HPLC, applications.
   (iii) Gas Liquid Chromatography (GLC): Principles, instrumentation - carrier gas, columns, the solid inert support, detector types, factors affecting separation, scope of GLC.
   (iv) Gas Chromatography and Mass Spectrometry (GC-MS): Principles, selective ion mode (SIM) and SCAN, quantification by SIM and SCAN method, common trouble shooting in operating GC-MS, use of GC-MS.

2. **Flame Photometry and Atomic Absorption Spectroscopy:** Atomic absorption and atomic emission, flame emission spectrometry – flame emission analysis, instrumentation, uses, atomic absorption spectrophotometry - basic principles,

instrumentation, interferences, background correction, sample requirements, operating techniques and applications, hydride vapour generation technique, advantages and disadvantages of AAS.

3. **Electrophoretic Techniques:** Principle of electrophoresis, types of electrophoresis, scope of separation of low and high molecular weight charged materials including DNA, protein, enzymes etc., sample introduction and detection.
4. **Thermal Analysis:** Working principles, instrumentation and uses of thermogravimetric analysis (TGA), derivative thermogravimetric analysis (DTGA), differential thermal analysis (DTA), and differential scanning calorimetry (DSC).

5. **Electron and Neutron Diffraction Techniques:** Basic principles, applications and the limitations of these techniques.

6. **Radiochemical Analysis:** Neutron activation analysis, particle induced activation analysis, isotope dilution analysis, radiotracer techniques, age determination - dating of rocks, minerals and fossil fuels and in medicine and biology.
7. **Methods in Analysis of Biological Samples:** Principles of detection and quantitative determination of sugars, proteins and lipids, low density lipoproteins (LDL), high density lipoproteins (HDL), triglycedride (TG) in blood.

Books Recommended

1. Practical Liquid Chromatography, S. G. Perry, R Amos, and P. I. Brewer.
2. Chromatography, B. K. Sharma.
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and T. A. Nieman.
4. Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch.
5. Analytical Chemistry, R. Kellner, J. -M. Mermet, M. Otto and H. M. Widmer edited.
6. Modern Analytical Chemistry, D. Harvey.
7. X-ray Structure Determination – A Practical Guide, G. H. Stout and L. H. Jensen.
8. Solid State Chemistry and Its Applications, A. R. West.
9. Radiochemistry and Nuclear Methods of Analysis, W. D. Ehmann and D. E. Vance.

MC 7544 Organic Reaction Mechanism and Stereochemistry (4 Credits, 100 marks)

1. **Molecular Orbitals and Frontier Orbitals:** Hückel molecular orbital (HMO) method, evaluation of aromaticity and the 4n+2 rule in terms of HMO method, prediction of thermal and/or photochemical reactions on the basis of aromatic and Möbius transition state concept, calculation of resonance energy by using α (coulomb integral) and β (resonance integral), frontier orbital theory; HOMO and LUMO; perturbation theory of reactivity; the α-effect; interpretation of ionic, pericyclic and radical reactions in terms of frontier orbital theory.

2. **Kinetics and Energetics in Reaction Mechanism:** Consecutive reactions-the steady-state approximation; parallel reactions, reversible reactions, derivation of the rate expressions, variation in kinetics in acid and base-catalyzed reactions; ambiguities in interpreting kinetic data; microscopic reversibility, correlation of reaction rates and equilibria.

3. **Mechanism for Some Common Reactions:** (i) Substitution reactions - Comprehensive treatment of solvolytic reactions, substitution reactions of ambident nucleophiles, attempted correlation of substitution rates - the Swain-Grunwald equation, the Hammett equation and correlation with *meta*-and *para*-substituted benzene derivatives, (ii) Addition reactions - Multi-centre addition reactions - Diel's-Alder and retroDiel's-Alder reactions, various types of dienes, and dienophiles, 1,3-dipolar additions, cheletropic reactions, and their stereochemistry, nucleophilic addition to C=O group and related unsaturated system, (iii) Molecular rearrangement -Carbocation rearrangements in bridged-bicyclic system - the norbornyl systems treating both classical and non-classical carbocations in small-ring compounds, (iv) Free radical reactions -Configuration of free radicals, generation and detection of free radicals, types of free radical reaction and some of their characteristics, iodine exchange reaction, autoxidation, decomposition of various peroxides, azo and diazo compounds.

4. **Optical Rotation and Rotatory Power (Chiroptical Properties):** Factors leading to chirality, molecular dissymmetry, atomic asymmetry and conformational asymmetry, circular birefringence and circular dichroism (CD), optical rotatory

dispersion(ORD),Cotton effect, description of ORD curve, haloketone ruleand octant rule,application of these in determining the structure, conformation and configuration of different compounds, optical rotation and rotatory power.

5. **Conformational Analysis:** Conformation and reactivity in heterocyclics, decalins, anthracenes, phenanthrenes, paddlances and propellanes, catenanes, rotaxane, knot, mobius strip, cubane, tetrahedrane, dodecahedrane, adamantane and buckminster fullerene), Curtin-Hammett principle,its application in determining the course of reaction.

6. **Prostereoisomerism, Prochirality and Pseudochirality:** Terminology, chiral, prochiral, and pseudochiral molecules, pro-R, pro-S, homotopic and hetereotopic ligands and faces, enantiotopic ligands (HCN addition), diastereotopic ligands and faces, heterotopic ligands and faces in enzyme-catalyzed reactions, heterotopicity and nuclear magnetic resonance.

Books Recommended

1. Mechanism in Organic Chemistry, R. W. Alder, R. Baker, J. M. Brown.
2. Frontier Orbitals and Organic Chemical Reactions, I. Fleming.
3. Organic Reaction Mechanisms: An Introduction, R. Breslow, W. A. Benjamin.
4. Physical Organic Chemistry, N. S. Isaacs.
5. Stereochemistry of Carbon Compounds, E. L. Eliel.
6. Stereochemistry of Organic compounds, E. L. Eliel, S. H. Wilen.
7. Stereochemistry: Conformation and Mechanism, P. S. Kalsi.

MC 7545 Chemistry of Food and Drugs (4 Credits, 100 marks)

1. **Food:** Macro and micro-nutrients in food,carbohydrate -source of different types of starch and their composition, glycemic index of starch dietary fiber (DF), importance of high and low DF content in staple food, addition of DF in bakery and other food products, cereals and their uses, plant sugar and artificial sweeteners (saccharin, cyclamate, sucralose, sorbitol, aspartame etc.) in food items, proteins - fish, meat, eggs, milk and milk products, lentils etc. and their nutritional values, lipids - source, edible and non-edible fats/oils, their occurrence and consumption in food items, free fatty acid, ω-fatty acids, trans-fatty acids and their effects on human health.

2. **Food Additive and Food Preservatives:** Natural colouring agents and preservatives in food stuff, isolation of lycopene from tomatoes, carotenes and tocopherols, flavonoids and anthocyanins from vegetables, food preservatives - their chemistry, applications and limitations.

3. **Toxicants:** Natural occurring toxicants in foods (anthocyanines, aflatoxins, safrole etc.), use of medicinal plants in diet, synthetic toxicants in poultry meat, fish, soft drink and other food stuff.

4. **Food Contamination:** Toxic trace elements, toxic compounds of microbial origins, pesticides, veterinary medicine and food additives, polychlorinated biphenyls (PCB's), polycyclic aromatic hydrocarbons, nitrosamines, cleansing agent and disinfectants.

5. **Structure-Activity Relationship in Drug Design:** Changing size and shape, introduction of new substituents, changing the existing substituents of a lead, quantitative structure activity relationship (QSAR): introduction, physiochemical properties, Hansch equation, the Craig plot, bioisosteres, QSAR study.

6. **Receptors and Messengers:** Receptors and messengers, receptor and the biological response, binding of ligands to receptors, ligand-receptor theories, receptor families, ion channels and their control, activation of membrane bound enzymes, neurotransmitters, neurotransmission processes, design of agonists and antagonists, partial agonists, depressants and stimulants.
7. **Drugs:** Fundamental aspects of drugs, classification of drugs, drugs discovery and design, methods and routes of drug administration, drug action, brief description of some common drugs –(i)allergy: histamine, allergens, storage and release of histamine, inhibition of histamine release, anti-histaminic agents, H_1 and H_2 antihistamines, (ii) antiviral

agents: classification of virus, agents for the treatment of HIV infection, biochemical targets for antiviral therapy, infection process for a virus, (iii) cancer chemotherapy: principles, biochemical basis of cancer, type of cancers, cancer therapy, class of anticancer agents and their mechanism of actions.

Books Recommended

1. Food Chemistry, L. H. Meyer.
2. Introductory Foods, M. Bennio.
3. Food Science, H. Charley.
4. Foye's Principles of Medicinal Chemistry, D. A. Williams and T. L. Lemke.
5. An Introduction to Medicinal Chemistry, G. L. Patrick.
6. Medicinal Chemistry: An Introduction, G. Thomas.

MC 7546 Environmental Pollution and Monitoring (4 Credits, 100 marks)

1. **Basic Concept of Environmental Chemistry and Its Scope:** Components of the environment, lithosphere, hydrosphere, atmosphere and biosphere, their natural and chemical composition.

2. **Air Pollution:** Primary and secondary pollutants, natural and anthropogenic air pollution, gas phase pollutants – particles, gases, ions and radicals, acid rain, PAN and photochemical smog formation, greenhouse gases - their sources and the individual contribution, its impact on global warming, Chapman mechanism for the formation of ozone layer, stratospheric ozone depletion, the Antarctic ozone hole and mechanism of its formation, impacts of air pollutants on human health, atmospheric sampling and monitoring, air quality index, control of atmospheric pollution.

3. **Water Pollution:** Water quality parameters and standards, types of water pollutants, nature of water pollutants – elemental, metalloids, heavy metals, organically bound-metals and metalloids, inorganic species, algal nutrients, fertilizers, pesticides, radionuclides, measurements of important water quality parameters such as pH, DO, BOD, COD and temperature, general aspects of chemical analysis of water pollutants, water treatment: preliminary treatment – screening, skimming, primary treatment- sedimentation, coagulation, flocculation, secondary treatment – activated sludge method, oxidation ponds, tertiary treatment – electrodialysis, reverse osmosis, ion exchange, chlorination, ultraviolet disinfection treatment, water quality and human health.

4. **Soil Pollution:** Soil profile,physical, chemical and biological characteristics of soil, types of soil pollutants, effects of soil pollution, treatment of soil pollutants, control measures of soil pollution.

5. **Toxicological Chemistry in the Environment:** Toxicants in the environment, biochemical effects of some heavy metals - As, Cr, Pb and Hg, gases – NO_x, SO_x, O_3 and cyanides, pesticides, environmental fate of toxicants, health risk, control and treatment mechanisms of As, Cr, Pb and Hg.

6. **Management of Solid Waste:** Major sources of solid waste, integrated waste management, land filling, composting, incineration, recycling and reuse.

7. **National Policy for the Protection of the Environment:** Environment law in Bangladesh, national environment quality standards (EQS), EEC and WHO guidelines for air and water quality.

Books Recommended

1. Environmental Chemistry, S. E. Manahan.
2. Environmental Chemistry, A. K. De.
3. Environmental Chemistry: Air and Water Pollution, H. S. Stoker and S. L. Seager.
4. Air Quality, T. Godish.

5. Atmospheric Chemistry, B. J. Finlayson-Pitts and J. N. Finlayson-Pitts.
6. Environmental Analytical Chemistry, F. W. Fifield and P. J. Haines edited.
7. Environmental Toxicology, M. Satake, Y. Mido, M. S. Sethi, S. A. Iqbal, H. Yasuhisa and S. Taguchi.

MC 7547Chemical Kinetics and Surface Chemistry(4 Credits, 100 marks)

1. **Theories of Reaction Rates:** Basic postulates and derivation of the rate equation, potential energy surface, kinetic theory of collisions, review of conventional transition-state theory, equilibrium hypothesis, statistical mechanics and chemical equilibrium, some applications of the conventional transition-state theory, reactions between atoms and molecules, thermodynamics of the conventional transition-state theory, unimolecular reactions, theories of Lindemann and Hinshelwood, RRK and RRKM modifications.

2. **Composite Reactions:** Composite reactions, rate equations for composite reactions, simultaneous and consecutive reactions, concept of steady-state treatment, straight chain reactions, decomposition of ozone, thermal explosion, branching chain explosion, Belousov-Zhabotinskii reaction.

3. **Reactions in Solutions:** Concept ofsolution reactions, transition-state theory in solutions, factors determining reactions rates in solution, reactions between ions, influence of ionic strengths and solvent dielectric constant, the Brønsted relation, linear free energy relations, ion-dipole and dipole-dipole reactions, diffusion-controlled reactions, diffusion control in ionic reactions, influence of hydrostatic pressure, substituent and correlation effects, Hammet equation and its applications.

4. **Properties of Surface:** Physical properties of surface, surface structure - pore structure and pore volume of solid, surface area, determination of surface area, adsorption, physisorption and chemisorption, isotherms, isobars and enthalpy of adsorption, geometry of adsorbate and adsorbent after chemisorptions, electrical property of solid, work function, work function change due to adsorption.

5 **Heterogeneous Catalysis:** General description of heterogeneous catalyst, catalyst preparation and modification, reaction pathway of catalyzed and non catalyzed reaction, transition state theory of heterogeneous reactions, specificity and selectivity in catalysis, catalytic activity, the volcano curve, industrial application of catalysis - hydrogenation of vegetable oils, catalytic cracking, synthetic gasoline production.

6. **Acid-Base Catalysis and Micellar Catalysis:** General and specific acid-base catalysis, kinetics and mechanisms for acid-base catalysis, Arrhenius and Van't Hoff intermediates, micellar catalysis - introduction, CMC, catalysis in aqueous solvent, theories of micellar catalysis, catalysis in nonaqueous solvent.

7. **Techniques for Analysis of Solid Surfaces and Absorbed Species:** Electron emission spectroscopy, ultraviolet photoelectron spectroscopy (UPS), X-ray photoelectron spectroscopy (XPS) and Auger electron spectroscopy (AES), vibrational spectroscopy of adsorbed species FTIR EELS, low energy electron diffraction (LEED), field emission microscopy (FEM), field ion microscopy (FIM), scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

Books Recommended

1. Physical Chemistry, P. W. Atkins.
2. Kinetics and Mechanism, A. A. Frost and R. G. Pearson.
3. Chemical Kinetics, K. J. Laidler.
4. Physical Chemistry of Surfaces, A. W. Adamson.
5. Surface Chemistry, E. M. McLash.
6. An Introduction to Chemisorption and Catalysis by Metals, R. P. H. Gasser.
7. Heterogeneous Catalysis: Principles and Applications, G. C. Bond.
8. Selected articles from recent journals.

MC 7548: Spectroscopy and Its Application (4 Credits, 100 marks)

1. **Review of Electronic and IR Spectroscopy:**Electronic spectroscopy - electronic transition, energy of electronic transition, selection rules, Franck-Condon principle and intensities of spectral lines, Woodward-Hoffman rules for the calculation of λ_{max}, kinetic studies using UV-visible spectroscopy, spectra of complex compounds, UPS and XPS;IR spectroscopy - Vibrational energy. Transition probabilities. Fundamental, overtone and hot band transitions. Infrared spectra of polyatomic molecules. Characteristics group frequencies; assignment of spectral bands; structural factors, including common organic functional groups, factors affecting group frequencies. Applications in structure elucidation. Techniques: radiation sources, optics, monochromators, sample holders, detectors for infrared spectrometers. Handling of samples: gaseous, liquid and solid samples. Principle of FTIR spectrometer and its advantages.

2. **Raman Spectroscopy:**Raman effect, classical theory of Raman scattering, criterion of Raman activity, Raman, polarization of Raman scattered light, resonance Raman scattering, surface enhanced Raman scattering (SERS), structure determination using Raman spectroscopy.

3. **Nuclear Magnetic Resonance Spectroscopy:** General theory of n.m.r, Chemical shift; shielding and deshielding of nuclei, relation between structure and chemical shifts, spin-spin coupling, coupling constant; vicinal, geminal, ortho, para and meta coupling.Proton exchange reactions; rotation about single bonds, geminal coupling non-equivalence of protons; relaxation; NOE.Simplification of complex spectra, double irradiation; ^{13}C spectra.Pulse and Fourier transformation methods, Experimental techniques.

4. **Electron Spin Resonance Spectroscopy:** Quantization of angular momentum, relation between magnetic moment and angular momentum, g factor, fine structure of e.s.r., hyperfine structure, instrumentation and applications of e.s.r.

5. **Mass Spectroscopy:** Techniques of ionization, electron impact, fast atom bombardment, field desorption, photoionization, multiphoton ionization, thermal methods, principles of mass separation, sector magnet technique, quadrupole mass separator, time of flight in mass spectrometer, ion optics, sampling for mass spectrometric measurements, molecular beam sampling, ionization potentials and measurements, fragmentation of ions, rearrangement of ions, base peak, molecular mass determination, mass spectra of various classes of compounds.

6. **Mössbauer Spectroscopy:** Mössbauer isotopes, Doppler effect, Mössbauer theory, isomer shift, quadrupole interactions, and magnetic splitting in Mössbauer spectrum, effect of electronegativity in isomer shift, application of isomer shift and quadruple splitting measurements in tin and iron complexes, detection of *cis*-, *trans*-isomer from quadruple splitting value.

7. **Combination of Spectroscopic Methods:** Structure elucidation of compounds by combined application of UV, IR, NMR (^1H and ^{13}C) and mass spectroscopic techniques.

Books Recommended

1. Fundamental of Molecular Spectroscopy, C. N. Banwell.
2. Introduction to Molecular Spectroscopy, G. M. Brown.
3. Electron Paramagnetic Resonance, J. A. Weil, J. R. Bolton and J. E. Wertz.
4. Introduction to Spectroscopy: A Guide for Students of Organic Chemistry, L. Pavia, G. M. Lampman and G. S. Kriz.
5. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill.
6. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming.

MC 7549 Chemistry of Polymers and Biopolymers (4 Credits, 100 marks)

1. **Kinetics of Polymerization:** Kinetics of addition polymerization (free radical chain polymerization), molecular-weight control and kinetic chain length, effect of chain transfer and chain transfer agents, autoacceleration, kinetics of step polymerization, crosslinking (Carother's equation, gelation and statistical approach), kinetics of cationic and anionic polymerization.

2. **Structures and Characteristics of Polymer:** Types of polymer - plastics, elastomers, fibers, some applications of polymer - coatings, adhesives, films and foams, advanced polymeric materials - ultrahigh molecular weight polyethylene (UHMWPE), liquid crystal polymers (LCPs), and thermoplastic elastomers (TPEs or TEs), configuration and conformation of polymer, secondary valency forces, nature of chain packing, molecular weight distribution.

3. **Crystalline and Amorphous State of the Polymer:** Melting of polymer and crystalline melting point T_m, factors affecting crystallinity and T_m, amorphous polymer and glass transition temperature T_g, experimental determination of T_g, detection of T_g, factors affecting T_g.

4. **Rheology and Mechanical Properties of Polymer:** Rheological behaviour of polymer, phenomena of viscous flow, kinetic theory and thermodynamics of rubber elasticity, molecular theory of viscoelasticity and five regions of viscoelastic behaviour, linear viscoelastic behaviour of amorphous polymer, creep, stress-strain behaviour of elastomer.

5. **Polymer Processing:** Plastic technology, molding, extrusion, other processing technique, additives and compounding, elastomer technology, vulcanization and reinforcement.

6. **Biological Macromolecules:** Introduction, structure of proteins -primary, secondary, tertiary and quaternary structures, protein sequencing, stability of protein conformation, factors responsible for stabilization, thermodynamic treatment of stability constant,protein binding, protein-ligand binding, binding equilibria, equilibrium dialysis, dynamic dialysis, hydrophobic interaction, denaturation of proteins, denaturating agents, mechanism of denaturation, protein binding and pharmacodynamics, complexation and drug action, metal complexation in biological systems, solubility of proteins-salting-in and salting-out effects, nucleic acids - types, structure, and functions, DNA sequencing, genetic engineering.

7. **Bioenergetics:** Introduction, bioenergetics and thermodynamics, bioenergetics systems, mechanism of collection and utilization of energy in biological systems, coupling mechanism, phosphorylation, oxidative chain and substrate level phosphorylation, self regulation of energy production, the Biochemist's Standard State, ATP - the carrier of energy, glycolysis, anaerobic glycolysis, limitations of thermodynamics.

8. **Biological Membrane:** Structure and functions of biological membrane,diffusion- simple diffusion, facilitated diffusion, active transport, passive transport, co-transport, Donnan effect, Donnanequilibria involving protein bearing multiple charges, Na^+/K^+- ATPase pump, Ca^{2+}- ATPase pump, membrane equilibrium.

Books Recommended

1. Textbook of Polymer Science, F. W. Billmeyer.
2. Polymer Chemistry: An Introduction, M. P. Stevens.
3. Polymer Science, V. R. Gowariker, N. V. Viswanathan and J. Sreedhar.
4. Physical Chemistry for the Biosciences, Raymond Chang.
5. Biochemistry (Lippincott Illustrated Review Series), R. A. Harvey and D. R. Ferrier.
6. Lehninger Principles of Biochemistry, D. L. Nelson and M. M. Cox.
7. Fundamentals of Material Science and Engineering, W.D. Callister.

MC 7550 Physical Chemistry Experiments (2 Credits, 50 marks)

List of Experiments

1. Spectrophotometric determination of p*K*a value of an indicator.
2. Study of kinetics of photodegradation of a dye using spectrophotometer.
3. Study of physico-chemical properties of a binary liquid mixture.
4. Determination of stability constants of a metal-diamine complex by pH measurements.
5. Study of kinetics of alkaline hydrolysis of ethyl acetate conductometrically at different temperatures and calculation of energy of activation of the reaction.
6. Determination of Fe^{2+} ion concentration in a given solution by potentiometric titration and the determination of the value of standard redox potential of Fe^{2+}/Fe^{3+}.
7. Characterization of a polymer by viscometric measurement.
8. Removal of organic compound from water by adsorption on charcoal and study of adsorption kinetics.
9. Determine the critical micelle concentration (CMC) of an anionic surfactant and study the effect of temperature and electrolyte on the CMC usingconductometer.
10. Determination of molecular weight by depression of freezing point
11. Kinetics of the alkaline hydrolysis of crystal violet in aqueous solution in the presence of a surfactant

MC 7551 Organic Chemistry Experiments (2 Credits, 50 marks)

List of Experiments

1. Quantification of the percentage of hydroxyl group in the supplied sample.
2. Separation of organic compounds from a mixture by chromatographic method and identification thereof.
3. Estimation of an amine in the supplied organic sample.
4. Preparation of an organic compound used as a common medicine like aspirin or paracetamol.
5. Preparation of two derivatives of an organic compound containing bifunctional group and identification of the organic compound there from.
6. Chromatographic separation of organic compounds from a mixture.
7. Estimation of the total amount of carboxylic acid supplied in gram.
8. Determination of the amount of phenol in a supplied organic sample.
9. Observation of the effects of supplied various solvent systems upon the rate of the S_N1 reaction.
10. Study the conversation of benzil to benzilic acid through a base catalyzed rearrangement.

MC 7552 Inorganic and Analytical Chemistry Experiments (2 Credits, 50 marks)

List of Experiments

1. Preparation and characterization of tris(thiourea)copper(I) sulphatedihydrate, $[Cu(tu)_3]SO_4.2H_2O$.
2. Analysis of mixtures by gravimetric and volumetric methods from the mixture solutions:
   (i) Pb(II) – Zn(II) – Cu(II)
   (ii) Cu(II) – Ni(II) – Zn(II)
3. Determination of a mixture of different metal ions by EDTA titration:
   (i) Ca(II) – Mg(II)
   (ii) Cu(II) – Zn(II)
4. Determination of magnesium, manganese and zinc in a mixture: use of fluoride ion as a demasking agent.
5. Separation and quantification of iron(III) and copper(II) using cation exchange chromatography.
6. Determination of the composition of a complex (Cu-EDTA) by continuous variation method.
7. The formula and stability constant of a complex ion: the silver-ammonia complex.
8. UV-VIS and IR spectrophotometric determination of Cr(VI) using diphenylcarbazide as the colouring agent.

Books Recommended

1. A Textbook of Quantitative Inorganic Analysis, A. I. Vogel.
2. Applied Chemistry: Theory and Practice, O. P. Vermani.
3. Commercial Methods of Analysis, F. D. Snell and F. M. Biffen.