

GC UNIVERSITY, FAISALABAD



Scheme of Studies

Master of Science in Chemistry

04 Semesters / 2 years Degree Program
for the year 2015 and onward

Department of Chemistry

Scheme of Studies 2015 to onward

M.Sc. Chemistry

Semester 1

| | | |
|---------|--------------------------|----------|
| CHM-331 | Physical Chemistry – I | 4(3 – 1) |
| CHM-333 | Organic Chemistry – I | 4(3 – 1) |
| CHM-335 | Inorganic Chemistry – I | 4(3 – 1) |
| MTH-571 | Mathematics for Chemists | 2(2 – 0) |
| CHM-337 | Environmental Chemistry | 3(3 – 0) |
| CHM-339 | Analytical Chemistry - I | 3(3 – 0) |
| | OR | |
| CHM-361 | Biochemistry - I | 3(3 – 0) |

Semester 2

| | | |
|---------|---------------------------|----------|
| CHM-332 | Physical Chemistry – II | 4(3 – 1) |
| CHM-334 | Organic Chemistry – II | 4(3 – 1) |
| CHM-336 | Inorganic Chemistry – II | 4(3 – 1) |
| CHM-338 | Analytical Chemistry – II | 3(3 – 0) |
| | OR | |
| CHM-360 | Biochemistry – II | 3(3 – 0) |
| CHM-362 | Introductory Spectroscopy | 2(2 – 0) |

Semester 3

The students have to adopt one specialization set from the followings

Specialization in Organic Chemistry

| | | |
|---------|---|----------|
| ENG-601 | English for Employment (EFE) | 3(3 – 0) |
| CHM-651 | Spectroscopic Organic Techniques | 3(3 – 0) |
| CHM-653 | Rearrangements and Pericyclic Reactions | 3(3 – 0) |
| CHM-655 | Pharmaceutical Chemistry | 3(3 – 0) |
| CHM-657 | Organic Chemistry Practicals | 2(0 – 2) |

Specialization in Analytical Chemistry

| | | |
|---------|---------------------------------|----------|
| ENG-601 | English for Employment (EFE) | 3(3 – 0) |
| CHM-659 | Electro Analytical Techniques | 3(3 – 0) |
| CHM-661 | Advanced separation techniques | 3(3 – 0) |
| CHM-663 | Atomic spectroscopy | 3(3 – 0) |
| CHM-665 | Analytical Chemistry Practicals | 2(0 – 2) |

Specialization in Inorganic Chemistry

| | | |
|---------|--|----------|
| ENG-601 | English for Employment (EFE) | 3(3 – 0) |
| CHM-687 | Main Group Organometallic and Organic Reagents | 3(3 – 0) |
| CHM-689 | Spectroscopic Methods of Analysis | 3(3 – 0) |
| CHM-691 | Metal Cluster Compounds | 3(3 – 0) |
| CHM-693 | Inorganic Chemistry Practicals | 2(0 – 2) |

Specialization in Physical Chemistry

| | | |
|---------|---------------------------------|----------|
| ENG-601 | English for Employment (EFE) | 3(3 – 0) |
| CHM-675 | Kinetics of Complex Reactions | 3(3 – 0) |
| CHM-677 | Nuclear and Radiation chemistry | 3(3 – 0) |

| | | |
|---------|-------------------------------|----------|
| CHM-683 | Material Chemistry | 3(3 – 0) |
| CHM-685 | Physical Chemistry Practicals | 2(0 – 2) |

Specialization in Biochemistry

| | | |
|---------|-------------------------------|----------|
| ENG-601 | English for Employment (EFE) | 3(3 – 0) |
| CHM-667 | Biological Metabolism | 3(3 – 0) |
| CHM-669 | Human Physiology | 3(3 – 0) |
| CHM-671 | Biochemistry of Nucleic Acids | 3(3 – 0) |
| CHM-673 | Biochemistry Practicals | 2(0 – 2) |

Semester 4

| | | |
|---------|--------|----------|
| CHM-680 | Thesis | 6(6 – 0) |
|---------|--------|----------|

Specialization in Analytical Chemistry

| | | |
|---------|------------------------------------|----------|
| CHM-679 | Seminar | 1(1 – 0) |
| STA-595 | Introduction to Statistical Theory | 3(3 – 0) |
| CHM-652 | Thermal Methods of Analysis | 3(3 – 0) |
| CHM-654 | Nuclear Analytical techniques | 3(3 – 0) |
| CHM-656 | Luminescence Spectrophotometry | 3(3 – 0) |
| CHM-658 | Food and Drug analysis | 3(3 – 0) |

Specialization in Organic Chemistry

| | | |
|---------|---|----------|
| CHM-679 | Seminar | 1(1 – 0) |
| STA-595 | Introduction to Statistical Theory | 3(3 – 0) |
| CHM-660 | Organic Polymers | 3(3 – 0) |
| CHM-662 | Reactive Intermediates and Photochemistry | 3(3 – 0) |
| CHM-664 | Disconnection Approach | 3(3 – 0) |
| CHM-666 | Organic Catalyst and catalysis | 3(3 – 0) |

Specialization in Inorganic Chemistry

| | | |
|---------|------------------------------------|----------|
| CHM-679 | Seminar | 1(1 – 0) |
| STA-595 | Introduction to Statistical Theory | 3(3 – 0) |
| CHM-676 | X-ray Spectroscopy | 3(3 – 0) |
| CHM-678 | Homogeneous Catalysis | 3(3 – 0) |
| CHM-684 | Radio Nuclear Chemistry | 3(3 – 0) |
| CHM-686 | Magneto Chemistry | 3(3 – 0) |

Specialization in Biochemistry

| | | |
|---------|---------------------------------------|----------|
| CHM-679 | Seminar | 1(1 – 0) |
| STA-595 | Introduction to Statistical Theory | 3(3 – 0) |
| CHM-668 | Molecular Biochemistry | 3(3 – 0) |
| CHM-670 | Clinical Diagnosis | 3(3 – 0) |
| CHM-672 | Biochemistry of Vitamins and Minerals | 3(3 – 0) |
| CHM-674 | Medical Biochemistry | 3(3 – 0) |

Specialization in Physical Chemistry

| | | |
|---------|------------------------------------|----------|
| CHM-679 | Seminar | 1(1 – 0) |
| STA-595 | Introduction to Statistical Theory | 3(3 – 0) |
| CHM-688 | Group theory and Solutions | 3(3 – 0) |
| | | |
| CHM-690 | Quantum and statistical Mechanics | 3(3 – 0) |

| | | |
|---------|--------------------------------------|----------|
| CHM-692 | Advanced Spectroscopy | 3(3 – 0) |
| CHM-694 | Electrochemical Aspects of Solutions | 3(3 – 0) |

Note: For research students (Thesis will opt only two courses & other students will study four courses along with two compulsory courses i.e. STA-595 (Introduction to Statistical Theory) and CHM-679 (Seminar).

M.Sc Chemistry

Semester 1

CHM-551

Physical Chemistry-I

4(3-1)

Kinetic Theory of Gases

Virial equations. Maxwells law of molecular velocities. Calculation of molecular velocities and binary collisions. Maxwell-Boltzmanns law of energy distribution.

Chemical Thermodynamics

Relation of entropy and energy with equilibrium constant and their dependence on temperature. Clausius-Clapeyron equation. Chemical potential. Partial molar quantities.

Chemical Kinetics

Integrated rate laws second and third order reactions with same and different initial concentrations of reactants. Elementary and complex reactions opposing, parallel and consecutive reactions. Steady state approximation, Lindemann theory of unimolecular reactions. Chain reactions, kinetics of thermal and photochemical reactions.

CHM-551

Practicals

- Equilibrium constant of the $KI + I_2 = KI_3$ reaction
- Kinetics of saponification of ethyl acetate
- Acid catalyzed hydrolysis of sucrose
- Study of the adsorption isotherms of acetic acid charcoal system
- Study of the charge transfer complex formation between iodine and benzene
- Determination of activation energy for the acid catalyzed hydrolysis of ethyl acetate
- Determination of partial molar volumes
- Determination of partition coefficient of a substance in two immiscible liquids.

Books Recommended:

1. R. A. Alberty, J. S. Robert, G. B. Mounji, "Physical Chemistry". 4th Ed, John Wiley and Sons (2004).
2. D. W. Ball, "Physical Chemistry" 1st Ed, Brooks/Cole Co. Inc. (2003).
3. Engel, Thomas, P. Reid, "Thermodynamics, Statistical Thermodynamics, and Kinetics" 1st Ed, Benjamin Cummings (2006).
4. K. James, P. Wothers, "Why Chemical Reactions Happen". 5th Ed, Oxford University Press, USA (2003).
5. Smith, E. Brian, "Basic Chemical Thermodynamics" 5th Ed, Imperial College Press, (2004).
6. B. R. Stephen, S. A. Rice, J. Ross, "Physical Chemistry" 2nd Ed., Oxford University Press, USA (2000).
7. I. Chorkendorff, J. W. Niemantsverdriet, "Concepts of Modern Catalysis and Kinetics" 1st Ed, John Wiley and Sons, USA (2003).
9. J. H. Espenson, "Chemical Kinetics and Reaction Mechanism" 2nd Ed, McGraw Hill (2002).
10. R. S. Berry, A. R. Stuart, J. Ross "Physical and Chemical Kinetics" 2nd Ed, Oxford University Press, USA (2000).

CHM-553

Organic Chemistry-I

4(3-1)

Acids and Bases

Concepts of acids and bases; scale of acidity and basicity; pKa values; predicting acids/basis reactions from pKa values; the effect of structure on the strengths of acids and bases, field effects, resonance effects, steric effects, hydrogen bonding effects and hybridization effects, the effect of the medium on the strengths of acids and bases; the Hammett and Tafts equations, applications and limitations.

Stereochemistry

Introduction; optical isomerism; optical activity, chirality, symmetry elements and optical inactivity, relative and absolute configuration, R, S notation, methods of determining configuration. Racemic mixtures and their resolution, asymmetric synthesis, optical activity in biphenyls, alkenes and spiro compounds, stereospecific and stereoselective reactions; Geometrical isomerism. Determination of configuration of geometrical isomers, Z, E, conventions cis-and trans- isomerism in cyclic systems; Conformational isomerism conformational analysis of monosubstituted cyclohexanes, disubstituted cyclohexanes and decalin systems.

Oxidation Reduction Reactions:

a) **Oxidation:** Introduction. Oxidation of saturated, olefinic and aromatic compounds. System containing oxygen and nitrogen compounds.

b) **Reduction** Introduction. Reduction of cycloalkanes, olefins, alkynes and aromatic rings. Hydrogenolysis. Reduction of systems containing oxygen and nitrogen compounds. **CHM-553** **Practicals**

Purification Techniques: Fractional distillation, fractional distillation under reduced pressure and fractional crystallization

Mixture Analysis: Analysis of two component mixture.

Books Recommended:

1. B. S. Furniss, A. J. Hannaford, P.W.G. Smith, A. R. Tatchell "Vogel's Practical Organic Chemistry", 5th Ed, Addition Wesley Longman, Harlow, England(1989).
2. J. Leonard, B. Lygo, G. Proctor, "Advanced Practical Organic Chemistry" 2nd Ed, Chapman, & Hall, London (1995).
3. H. L. Clarke, D. Hynes, "A Hand Book of Organic Analysis", Edward Arnold, London, (1995).
4. F. A Carey, R. J Sunderg, "Advanced Organic Chemistry". 3rd Ed, Part A & B, Pleman Press, New York, USA (1990).
5. K. Mislow "Stereochemistry", 2nd Ed, W. A. Benjamin Inc. New York, USA (1965).
6. E. L Eleil, S. H Wilen, L. N Mander, "Stereochemistry of Organic Compounds", 4th Ed, John Wiley & Sons, USA (1994).
7. S. H. Pine, "Organic Chemistry", 5th Ed, McGraw Hill, New York, USA (1987).
8. G. M. London, "Organic Chemistry", Addison Wesley, London, UK (1998).

CHM-555

Inorganic Chemistry-I

4(3-1)

1. BONDING MODELS FOR NON TRANSITION ELEMENTS

(a) Covalent bond. VSEPR model followed by VBT for prediction of geometries of molecules and ions containing sigma bonds as well as pi bonds. MOT for homonuclear and heteronuclear diatomic molecules.

(b) Metallic bond. Band theory to describe conductors, insulators and semiconductors.

(c) 3 center 4 electrons bond, 3 center 2 electrons bond, bent bond, H bonding.

2. CHEMISTRY OF COORDINATION COMPOUNDS

Nomenclature, theories of bonding (Werners theory, Sigwick theory, Chain theory, VBT, CFT, LFT). Stereochemistry of coordination compounds, Coordination geometries (CN 2-6). Preparation of coordination compounds Stability of coordination compounds. Spectrochemical series. Application of coordination compounds in Chemistry, life and industry.

3. LANTHANIDES AND ACTINIDES

Historical survey, occurrence, separation and preparation. Oxidation states, magnetic properties of Lanthanides and Actinides. Lanthanides contraction. Applications and uses of elements and their compounds.

CHM-555

Practicals

1. Separation of cations by paper chromatography: (Pb^{2+} , Cd^{2+} , Cu^{2+} , Co^{2+} , Ni^{2+} , Ag^+)

2. Preparation And Characterisation Of Complex Compounds:

(i) Sodium Cobaltinitrate (ii) Potassium trioxalato aluminate (iii) Ammonium Nickel (II) Sulphate (iv) Hexa aqua Chromium (III) chloride).

3. Complexometric Titration (Any four) Cu^{2+} / Ni^{2+} ; Ca^{2+} / Ba^{2+} ; Au^{2+} / Pb^{2+} ; Cd^{2+} / Zn^{2+} ; Ni^{2+} / Mg^{2+} ; Ca^{2+} / Zn^{2+}

Books Recommended:

1. P. Atkins, L. Jones, "Chemical Principles" 2nd Ed, Freeman and Company (2002).
2. F. Basolo, R. C. Johnson, "Coordination Chemistry: The Chemistry of Metal Complexes" W. A. Benjamin, Inc. (1964).
3. J. E. Brady, J. R. Holum, "Chemistry-The Study of Matter and Its Changes" 3rd Ed, John Wiley and Sons, Inc. (2000).
4. B. Douglas, D. McDaniel, J. Alexander, "Concepts and Models of Inorganic Chemistry" 3rd Ed John Wiley & Sons, Inc. (1994).
5. S. F. A. Kettle, "Coordination Compounds" 1st Ed, Thomas Nelson & Sons Ltd. (1969).
6. G. L. Miessler, A. T. Donald, "Inorganic Chemistry" 2nd Ed, Prentice-Hall International, Inc. Prentice-Hall, (1991).
7. D. F. Shriver, P.W. Atkins, C. H. Langford, "Inorganic Chemistry". 2nd Ed, Oxford University Press. USA (1994).

CHM-557

Environmental Chemistry

3(3-0)

Introduction, General principle and Techniques. Soil, sludge, sediment and dust analysis. Analysis of plant Material, Analysis of Atmospheric samples, Analysis of Water, determination of toxic organic Chemistry. Toxicity of heavy metals. Biological indicators, Green Chemistry, Echo toxicology.

Recommended Books:

1. B. B. Kebbekus, S. Mitra "Environmental Chemical Analysis", 1st Ed., Blackie Academic & Professional, New York, USA (1998).
2. D. Barcelo, "Environmental analysis: Techniques, Applications and Quality Assurance", Volume 13, Elsevier B.V., Netherland (1993).
3. P. Patnaik, "Handbook of Environmental Analysis", 2nd Ed, CRC Press, Taylor and Francis Group, UK (2010).

CHM-559

Analytical Chemistry-I

3(3-0)

Chemical Analysis and Data Handling

Accuracy of analytical processes such as sampling, weighing, volume measurements, precipitation, washing, filtration and ignition. Recent developments in the sampling techniques, statistical analysis; random and systematic errors, rounding off the data, arithmetic mean, median, mode, standard deviation, relative standard deviation, student t-test, F-test etc., quality control and quality assurance constructing and interpreting quality control and quality assurance constructing and interpreting quality control plots. The use of computer in data handling.

Ionic Equilibria in Solutions

Activity and activity coefficients, Hydrogen ion activity and pH for weak acids and bases, Determination of pKa and pKb value, common ion effect and its industrial applications. Buffer its composition and mechanism and buffer capacity. Stability and formation constants of complexes, methods for their determination.

Separation Techniques

Solvent extraction Principle, factors affecting the extraction systems, Distribution la, coefficient and ratio, multiple batch extraction, practical applications in chemical analysis.

Chromatographic methods General theory of chromatography, classification of chromatographic methods, column, paper, thin-layer, and ion-exchange chromatography and their applications.

Books Recommended:

1. Blackburn, R. Thomas, "Equilibrium- A Chemistry of Solutions", 2nd Ed, Holt, Rinehart and Winston, Inc., (1969).
2. G. D. Christian, "Analytical Chemistry" 6th Ed, John Wiley & Sons, New York, USA (2003).
3. D. C. Harris, "Quantitative Chemical Analysis" 4th Ed, Freeman (1995).
4. D. A. Skoog, D. D. West, F. J. Holler, "Fundamentals of Analytical Chemistry" 6th Ed., Saunders College Publishing (1992).

CHM-561

Biochemistry-I

3(3-0)

Introduction to biochemistry, scope of biochemistry, living systems, evolution and rise of living systems, important elements of living systems including carbon, nitrogen, phosphorus, hydrogen etc. foundations of biochemistry, the physical, cellular, chemical, genetic and evolutionary foundations of life, nature of organic matter, isomerism, general reactions of different functional groups, biologically important organic compounds, carbohydrates, proteins, lipids and nucleic acids

Books Recommended:

1. D. L. Nelson, M. M. Cox. W. H. Freeman “Lehningers Principles of Biochemistry, 5th Ed. (2008).
2. D. J. Voet, G.J. Voet, C. W. Pratt “Fundamentals of Biochemistry, 3rd Ed., J. Wiley & Sons Inc. USA (2008).
3. C. K. Mathews, K. E. Van Holde, K.G. Ahern “Biochemistry, 3rd Ed., Prentice Hall (1999).

Semester 2

CHM-552

Physical Chemistry-II

4(3-1)

Electrochemistry

Theory of metallic conduction, electrode potential, electrochemical cell, electrolysis and related issues, liquid junction potential electron transfer reactions, rate of charge transfer reaction, cell potential and thermodynamics, and Nernst equation, Voltammetry, fuel cells. Corrosion and its prevention. Ion in aqueous solution, ionic activity and Debye Huckel Theory.

Quantum Chemistry and Spectroscopy

Simple harmonic oscillator. Rigid rotor, Hydrogen atom. Quantum numbers, rotational, vibrational, vibrational and rotational-vibrational spectra of diatomic and polyatomic molecules.

Symmetry Elements

Introduction, Coordinate System, Symmetry operations and symmetry Elements, The Symmetry Point Groups.

CHM-552

Practicals

- Determination of molecular weight of a polymer by viscosity method
- Precipitation value of electrolytes
- Measurement of IR spectra of simple compound and their interpretation
- Measurement of cyclic voltammogram of an organic compound and its interpretation
- Determination of dipole moment of an organic liquid
- Determination of percentage composition of KMnO_4 / $\text{K}_2\text{Cr}_2\text{O}_7$ in a given solution by spectroscopy.
- Stoichiometry of a complex in solution by jobs method
- Evaluation of pKa value of indicator by spectrometric method

Books Recommended:

1. F. Cotton, Albert "Chemical Applications of Groups Theory", 1st Ed, Interscience Publishers (1963).
2. G. W. King, "Spectroscopy and Molecular Structure", 1st Ed, Rinehart and Winston (1964).
3. J. Albery, "Electrode Kinetics", 2nd Ed, Clarendon, Oxford, (1975).
4. O. M. J. Bockris, A. K. N. Reddy, "Modern Electrochemistry" 2nd Ed, Vol. I and 2, Plenum Press, New York, USA (1970).
5. D. F. Micheal, "Elements of Quantum Mechanics" 2nd Ed., Oxford University Press, USA (2005).
6. H. H. Lowell, "Group Theory and Symmetry in Chemistry" 1st Ed, McGraw Hill Book Company (1969).
7. D. H. Whiffen, "Spectroscopy" 1st Ed, Longmans Green and Co.: London, (1966).
8. J. Bockris, "Modern Electrochemistry", 1st Ed, Rosetta Publishing Co., Vol: 1,2 (1970).
9. G. Barrow, "Molecular Spectroscopy" 2nd Ed, McGraw Hill (1962).

CHM-554

Organic Chemistry-II

4(3-1)

Aliphatic nucleophilic substitution and Elimination reactions

Aliphatic nucleophilic substitution reactions Mechanisms and study of SN1, SN2, SN1, SN2, mechanism; neighbouring group participation intra molecular displacement by neighbouring oxygen, nitrogen, sulphur and halogen; The effects of the substrate structure, entering group, leaving group and reaction medium on the mechanisms and rates of substitution reactions.

Elimination Reactions Mechanisms study of E1, E1cB and E2 mechanisms; attacking base, leaving group and the reaction medium on the rates and mechanisms of elimination reactions; competition between elimination and substitution reactions.

Aromatic Substitution reactions

Electrophilic substitution Aromaticity; mechanisms of substitution; orientation sulfonation, Friedel-Crafts reactions, diazo-coupling, formylation and carboxylation.

Nucleophilic substitution Mechanisms-Study of SNAr, SN1 and benzyne mechanisms; The effects of substrate structure, leaving group and the attacking nucleophile on the rates of substitution reactions.

Named Organic Reactions

Cannizzaro reaction, Perkin reaction, Michael reaction, Claisen-Schmidt reaction, Darzens Glycidic Ester reaction, Stobbe reaction, Mannich reaction, Wittig reaction, Ene reaction and Reformatsky reaction, Diels-Alder reaction.

CHM-554

Practicals

Organic Synthesis at least four experiments involving two step synthesis

Estimation of Amide and Carboxyl groups, Phenol and other functional groups.

Determination of Saponification value and acid value in oil.

Books Recommended:

1. F. A. Carey, R. J. Sundberg, "Advanced Organic Chemistry (Part B: Reactions and Synthesis)", 3rd Ed, Plenum Press, New York, USA (1990).
2. B. K. Carpenter, "Determination of Organic Reaction Mechanisms", "John Wiley & Sons, Inc. (1984).
3. G. R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", 1st Ed., Himalaya Publishing House (1987).
4. J. Fuhrhop, G. Penzlin, "Organic Synthesis Concepts, Methods, Starting Materials", 2nd Ed., Weinheim Germany (1983).
5. R. K. Mackie, D. M. Smith, "Guide book to Organic Synthesis", Longman Group Ltd. (1982).
6. J. March, "Advanced Organic Chemistry Reactions, Mechanisms and Structure", 4th Ed, John Wiley & Sons, Inc; USA (1992).
7. A. Streitwieser, C. H.H. Cock, "Introduction to Organic Chemistry", 3rd Ed, Macmillan Publishing Company (1989).
8. P. Sykes, "A Guide Book to Mechanism in Organic Chemistry", 6th Ed, Longman Group Ltd. (1986).
9. A. L. Vogel, "Elementary Practical Organic Chemistry Part III: Quantitative Organic Analysis", 1st Ed., Longman Group Ltd (1958).

CHM-556

Inorganic Chemistry-II

4(3-1)

1. Chemistry of Non-Aqueous Solvents;

Classification of solvents. Type of reactions in non-aqueous solvents. Physical and chemical properties of solvents. Study of reactions in liquid NH_3 , HF , SO_2 , BrF_3 , CH_3COOH and HCN . Reactions in molten salt system.

2. Pi-Acceptor Ligands:

Class of ligands. Metal carbonyls, molecular structure, localized bonding (EAN rule, 18 electron rule). Delocalized bonding (Wades rule), spectroscopic evidence of bonding situation. Chemical properties of metal-carbonyls (carbonylate anions, carbonyl hydrides and carbonyl halides). Metal nitrosyls and their derivatives. Applications of metal carbonyls and their derivatives to catalysis and organic synthesis.

3. Kinetics and mechanism of inorganic reactions:

Rate law, Stationary state approximation, Labile and inert complexes. Mechanism of substitution reactions in octahedral complexes (hydrolysis reactions, anation reactions, reactions of substituted ligand and redox reactions). Thermodynamic and kinetic stability. Half life.

CHM- 556

Practicals

1. Estimation Of Anions (Any four)

Chloride/Phosphate; Chloride/Nitrate; Bromide/Nitrate; Iodide/Nitrate; Borate/Acetate; Oxalate/ Chloride; Sulphate/Phosphate

2. KIO_3 Titrations (Any two)

3. Gravimetric Estimations:

Estimations of Ba^{2+} ; Oxalate ions.

Books Recommended:

1. J. E. Huheey, "Inorganic Chemistry Principles of Structure and Reactivity" 2nd Ed. Harper and Row Publishers (1978).
2. J. D. Lee, "Concise Inorganic Chemistry" 5th Ed. Chapman and Hall (1996).
3. K. M. Mackay, R. A. Mackay, W. Henderson, "Introduction to Modern Inorganic Chemistry" 5th Ed. Stanley Thornes (Publishers) Ltd. (1996).
4. G. L. Miessler, A. T. Donald, "Inorganic Chemistry". 2nd Ed, Prentice-Hall Prentice-Hall International, Inc. (1991).
5. F. A. Cotton, G. Wilkinson, "Advance Inorganic Chemistry", 5th Ed, John Wiley & Sons, Inc. (1988).
6. F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bockmann, "Advanced Inorganic Chemistry" 6th Ed, John Wiley & Sons, Inc. USA (1999).
7. A. K. Holliday, A. G. Massey, "Inorganic Chemistry in Non-Aqueous Solvents", 6th Ed., Pergamon Press. (1985).

CHM-558 Analytical Chemistry II 3(3-0)

Properties of Light and its interaction with matter, relation between frequency, velocity and wave number, Lambert-Beer's Law and its limitations, Single and double beam spectrophotometers, sources of light (lamp and lasers), monochromators, photomultiplier tubes, detectors, diode array and charged coupled devices, applications of UV-Vis spectrophotometer in natural product research, pharmaceutical industry, separation process, enzyme assay study, clinical studies, microbiology. Applications of IR, NMR and Mass spectrophotometer in research & development and quality control process.

Reference Books:

1. Christian, G.D. Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).
2. Harris, D.C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Skoog, D. A., West, P.M., Holler, F.J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning, (2013).
4. Braun, R.D. *Introduction to instrumental Analysis, International student Edition*, (1985).

CHM-560 Biochemistry-II 3(3-0)

Physical aspects of Biochemistry

Weak interaction in aqueous system. Ionization of water. Weak acids and weak bases. Buffers. Buffering against pH changes. Diffusion, osmosis and osmotic pressure.

Digestion Absorption and Utilization:

Carbohydrates, Lipids proteins nucleic acids, vitamins, minerals.

Enzymes

Chemical nature, nomenclature and classification. Enzyme activity. Effect of different factors on enzyme activity. Coenzymes and immobilized enzymes.

Books Recommended:

1. J. F. Robert. "Essentials of Carbohydrate Chemistry" 2nd Ed., Springer verlag, (1998).
2. D. J. Voet, G. J. Voet, C. W. Pratt "Fundamentals of Biochemistry, 3rd Ed. by. J. Wiley & Sons Inc, USA (2008).
3. S.C. Rastogi "Biochemistry, 2nd Ed, McGraw Hill, (2008).
4. S. P. Singh "Text book of Biochemistry, 4th Ed, CBS Publishers, (2008).
5. Vasudevan "Text book of Biochemistry for Medical Students, 4th Ed, J P Brothers medical (2005).

CHM-562

Introductory Spectroscopy

2(2-0)

Spectroscopy:

Introduction to principle, instrumentation and application of Electronic (UV / Visible) Atomic (Emission /Absorption), Molecular (Infrared) and Nuclear Magnetic Spectroscopy.

Recommended Books:

1. H. H. Jaffé, M. Orchin, "Theory and Applications of Ultraviolet Spectroscopy," 1st Ed, Wiley, USA (1962).
2. H. Gunther, "NMR Spectroscopy - An Introduction," 3rd Ed, John Wiley and Sons, USA (1980).
3. J. Akitt, "NMR and Chemistry; An Introduction to Nuclear Magnetic Resonance Spectroscopy," Chapman and Hall, London, (1973).
4. D. L. Pavia, G. M. Lampman, G. S. Kriz, Jr., "Introduction to Spectroscopy," 2nd Ed, W. B. Saunders, (1979).

Semester 3

Specialization in Organic Chemistry

CHM-651 Spectroscopic Organic Techniques 3(3 – 0)

(a) Introduction

Electromagnetic radiations. Wavelength, frequency, wave number and energy of electromagnetic radiations and their interconversion. Electromagnetic spectrum. Interaction transitions and spectral regions. Relaxation of the excited molecules.

(b) Ultraviolet/Visible Spectroscopy:

Introduction, Electronic transitions and absorption of electromagnetic radiations, Intensities of absorption, Beer-Lambert Law and its applications, Instrumentation and sample handling, The chromophore, Absorption by conjugated systems, Woodward fieser rules for conjugated dienes and unsaturated carbonyl systems, Absorption by aromatic compounds, Application of UV/Vis spectroscopy.

(c) Infrared Spectroscopy:

Introduction, Vibrational modes and absorption frequencies, Hooks Law, Instrumentation and sample handling, Interpretation of Infrared spectra, Characteristic absorptions frequencies of some common functional groups, Applications of Infrared spectroscopy.

(d) Nuclear Magnetic Resonance:

Introduction, Spin flipping Nuclear Precession and absorption of electromagnetic radiation, Spin relaxation, The Chemical shift and integration curve, Molecular structure and chemical shifts, Instrumentation and Sample handling, Spin splitting and coupling constants. Interpretation of NMR spectra.

(e) Mass spectrometry:

Introduction, Basic Principle, Instrumentation (theory and operation) The mass spectrum, Modes of Fragmentation of various organic molecules. Applications of mass spectrometry determination of molecular weight, molecular formula and molecular structure. Interpretation of mass spectra.

Recommended Books:

1. H. E Duckworth, R. C Barber, V.S Barber, V.S Venkatasubramanian “Mass Spectroscopy”, 2nd Ed., Cambridge University Press, London, UK (1996).
2. E. D. Hoffmann, J. Charette, V. Stroobant, “Mass Spectrometry, Principles & Applications”, John Wiley & Sons, USA (1996).
3. A. Frigerio “Essential Aspects of Mass Spectrometry”, Spectrum Publication, Ine New York, USA (1974).
4. H. Friebolin “Basic one and two dimensional NMR Spectroscopy”, 2nd Ed, VCH (1988).
5. G. E Martin, A. S Zektzer, “Two Dimensional NMR Methods for Establishing Molecular Connectivity” VCH (1988).
6. W. Voelter “Carbon-13 NMR Spectroscopy”, 3rd Ed., VCH (1990).
7. Atta-ur-Rahman “Nuclear Manetic Resonsance Spectroscopy”,UGC, Islamabad (1989).
8. H. Gunther, “NMR Spectroscopy”, 3rd Ed., John Wiley and Sons, New York, USA (1972).
9. R. M. Silverstein, G. G. Bassler, “Spectrometric Identification of Organic Compounds” 5th Ed., John Wiley & Sons, New York, USA (1998).
10. W. Kemp, “Organic Spectroscopy”, 3rd Ed., Macmillan, London, USA (1991).

CHM-653 Rearrangements and Pericyclic Reactions 3(3 – 0)

Classification of rearrangement, Pinacol Pinacolone rearrangement, Benzil benzilic acid rearrangement, R.A involving Diazomethane, Favorski R.A, Hofman R.A. Schmidt R.A, Lossen R.A, Bayer Villiger, R.A, benzidine R.A, Fries R.A. Sigma tropic R.A. Migration of carbon, cope rearrangement, claisen rearrangement benzidine rearrangement. [1,3] H, [1,5], [1,7] H, [1,9] H migration.

Pericyclic Reactions

Conrotatory and Disrotatory motion of orbital, electrocyclic reactions, thermal cyclization, Photochemical cyclization, Hofman rule, Fukui Theory of Frontier orbitals. Introduction to cycloaddition reactions. Suprafacial and Antanafacial addition woodward Hofman Rule. Frontier theory and mobius huckle theory for (2 + 2) and (2 + 4) thermal and photochemical cycloaddition reaction.

Recommended Books:

1. R. O .C. Norman “Principles of Organic Synthesis”, Blackie Academic & Professional, 3rd Ed. (1993).
2. F. L. Ansari, R. Qureshi and M. L. Qureshi “Electrocyclic Reactions – from Fundamentals to Research”, 1st Ed., John Wiley and Sons, (1999).
3. J. Clayden, N. Greeve, S. Warren, P. Wothers, “Organic Chemistry”, 1st Ed., Oxford University Press, USA (2001).

CHM-655 Pharmaceutical Chemistry 3(3 – 0)

Alkaloids

Introduction, occurrence, function of Alkaloids in plants, Classification, Nomenclature, Pharmaceutical Applications, Isolation, Qualitative Test and General Properties, General Method of Structure Determination. Morphines, Nicotine, Quinine.

Drugs

Introduction, Sources, Route of administration, Metabolites and mechanism of drug action. Sulfonamide, Antipyretics, Analagasic, Barbiturates, Antibiotics, their general synthesis and structure activity relationship.

Recommended Books:

1. Koji Nakanishi et “Natural Products Chemistry”, 1st Ed., Vol. I. (1974).
2. Mann, “Secondary Metabolism”, Oxford Science Publication, 2nd Ed. (1987).
3. J. D. Bu Lock “The Biosynthesis of Natural Products”, 1st Ed., McGraw-Hill, London, UK (1965).
4. S. V. Bhat, B. A. Nagasampagi, M. Sivakumar “Chemistry of Natural Product” 1st Ed., Narosa Publishing House (2005).

CHM-657 Organic Chemistry Practicals 2(0-2)

Synthesis of Organic Compounds:

Synthesis of the following organic compounds involving more than two steps using various synthetic methods.

Anthranilic Acid, Benzoic acid, p-nitro aniline, Phenacetin, Acridon.

Analysis of three organic Compounds.

Specialization in Analytical Chemistry

CHM-659 Electroanalytical Techniques 3(3-0)

potentiometry:

Electrode potential, Nernst equation and its use for measuring half-cell potential, different kinds of electrodes including glass and calomel electrodes, working of potentiometer and its application including pH measurements, ion selective electrode systems, ion exchange membrane electrode, solid state membrane electrodes and bio-membrane electrodes, potentiometric titrations.

Coulometry and Electrogravimetry:

Basic electrochemistry, principle, instrumentation of coulometry, principle, instrumentation of electrogravimetry, consequences of electrogravimetry, Ohmic drop, activation over potential, concentration and gas polarization, basic difference and merits/demerits of coulometry and electrogravimetry.

Voltammetry and Polarography:

Basic principle, voltammogram, polarizable and non-polarizable electrodes, solid electrodes, their scope and limitations, cyclic voltammetry, anodic stripping voltammetry, voltammetric equation, basic concept of polarography and interpretation of various polarographic curves, measurement of decomposition potential, diffusion and limiting currents, derivation of Ilkovic equation, logarithmic analysis of polarographic wave, advantages and limitation of dropping mercury electrode.

Reference Books:

1. Christian, G.D. Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).
2. Harris, D.C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Skoog, D. A., West, P.M., Holler, F.J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning, (2013).
4. Braun, R.D. *Introduction to instrumental Analysis, International student Edition*, (1985).

CHM-661 Advanced Separation Techniques 3(3-0)

Chromatography:

Classification of chromatographic techniques, chromatographic processes, rate theory of chromatography, Van-Deemter equation and its significance in evaluating column efficiency.

Gas Liquid Chromatography:

General principle, sample preparation/derivatization, separation process and instrumental aspects and its applications.

High Performance Liquid Chromatography:

General principle, sample preparation, separation process (normal phase and reverse phase separation), instrumentation, method development and applications.

Capillary Electrophoresis (CE):

Introduction of Electrophoresis, Theory and principle of CE, mobility, electro-osmotic flow separation by CE, instrumentation, modes of operation, applications.

Reference Books:

1. Skoog, D. A., West, P.M., Holler, F.J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning, (2013).
2. Christian, G.D. Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).
3. Braun, R.D. *Introduction to Chemical Analysis, International student Edition*, (1985).

CHM-663 Atomic Spectroscopy 3(3-0)

Atomic Absorption Spectrophotometry:

principle of atomic absorption spectrophotometry, concentration dependence of absorption, quantitative methodology, instrumentation for atomic absorption spectrophotometry, radiation sources, atomizers, flames, graphite furnaces and electrochemical atomizers, wavelength selectors, detectors, handling background absorption, interferences in atomic absorption spectrophotometry, sample handling in atomic absorption spectrophotometry, preparation of the sample, use of organic solvents, microwave, digestion, sample introduction methods, applications of atomic absorption spectrophotometry.

Atomic Emission Spectrophotometry:

introduction, principle of atomic emission spectrometry, atomic emission spectrometry using plasma sources, plasma and its characteristics, inductively plasma, direct current plasma, microwave induced plasma, choice of argon as plasma gas, instrumentation for ICP-MS.

Atomic Fluorescence Spectrometry:

Origin of atomic fluorescence, atomic fluorescence spectrum, types of atomic fluorescence transitions, principle of atomic fluorescence spectrometry, fluorescence intensity and analyte concentration, instrumentation for atomic fluorescence

spectrometry, applications of atomic absorption spectrophotometry, interferences, merits and limitations.

Reference Books:

1. Christian, G.D. Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).
2. Harris, D.C. Quantitative Chemical Analysis, 8th ed., W. H. Freeman and Company, New York, (2011).
3. Skoog, D. A., West, P.M., Holler, F.J. and Crouch, S. R., Fundamentals of Analytical Chemistry, 9th ed., Cengage Learning, (2013).
4. *Braun, R.D. Introduction to instrumental Analysis, International student Edition, (1985).*

CHM-665

Analytical Chemistry Practicals

2(0 - 2)

Practicals

The experiments may be set making use of the following instruments depending upon their. Availability, special experiments may also be designed for which a specimen list of instruments is Given below. For the innovative designing of experiments the Journal of Chemical Education may be consulted.

INSTRUMENTS

UV/Visible spectrophotometers
Flame photometers
pH-meters
Conductivity bridge
Gas chromatography
HPLC chromatography
Electro gravimetric apparatus
Atomic absorption spectrophotometer
Infrared spectrophotometers

Experiments

Determination of iron in soil by spectrophotometry.
Spectrophotometric determination of molybdate ion.
Separation of dyes using column/paper/thin layer chromatography.
Separation of sugars using paper chromatography.
Separation of amino acids using paper/thin layer chromatography.
Separation of hydrocarbons using GC/HPLC.
Determination of iron in foods products spectrophotometrically.
Determination of phosphate content in commercial fertilizers by spectrophotometry.
Determination of nickel in vegetable ghee by spectrophotometry involving solvent extraction.
Identification and spectrophotometric determination of aspirin, phenacetine and caffeine in pharmaceutical samples.

IR analysis and identification of human body stones

Mass spectrometry of mineral oil samples.

To determine pKa values for the given samples of weak acids by potentiometric method.

To determine the quality parameters i.e. pH, conductance and concentration of anions cations.

To determine Ni (II) in steel using DMG reagent by spectrophotometric method.

To determine vitamin-C concentration in the given samples.

To determine calcium and zinc in milk by atomic absorption spectrophotometer.

To determine lead in sewage sludge by atomic absorption spectrophotometer.

To determine Mn and Cr in stainless steel spectrophotometrically.

To record and characterization of IR spectra of at least 1 organic compounds.

Specialization in Biochemistry

CHM-667

Biological Metabolism

3(3-0)

Dietary carbohydrates, Glycolysis, biomedical significance, Fermentation, feeder pathway and fate of pyruvate, Citric acid cycle, Gluconeogenesis, Cori cycle, Glycogenesis, Glycogenolysis, HMP shunt, Uronic acid pathway, Glyoxylate pathway, photosynthesis, General aspects of amino acids metabolism, urea cycle Breakdown and synthesis of individual amino acids, protein degradation, transport of fatty acids to mitochondria, β and ω -oxidation of fatty acids, ketone bodies biosynthesis of fatty acids, Triacylglycerides, ecosanoids, prostaglandins, cholesterol, steroids, concept of central dogma.

Recommended Books:

1. D. L. Nelson, M. M. Cox. W. H. Freeman, "Lehninger Principles of Biochemistry" 5th Ed. Publishers Essentials of Carbohydrate Chemistry J. F. Robert. Springer verlag, (1998).
2. D. J. Voet, G.J. Voet, C. W. Pratt "Fundamentals of Biochemistry 3rd Ed., John Wiley & Sons Inc, (2008).
3. S. C. Rastogi, "Biochemistry, 2nd Ed, McGraw Hill, (2008).
4. S. P. Singh, "Text book of Biochemistry, 4th Ed., CBS Publishers, (2008).
5. Vasudevan, "Text book of Biochemistry for Medical Students, 4th Ed., J P Brothers medical, (2005).

CHM-669

Human Physiology

3(3-0)

Components and physiology of body systems, structure and functions of liver; with special reference to detoxification functions, circulatory system, blood composition, blood pressure, blood groups, blood coagulation and blood clotting factor, blood buffers, respiratory system, structure and functions of lungs, transport of oxygen and carbondioxide in blood, acid base balance, excretory system, kidney; structure and functions, water and electrolyte balance, nervous system, hormones, introduction, classification, chemical nature, general mechanism of action, regulation, secretion, mode of action and biological functions of thyroid, parathyroid, pituitary, adrenal, gonadal and pancreatic hormones, structure and functions of muscle

Recommended Books:

1. D. Voet, J. G. Voet, C. W. Pratt, "Fundamentals of Biochemistry, 3rd Ed, John Wiley and Sons, New York, USA (2008).
2. C. Arthur, J. Gyton, E.W. B. Hall, "Text Book of Medical Physiology 10th Ed, Saunders Company, (2008).
3. A. J. Vender, J. H. Sherman, D. S. Luciano, "Human Physiology, 5th Ed, McGraw-Hill Company, (2003).
4. A. L. Lehninger, D. L. Nelson, M. M. Cox, "Principles of Biochemistry, 5th Ed, Worth Publishers, New York, USA (2008).

CHM-671

Biochemistry of Nucleic Acids

3(3-0)

Introduction, Nucleus, Genome organization, Nucleic acids and their importance, Types, chemical composition, Sugars and bases: purines and pyridines, Unusual bases and their functions, Nucleosides, nucleotides and their derivatives, Nucleotide coenzymes, synthesis and degradation of nucleotides, Phosphodiester bond, Oligonucleotide, Polynucleotide, Double helical structure, Unusual structure of DNA, Structures of RNA, Physical and chemical properties of nucleic acids, DNA denaturation and hybridization, DNA sequencing, Chemical synthesis of DNA, gene and genome, Differences in prokaryotic and eukaryotic genes, Histones, Nucleosome, DNA supercoiling, Structure of chromosome, Genetic information,

Recommended Books:

1. D. L. Nelson, M. M. Cox, "Lehninger Principles of Biochemistry, 5th Ed. W. H. Freeman Publishers, (2008).
2. D. J. Voet, G. J. Voet C. W. Pratt, "Fundamentals of Biochemistry 3rd Ed. John Wiley and Sons, USA (2008).
3. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, "Molecular Biology of the Cell, 5th Ed, Garland Sciences, Taylor and Francis. USA (2008).
4. H. Lodish, A. Berk, L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell, "Molecular Cell Biology, 4th Ed., W.H. Freeman, (2000).

CHM-673

Biochemistry Practicals

2(0 - 2)

General phenomenon: Solution preparation, centrifugation, precipitation, chromatography, spectrophotometry, lyophilization, electrophoresis, proximate analysis

Carbohydrates: qualitative analysis of known carbohydrates, Extraction of starch and glycogen,

Proteins: Qualitative tests of amino acids and proteins, quantitative determination of proteins in serum/plasma and urine

Lipids: Extraction of lipids and oils, lipid unsaturation test, Saponification and emulsification,

Nucleic acids: Isolation of DNA from tissues, extraction of genomic and plasmid DNA, Digestion of DNA with restriction enzymes, Separation of DNA fragments by agarose and polyacrylamide gel electrophoresis

Blood and Urine: Collection of blood, urine and other biological fluids, determination of blood groups, Complete Blood count/Picture (CBC/CBP), clotting time, prothrombin time, SGOT, SGPT, kidney function test, pregnancy test, serum electrolytes, urea, creatinine and uric acid, Lipid profile, Vidals test, Test for malarial parasite, tests for hepatitis, ELISA, PCR

Specialization in Physical Chemistry

CHM-675 Kinetics of Complex Reactions 3(3-0)

Chemical Reactions

Advanced theories of unimolecular reactions, Chain and non chain complex reactions, Fast reactions, Experimental techniques for measurement of fast reaction kinetics, Kinetics of catalyzed reactions

Photochemical reactions

Introduction, Photochemical reactions, photochemical reactions in gas phase and in solutions, quantum yields, flash photolysis, photochemical reaction kinetics

Interfacial Phenomena

Solid surfaces, Gas solid interfaces, thermodynamics of adsorption, adsorption at liquid surfaces, organized molecular assemblies, colloids and surfactants, liquid interfaces, surface tension and adsorption from solutions,

Recommended Books:

1. S. Asperger, "Chemical Kinetics and Inorganic Reaction Mechanisms" 2nd Ed., Springer Verlag (2003).
2. J. H. Espenson, "Chemical Kinetics and Reaction Mechanism" 2nd Ed., McGraw Hill London, UK (2002).
3. D. C. Neckers, G. von, B. Unau, W. S. Jenks, "Advances in Photochemistry", Vol. 27, John Wiley & Sons, Inc. USA (2002).
4. P. W. Atkins, "Physical Chemistry" 6th Ed, W. H. Freeman and co. New York, (1998).
5. K. J. Laidler, "The World of Physical Chemistry" 1st Ed., Oxford University Press, pp. 488 (1993).

CHM-677 Nuclear and Radiation Chemistry 3(3-0)

Nuclear Chemistry

Introduction to Nuclear chemistry, Nuclear systematic, sources of nuclear instability, nuclear energetics , nuclear fission and fusion

Nuclear Techniques

Principles, sources of nuclear radiation. Nuclear track detectors. Etchings. Kinetics and mechanism of track etching. Nuclear materials. Nuclear techniques.

Radiation Chemistry

Tracers. Radiation Chemistry, theoretical aspects. Various models. Kinetic studies of radiolytic processes. Dosimetry (physical and chemical). Radiation chemical yields. Dose and dose rate effects on primary and secondary products. Steady state and pulse radiolysis techniques. Radiolytic studies of gaseous, water, aqueous and organic systems. Radiology.

Recommended Books:

1. G. Friedlander, J. W. Kennedy, "Nuclear and Radiochemistry", 3rd Ed. John Wiley & Sons, New York, USA (1981).
2. G. R. Choppin, J. Rayberg "Nuclear Chemistry Theory and Applications", 1st Ed., Pergaman Press, Oxford, USA (1998).
3. F. Aziz, M. A. J. Rodgers, "Radiation Chemistry Principles and Application" Ed., VCH Publishers, Inc, (1987).
4. R. Gregory, Choppin, J. Rayberg "Nuclear Chemistry Theory and Applications", 1st Ed., Pergaman Press, Oxford, USA (1998).

CHM-683

Material Chemistry

3(3-0)

Physical Chemistry of Macromolecules

Introduction, molecular forces and chemical bonding in macromolecules, configurations and conformation of polymer chains, theories of polymer solutions, spectroscopic analysis, thermal analysis, polymer rheology

Solid State

Introduction, attractive forces, properties of solids, crystal structure, crystal defects, crystallography, theories of bonding, packing of atoms in metals.

Modern Materials

Composite materials, superconductors, conducting polymers, biopolymers, Bullet proof polymers, edible plastics, smart materials, nano particles.

Recommended Books:

1. S. F. Sun, "Physical Chemistry of Macromolecules" 2nd Ed, John Wiley and Sons, INC. New York, USA (2004).
2. G. C. Bond, "Heterogeneous Catalysis" 2nd Ed., Clarendon Press. Oxford, USA (1987).
3. Anthony West "Basic Solid State Chemistry" John Wiley and sons, 1988, USA.
4. Robert J. Young, " Introduction to polymers" Capmann and Hall, 1981, USA.
5. Joel R. Fried " Polymer Science and Technology " Prentice Hall PTR. 1995.USA.
6. Fred W. Billmeyer "Text of Polymer Science" Wiley Interscience Publications, John Wiley and sons , 1984, USA.

CHM-685

Physical Chemistry Practicals

2(0 –2)

1. Sugar analysis and inversion studies by polarimetry
2. Verify Beer's Lambert's Law for the given solution.
3. Investigate the kinetics of hydrolysis of ethyl acetate in the presence of hydrochloric acid at room temperature and determination of order of reaction.
4. Interpretation of IR and NMR spectra
5. Determination of molecular weight of given sample of polymer viscometrically
6. Thermal analysis of given polymer sample with the help of available established literature
7. Surface characteristics of given polymer sample with the help of available established literature
8. Waste water treatment using chemicals
9. Waste water treatment using advanced oxidation process
10. Study of isotherms and experiments of surface chemistry
11. Preparation of colloidal solution and determination of precipitation value of colloidal solution by using monovalent, bivalent and trivalent cations
12. Determination of apparent molar volume of different sample solutions
13. Calculation of partial molar volume by graphical method
14. Kinetic study of enzyme catalyzed reactions

Specialization in Inorganic chemistry

CHM-687 Main Group Organometallic and Organic Reagents 3(3 - 0)

Main Group Organometallic Reagents

Introduction, Preparation, classes of nucleophilic organometallic reagents organo-Li, S, Sc, Si, B, Sn, Sb and Zn in organic synthesis, control side reaction (Enolization vs. nucleophilic addition, substitution vs. elimination, selectively among functional groups via organometallic reagents

Organic reagents in inorganic Analysis

Type of reagents, their specific nature and methods of applications with specific examples, Complexometric and gravimetric methods involving various reagents, chelates and chelate effect.

Recommended Books:

1. C. R. Dillard, D. E. Goldberg, "Chemistry, Reactions, Structure and Properties" Colliers-Macmillan Limited, London, UK (1971).
2. E. S. Gould, "Inorganic Reactions and Structures" Holt, Rinehart and Winston, Inc. Revised Edition (1962).
3. A. K. Holliday, A. G. Massey, "Inorganic Chemistry in Non-Aqueous Solvents", 6th Ed., Pergamon Press. (1985).
4. J. E. Huheey, "Inorganic Chemistry Principles of Structure and Reactivity" 2nd Ed., Harper and Row Publishers (1978).

CHM- 689 Spectroscopic Methods of Analysis 3(3-0)

Physical methods of analysis in Inorganic Chemistry, NMR, IR, UV Spectroscopy, Mass Spectrometry, Basic Principles, Instrumentation and Applications.

Recommended Books:

1. D. L. Pavia, G. M. Lampman, G. S. Kriz, Jr., "Introduction to Spectroscopy," 2nd Ed., W.B. Saunders, (1979).
2. D. W. Mathieson, "Nuclear Magnetic Resonance for organic Chemistry," Academic Press, London, UK (1967).
3. A. Douglas, F. Skoog, J. Holler, A. T. Neuman "Principles of Instrumental Analysis", 5th Ed, Saunders College Publishing, New York, USA (1997).
4. E. A. V. Ebsworth, D. W. H. Rankin, S. Craddock, "Structural Methods in Inorganic Chemistry," 2nd Ed., Blackwell, (1987).
5. E. D. Hoffmann, "Mass Spectrometry: Principles and Applications" 2nd Ed., V. Stroobant (Ed.,) John Wiley & Sons, USA (2001).
6. H. Budzikiewitz, C. Djerassi, D. H. Williams, J. R. Chapman, "Practical Organic Mass Spectrometry," John Wiley and Sons, USA (1985).

CHM-691 Metal Cluster Compounds 3(3-0)

Introduction, Compounds of transition metals, Single, Double and tripple bonds to carbon, Acyls, Alkylidene and Alkalidyne complexes, Delocalized hydrocarbon system: alkenes, olefins, allyl and butadienes: alkyne complexes, Cylic complexes: four-five-six-members rings.

Recommended Books:

1. K. F. Purcell, J. C. Kortz, "Inorganic Chemistry" W. B. Saunders Company. Holt-Saunders International Editions (1977).
2. K. F. Purcell, and J. C. Kortz, "An Introduction to Inorganic Chemistry" Saunders College Publishing (1980).
3. D. F. Shriver, P. W. Atkins, C. H. Langford, "Inorganic Chemistry" 3rd Ed., Oxford University Press. USA (1990).

CHM-693 Inorganic Chemistry Practicals 2(0-2)

1. Conductometry

- Titration of strong acid and weak acid with a strong base.
- Precipitation titration involving AgNO₃ and KCl.

2. Potentiometry

- Determination of K₁, K₂ and K₃ for H₃PO₄
- Determination of chloride in the presence of iodide and evaluation of AgI and AgCl

3. Spectrophotometry

- Micro determination of Cr(III) by Di-phenyllecarbazine.
- Determination of Fe (II) by 1-10Phenanthroline.
- Determination of nitrites. Determination of Fe (III) by 8-hydroxyquinoline.

4. Use of some Organic Reagents for the estimation of various elements by gravimetric estimation.

- 8-Hydroxyquinoline Al (III) and Fe (III)
- Salicylaldehyde: Ni (II) in the presence of Cu (II)
- Anthranilic acid: Co (II) and Zn (II)

5. Inorganic Synthesis:

Preparation of at least six inorganic compounds/complexes in a pure state and determination of their state of purity.

Semester 4

Specialization in Analytical Chemistry

CHM-652 Thermal Methods of Analysis 3(3-0)

Thermal Analysis:

Introduction, classification and principles of thermal analysis, thermograms, instrumentations, applications and limitations of thermal analysis.

Thermogravimetric Analysis (TGA) and Derivative Thermal analysis (DTA):

Introduction and principle of thermogravimetric analysis and derivative thermal analysis, its instrumentation, applications, data interpretations, limitations.

Differential Thermal Analysis (DTA):

Introduction and principle of differential thermal analysis, its instrumentation, applications, data interpretations, limitations.

Differential Scanning Calorimetry (DSC):

Introduction and principle of differential scanning calorimetry, its instrumentation, applications, data interpretations, limitations.

Differential Photo-Calorimetry (DPC):

Introduction and principle of evolved gas analysis, its instrumentation, data interpretations, applications.

Evolved Gas Analysis (EGA):

Introduction and principle of evolved gas analysis, its instrumentation, data interpretations, applications.

Thermo-mechanical Analysis (TMA):

Introduction and principle of thermo-mechanical analysis, its instrumentation, applications, data interpretations, limitations.

Dynamic Mechanical Analysis (DMA):

Introduction and principle of dynamic mechanical analysis, its instrumentation, data interpretations, applications.

Di-electric Thermal Analysis (DETA):

Introduction and principle of di-electric thermal analysis, its instrumentation, data interpretations, applications.

Reference Books:

1. Principles of Thermal Analysis and Calorimetry, by P. J. Haines *Oakland Analytical Services, Farnhurn, Surrey, U K, Royal Chemical Society.*
2. Braun, R.D. *Introduction to Instrumental Analysis, International student Edition, (1985).*
3. Haines. P. J., Whiltby, *On Canada Mcgraw Hill Ltd., Thermal Methods of Analysis Principles, applications and problems, 1st ed. Springer, (1985).*
4. Stephen Z.D. Cheng, *Handbook of Thermal Analysis and Calorimetry, Vol. 3, Elsevier, (2002).*
5. Brown, M. E. *Introduction to Thermal Analysis: Techniques and Applications, 2nd ed., Kluwer Academic Publishers, (2001).*
6. Gabbot, P., *Principles & Applications of Thermal Analysis, Wiley-Blackwell, (2007).*

CHM-654 Nuclear Analytical Techniques

3(3-0)

Introduction to Nuclear sciences, Radioactive decay, Production of nuclear radiation, Interaction of radiation with matter, Radio-analytical techniques, Radiation detection and measurement instruments, Role of radiotracers in development of modern nuclear analytical techniques, Applications of radio-tracers in medical, environment, agriculture and industrial.

Reference Books:

1. V.S. Ramachandran, J.J. Beaudoin Handbook of Analytical Techniques in Concrete Science and Technology, Principle, Technique and Applications. William Andrew Publishing. Norwich, New Yourk, USA, 2001.
2. Brune, D.; Forkman, B.; Persson, B. Nuclear analytical chemistry, Chartwell-BrattLtd.,Bromley, England, United States, 1984.
3. R Cornelis, J Caruso, H Crews, K Heumann Handbook of elemental speciation II: species in the environment, food, medicine and occupational Health. Wiley Online Library, England, 2005

CHM-656

Luminescence Spectrophotometry

3(3-0)

introduction, origin of fluorescence and phosphorescence spectra, Jablonski diagram, activation, deactivation, fluorescence spectrum, fluorescent and phosphorescent species, photoluminescence and structure, factors affecting fluorescence and phosphorescence, fluorescence quenching, quantum yield, instrumentation for fluorescence measurement, sources, wavelength selectors, sampling, detectors, read out devices, instrumentation for phosphorescence measurement, sampling , recording procedure, application of fluorescence and phosphorescence.

Reference Books:

1. Skoog, D. A., West, P.M., Holler, F.J. and Crouch, S. R., Principle of Instrumental Analysis, 5th ed., Cengage Learning, (2013).
2. Christian, G.D. Analytical Chemistry, 6th ed., John-Wiley & Sons, New York, (2004).
3. Braun, R.D. *Introduction to Chemical Analysis, International student Edition*, (1985).

CHM-662 Reactive Intermediates and Photochemistry 3(3-0)

Nomenclature, Preparation, Reaction of Carbene. Nitrene: Nomenclature, Preparation, Reactions, Preparation, Reaction. Arynes: Preparation, Reactions.

Photochemistry:

Introduction, Principles, Difference between thermal and photochemical reaction, laws of photochemistry, quantum yield, inter system crossing, Jablonski diagram, Photofragmentation, Norrish type I and II reaction. Photoreduction, Paterno Buchi Reaction. Reactivity of ketone, photochemistry of olefins. Pinnerization reaction.

Recommended Books:

1. N.S Isaacs "Reactive Intermediates in Organic Chemistry", John Wiley & Sons USA (1974).
2. H. Okabe "Photochemistry of small Molecules", John Wiley & Sons, New York, USA (1978).
3. C. W Rees, T.I. Gilchrist, "Carbenes, Nitrenes Arynes," Nelson, London, UK (1973).

CHM – 664 Disconnection Approach 3(3-0)

The Disconnection Approach

Basic Principles: Synthesis of Aromatic Compounds, One Group: C – X Disconnections, Strategy II: Chemoselectivity, Two Group C – X Disconnections, Strategy V: Stereoselectivity A, One Group C – C Disconnections II: Carbonyl Compounds, Strategy VI: Regioselectivity, Two Group Disconnections II: 1,3-Difunctionalized Compounds and α,β -unsaturated Carbonyl Compounds, Two Group Disconnections III: 1,5-Difunctionalized Compounds, Michael Addition and Robinson Annulation, Two Group Disconnections IV: 1,2-Difunctionalized Compounds, Strategy XIII: Introduction to Ring Synthesis. Saturated Heterocycles, Three Membered Rings, Strategy XV: Use of Ketenes in Synthesis, Six-membered Rings

Recommended Books:

1. T. H. Lowry, K. S. Richardson, "Mechanism and Theory in Organic Chemistry", 3rd Ed, Harper and Row Publisher (1987).
2. G. M. Loudon "Organic Chemistry", 3rd Ed. Addison Wesley London Company (1995).
3. S. H. Pine, "Organic Chemistry", 5th Ed., McGraw Hill, New York, USA (1987).
4. G. M. Loudon, "Organic Chemistry", 2nd Ed., Addison Wesley, London (1998).
5. H.O. House "Modern Synthetic Reactions", 2nd Ed, Benjamin, California, USA (1972).

CHM – 666

Organic Catalyst and Catalysis

3(3-0)

Homogeneous and heterogeneous catalysis, Acid Catalysis, Base Catalysis, Metal ion catalysis, Hydrogenation, Asymmetric hydrogenation, Hydroboration and Hydrocyanation of olefins, Transformation of alkenes and alkynes i.e. polymerization, metathesis, dimerization and oligomerization and olefin isomerization, oxidation of olefins using catalysts, Metal complexes and Quaternary ammonium compounds in organic synthesis.

Recommended Books:

1. T. H. Lowry, K. S. Richardson “Mechanism and Theory in Organic Chemistry”, 3rd Ed, Harper and Row Publisher (1987).
2. S. H. Pine, “Organic Chemistry”, 5th Ed., McGraw Hill, New York, USA (1987).
3. G. M. Loudon, “Organic Chemistry”, 2nd Ed., Addison Wesley, London (1998).

Specialization in Biochemistry

CHM-668

Molecular Biochemistry

3(3-0)

Structural organization of genes and chromosomes in prokaryotes and eukaryotes, nucleosomes, base equivalence in DNA, Replication of DNA: Replication theory and semi-conservative replication, molecular mechanism of replication in prokaryotes and eukaryotes. Enzymes involved in replication. Molecular nature of mutations, DNA damage and repair. Modification and restriction, DNA recombination, Transcription: Synthesis and processing of RNA. Reverse transcription and RNA replication in viruses. Genetic code and Wobble hypothesis. Translation, Post-translational modifications and targeting of proteins. Control of transcription and translation.

Recommended Books:

- 1- B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter “Molecular Biology of the Cell, 5th Ed, Garland Sciences, Taylor and Francis, (2008).
- 2- G. Karp “Cell and Molecular Biology: Concepts and Experiments” John Wiley & Sons. (2008).
- 3- D. J. Voet, G. J. Voet, C. W. Pratt, “Fundamentals of Biochemistry. 3rd Ed., John Wiley & Sons Inc. (2008).
- 4- R. K. Murray, D. K. Grannar, V. W. Rodwell, “Harper’s Illustrated Biochemistry, 27th Ed, McGraw Hill, (2008).
- 5- H. Lodish, A. Berk, L. Zipursky, P. Matsudaira, D. Baltimore & J. Darnell “Molecular Cell Biology” 4th Ed., W.H. Freeman. (2000).
- 6- R. Sheeler, D. E. Bianchi. “Cell and Molecular Biology” John Wiley & Sons Inc. U.S.A. (2000).

CHM-670

Clinical Diagnosis

3(3-0)

Sampling techniques and preservation, Microscopy, Complete Blood Picture (CBP) including haemoglobin and Packed Cell Volume (PCV), preparation of blood smear, staining, and differential leucocyte count, count of neutrophils, eosinophils, monocytes and lymphocytes. Total leucocyte count. Bleeding time, clotting time, prothrombin time. Liver function tests; SGOT, SGPT, LDH, S. phosphatase and CPK. Kidney function test, Pregnancy test; A/G ratio, serum electrolytes. Urine analysis. General considerations and normal values, bile pigment, bilirubin, urobilin and urobilinogen, albumin, urea, ketone bodies, reducing sugars, creatinine and uric acid crystals. Blood groups. Sero-diagnosis of infectious diseases through ELISA, PCR, RIA, Lipid profiles.

Recommended Books:

1. C. A. Burtis, Ashwood, N. W. Tietz "Tietz Textbook of Clinical Chemistry", W. B.Saunders Co. (1999).
2. W. Levinson, E. Jawetz. "Medical Microbiology and Immunology, 4th Ed, Appletan and Lange, Stanford, Connecticut, USA. (1996).
3. W. J. Marshall, S. K. Bangert, "Clinical Biochemistry". Churchill Livingstone. New York, USA (1995).
4. S. J. Dacie, S. M. Lewis, "Practical Haematology, 7th Ed., ELBS, UK (1991).
5. H. Varley, A. H. Gowenlock, M. Bell, "Practical Clinical Biochemistry, Vol.I 5th Ed., William Heinemann Medical Books Ltd. (1980).

CHM-672

Biochemistry of Vitamins and Minerals

3(3-0)

Occurrence, sources, absorption, metabolic role, physiological functions, structures and chemistry of water soluble and lipid soluble vitamins, Interactions of various vitamins in intermediary metabolism, hypervitaminosis and deficiency symptoms, water intake and output, volume and composition of body fluids,. Regulatory mechanisms, Acid-base balance, physiological buffer systems, pH interactions, abnormalities; acidosis and alkalosis. Bulk and trace minerals; their metabolism, absorption, excretion, distribution, functions, deficiency manifestations, interactions and requirements.

Recommended Books:

1. R. Passmore, M. A. Eastwood, "Human Nutrition and Dietetics" Churchill, Livingstone/EL BS, London, UK (1995).
2. D. W. Mortin, P. A. Mayes, V. W. Rodwell, D. K. Granner. "Harper's Review of Biochemistry, 25th Ed. Lange Medical Publications USA (1995).
3. J. K. Kolmer, E. H. Spanlding, H. W. Robinson, "Approved Laboratory Techniques" 3rd Ed. Appletan and Company, USA (1959).
4. G. Rendina, "Experimental methods in modern biochemistry" W. B. Saunders Company Philadelphia, (1971).

CHM-678 Homogenous Catalysis 3(3-0)

Reaction of CO and hydrogen, Hydroformylation, reductive carbonylation, reduction of CO by hydrogen, synthesis of water gas and shift reactions. Carbonylation reaction, Synthesis of methanol and methyl acetate, adipic ester, other carbonylation and decarbonylation reactions. Catalytic addition of molecules to C-C multiple bonds, Homogeneous hydrogenation, and hydrocylation and hydrocyanation.

Recommended Books:

1. P. Powell, "Principles of Organometallics Chemistry", 2nd Ed, London, Chapman and Hall, New York, USA (1988).
2. A. Yamamoto "Organotransition metal chemistry" John Wiley and Sons: New York, USA (1986).
3. M. Bochmann "Organometallics 2, complexes with transition metal carbon π -bonds" Oxford University Press, UK (1993).
4. G. L. Miessler, D. A. Tarr, "Inorganic chemistry" 2nd Ed., Prentice Hall International, USA (1998).
5. F. A. Cary, "Organic Chemistry" 7th Ed, The McGraw-Hill Company, USA (2008).

CHM-684 Radio Nuclear Chemistry 3(3-0)

Fundamentals and applied aspects of Radio activity and nuclear chemistry. Trans-Uranium elements; Natural and artificial radioactivity, methods for isotope production, nuclear reactions; mass spectrograph, Astam mass spectrograph, The structure of the nucleus; nuclear stability and radioactive decay; Types, characteristics and detection of radio active Particles; laws of radioactive decay; the interaction of radiation with matter including radiological health hazards; Processing of the nuclear materials. Accelerators of charged particles Applications of radioisotopes.

Recommended Books:

1. F. Landler, Kennedy, Miller, "Nuclear and Radiochemistry", 2nd Ed, John Wiley and Sons, Inc. (1964).
2. G. R. Choppin, J. Rydber, "Theory and Applications", 1st Ed., Pergamon (1980).
3. H. J. Arnikan, "Essentials of Nuclear Chemistry", 4th Ed, (1990).
4. B. G. Harvey, "Nuclear Physics and Chemistry", Prentice-Hall Inc., (1990).
5. I. I. Naqvi, "Radiochemistry", McGraw Hill, USA (1990).

CHM-686 Magneto Chemistry 3(3-0)

Theory of magnetism, diamagnetism, paramagnetism, ferro-, ferri- and antiferromagnetism, magnetic susceptibility, magnetic moments, Faraday's & Gouy's methods, orbital contribution to magnetic moment, Russell-Sanders coupling scheme, derivation of term symbols of for $p^1 - p^6$ and $d^1 - d^{10}$ systems, pigeon holes diagram, effect of temperature on magnetic properties of complexes. Magnetic moment of lanthanides.

Recommended Books:

1. B. Douglas, D. McDaniel, J. Alexander, "Concepts of Models of Inorganic Chemistry", 3rd Ed, John Wiley & Sons Inc., (.1994).
2. J. E. Huheey, E. A. Keiter, R. L. Keiter, "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper & Row, New York, USA (2001).
3. K. M. Mackay, R. A. Mackay, W. Henderson, "Introduction to Modern Inorganic Chemistry", 5th Ed, Stanley Thomas Publisher Ltd. (1996).
4. G. L. Miessler, A. T. Donald, "Inorganic Chemistry", 2nd Ed., Prentice Hall International, 1991.

Specialization in Physical Chemistry

CHM-688 Group Theory and Solutions

3(3-0)

Advanced Group Theory

Group Algebra. Point groups. Classes Symmetry, The character table and representation, Group theory application in chemistry

Solution Chemistry

Physicochemical characteristics of solvents. Solute-solvent interaction, solvation of ions, preferential solvation. Thermodynamic methods for study of solutions

Biophysical Chemistry

Principles of biophysical chemistry; thermodynamic aspect of simple molecules, macro molecules, lipids and biological membranes; nucleic acids and proteins; enzyme kinetics and catalysis; experimental techniques

Recommended Books:

1. F. A. Cotton, "Chemical Applications of Groups Theory", Interscience Publishers (1963).
2. A. Mohammad, "Application of Symmetry and Group Theory in Chemistry" University Grants Commission, Islamabad, (1984).
3. Alan Vincent "Molecular Symmetry and Group Theory" John Wiley & sons , 1976, USA.
4. Alberty, R. A., Robert J. S. and Mounji G. B. "Physical Chemistry". 4th Edition , John Wiley and Sons, (2004).
5. Smith, E. Brian, "Basic Chemical Thermodynamics" 5th Edition. Imperial College Press,. (2004).
6. Stephen B. R., Rice S. A., and Ross J., "Physical Chemistry" 2nd Ed., Oxford University Press, (2000).
7. Jurg, W., "Basic Chemical Thermodynamics" W. A. Benjamin (1969).
8. Robert G. Mortimer. "Physical Chemistry" 3rd Edition, Elsevier Academic Press, UK (2008).

CHM-690 Quantum and Statistical Mechanics 3(3-0)

Statistical Mechanics

Average values, fluctuations. Partition functions of diatomic and polyatomic gases. Statistical mechanical treatment of chemical processes and equilibria. Imperfect gases, liquid state, dilute solutions and perfect crystals.

Quantum Chemistry

Operators and their properties, angular momentum. Central field problem. Variation and perturbation methods. Approximate methods in molecular quantum chemistry. Applications to quantum mechanical systems.

Theoretical and Computational Chemistry

Molecular orbital calculations. Essential concepts, semiempirical and Ab-initio methods. Reactivity. Configuration interaction method. Potential energy surfaces. Quantitative structure-activity relationship (QSAR). Computer programming and three dimensional graphics using standard packages.

Recommended Books:

1. D. J. Griffiths, "Introduction to Quantum Mechanics" 2nd Ed, Prentice Hall (2004).
2. M. G. Barrow, "Physical Chemistry" 5th Ed., McGraw Hill (1992).
3. R. Alberty, "Physical Chemistry" 17th Ed., John Wiley and Sons, USA (1987).
4. P. W. Atkins, "Physical Chemistry" 6th Ed, W. H. Freeman and co. New York, USA (1998).
5. K. J. Laidler, "The World of Physical Chemistry" 1st Ed., Oxford University Press, USA (1993).
6. K. J. Laidler, H. M. John, C. S. Bryan, "Physical Chemistry" 4th Ed., Houghton Mifflin Publishing Company Inc. (2003).
7. E. Thomas, P. Reid, "Thermodynamics, Statistical Thermodynamics", and Kinetics 1st Ed., Benjamin Cummings, (2006).

CHM-692 Advanced Spectroscopy 3(3-0)

Molecular Spectroscopy

Electromagnetic radiations, interactions of electromagnetic radiations with matter, microwave, infrared and Raman spectroscopy of polyatomic molecules, vibrational-rotational spectra,

Nuclear Magnetic Resonance

Principles of magnetic resonance. Nuclear magnetic resonance (NMR) spectroscopy. Coupling phenomenon in simple (AX_n) and complex systems. Relaxation mechanisms and their applications. Dynamic NMR. Applications in structure elucidation.

Electron Spin Resonance

Electron spin resonance spectroscopy (ESR). Principles and applications to solids and solutions.

Recommended Books:

1. J. D. Gray, "Molecular Spectroscopy," McGraw-Hill, New York, USA (1988).
2. G. M. Barrow, "Introduction to Molecular Spectroscopy," 2nd Ed, McGraw-Hill, New York, USA (1962).
3. C.N. Banwell, "Molecular Spectroscopy" 3rd edition Tata-Mc Grawhill Publishing Company, New Delhi, India, 1983.

CHM-694 Electrochemical Aspects of Solutions 3(3-0)

Electrochemistry of Solution

Conductance and resistance, Fugacity, activity, activity coefficient, colligative properties of electrolytes, ionic mobility, cell constant, ionic strength

Kinetics of Electrode Process

Theories of electrolytes, interfacial phenomena, electrode kinetics, mechanism of electrode reactions, Butler Volmer equation, cyclic voltametry and its applications

Modern Aspects of Electrochemistry

Electroplating, Bioelectrochemistry, photoelectrochemistry, Electrochemiluminescence, Batteries, Piezoelectricity, Fuel cell

Recommended Books:

1. J. Albert, "Electrode Kinetics" Clarendon, Oxford, USA (1975).
2. B. R. Stephen, S. A. Rice, J. Ross, "Physical Chemistry" 2nd Ed., Oxford University Press, USA (2000).
3. W. Jurg, "Basic Chemical Thermodynamics" W. A. Benjamin (1969).
4. Smith, E. Brian, "Basic Chemical Thermodynamics" 5th Ed, Imperial College Press. (2004).
5. R. A. Alberty, J. S. Robert, G. B. Mounqi, "Physical Chemistry". 4th Ed, John Wiley and Sons, (2004).
6. D. W. Ball, "Physical Chemistry" 1st Ed., Brooks/Cole Co. Inc., (2003).

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