

Instructions

*Please follow the scheme of studies of relevant prospectus strictly.

*Course Code and Course Title should be carefully noted.

*Prospectus are available in soft form at university website.

*For any clash of scheme of studies in prospectus and outlines, please contact the Focal person (Department of Chemistry)

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M.Sc Chemistry 2018-20

Semester 1

Course Code	Course Title	Credit Hours
CHM-551	Physical Chemistry – I	4(3 – 1)
CHM-553	Organic Chemistry – I	4(3 – 1)
CHM-555	Inorganic Chemistry – I	4(3 – 1)
CHM-557	Analytical Chemistry – I	4(3 – 1)
MTH-571	Mathematics for Chemists	2(2 – 0)
	Total	18

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 interfacial 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. Mounqi, "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).

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. Fumiss, 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 trioxalatoaluminate (iii) Ammonium Nickel (II) Sulphate (iv) Hexa aqua Chromium (III) chloride).
3. Complexometric Titration (Any four) $\text{Cu}^{2+} / \text{Ni}^{2+}; \text{Ca}^{2+} / \text{Ba}^{2+}; \text{Au}^{2+} / \text{Pb}^{2+}; \text{Cd}^{2+} / \text{Zn}^{2+}; \text{Ni}^{2+} / \text{Mg}^{2+}; \text{Ca}^{2+} / \text{Zn}^{2+}$

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

Analytical Chemistry-I

4(3-1)

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, 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 pK_a and pK_b 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 efficiency, Types and practical applications of solvent extraction in chemical analysis. Chromatographic methods General theory of chromatography, classification of chromatographic methods, column, paper, thin-layer, and ion-exchange chromatography and their applications.

Practicals

1. Laboratory materials, reagents and safety measures, Calibration of glassware used for volumetric analysis

2. Preparation and standardization of reagents and solutions.
3. Solvent extraction of organic compounds
4. Single step and multiple batch solvent extraction and comparison of efficiency
5. Analysis of iron sodium and potassium in tap water/food samples by spectrophotometry
6. Separation of mixture of organic and inorganic compounds by chromatography methods

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).

Course Code	Course Title	Credit Hour
MTH-571	Mathematics for Chemists	2(2-0)

Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Composition of functions, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal. Integral as Anti-derivative, Indefinite Integration of Simple Functions. Methods of Integration: Integration by Substitution, by Parts, and by Partial Fractions, Definite Integral as Limit of a Sum.

RECOMMENDED BOOKS

1. Swokowski, Olinick and Pence, *Calculus and Analytical Geometry*, 6th edition, 1994, Brooks/Cole Publishers.
2. Howard Anton, *Calculus*, 7th edition. 2002, John Wiley and Sons (WIE).
3. William E. Boyce Richard C. Diprima, *Calculus*, John Wiley & Sons, ISBN: 0471093335.
4. Thomas Finny, *Calculus and Analytical Geometry*, 10th edition, John Wiley and Sons.
5. Erwin Kreyzig, *Advanced Engineering Mathematics*, 7th edition, 1993, John Wiley & Sons Inc.

Semester 2

Course Code	Course Title	Credit Hours
CHM-552	Physical Chemistry – II	4(3 – 1)
CHM-554	Organic Chemistry – II	4(3 – 1)
CHM-556	Inorganic Chemistry – II	4(3 – 1)

- H. H. Lowell, "Group Theory and Symmetry in Chemistry" 1st Ed, McGraw Hill Book Company (1969).
- D. H. Whiffen, "Spectroscopy" 1st Ed, Longmans Green and Co.: London, (1966).

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:

- F. A. Carey, R. J. Sundberg, "Advanced Organic Chemistry (Part B: Reactions and Synthesis)", 3rd Ed, Plenum Press, New York, USA (1990).
- B. K. Carpenter, "Determination of Organic Reaction Mechanisms, "John Wiley & Sons, Inc. (1984).
- G. R. Chatwal, "Reaction Mechanism and Reagents in Organic Chemistry", 1st Ed., Himalaya Publishing House (1987).
- J. Fuhrhop, G. Penzlin, "Organic Synthesis Concepts, Methods, Starting Materials", 2nd Ed., Weinheim Germany (1983).
- 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 NH₃, HF, SO₂, BrF₃, CH₃COOH 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. KIO₃ Titrations (Any two)

3. Gravimetric Estimations:

Estimations of Ba²⁺ ; 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. Bockhmann, "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 4(3-1)

Spectroscopy, Theory and principals of Spectroscopy, 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 essay study, clinical studies, microbiology. Applications of IR, NMR and Mass spectrophotometer in research & development and quality control process.

Practicals

1. Qualitative and quantitative analysis by UV/Visible Spectroscopy
2. Identification of functional groups of organic compounds by IR spectroscopy
3. Identification of organic compounds using available and accessible spectroscopic techniques
4. Sample preparation for various molecular spectroscopic techniques; IR, FTIR, MS
5. Visit of Hi-Tech Lab and practical demonstration of molecular spectroscopic techniques; IR, FTIR, MS

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).

Braun, R.D. Introduction to instrumental Analysis, International student Edition, (1985).

CHM-560 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).

Semester 3

English for Employment 7th Semester (BS), 3rd Semester(MSc.)

Contents:

1. **Forms of Communication:**
 - Verbal Communication
 - Non-Verbal Communication
 - Written Communication
2. **Non-Verbal Communication**
 - What is Non-Verbal communication
 - Characteristics of Non-Verbal Communication
 - Classification of Non-Verbal Communication
 - Advantages of learning Non-Verbal Communication
 - Guidelines to develop Non-Verbal Communication
3. **Verbal Communication**
 - Presentation Skills
 - ❖ What is presentation?
 - ❖ Qualities of a good presenter
 - ❖ Essential characteristics of a good presentation
 - ❖ Elements of a presentation
 - ❖ Designing of your presentation
 - Interview Skills
 - ❖ Preparation of an interview
 - ❖ How to handle difficult questions
 - ❖ Most common mistakes to avoid during an interview
 - ❖ Tips of a successful interview
 - Telephonic Conversations
 - ❖ How to enquire (job vacancy, scholarships, admissions)
 - ❖ How to respond to an enquiry
 - ❖ Effective use of Meta communication (Vocalization)
4. **Written Communication**
 - Principles of effective writing
 - Business writing- keys points to remember
 - E-mail Writing
 - ❖ Advantages of e-mail writing
 - ❖ The most common complaints about e-mail in practice
 - ❖ How to create electronic rapport
 - ❖ Sample e-mail messages
 - ❖ Writing subject lines
 - ❖ Writing negative messages
 - ❖ Writing positive messages
 - ❖ Writing an enquiry e-mail
 - ❖ Writing a response to an enquiry
 - CV Writing
 - ❖ How to read a job advertisement

- ❖ Responding to Job advertisement
- ❖ To identify individual strengths and skills to write CV
- ❖ Writing an effective CV
- How to fill job application form
- How to write a Cover letter
- Report writing
- How to write a Research Proposal
- 5. **Employability Skills**
- Strategies to identify employment opportunities
- Business Etiquettes
- ❖ Etiquette in the Workplace
- ❖ Etiquette in the Social settings
- Workplace Ethics
- Cultural Awareness
- ❖ Intercultural sensitivities
- ❖ Communicating effectively across cultures
- Positive thinking
- ❖ Role of positive thinking in successful career
- ❖ How to be positive in crucial situation

Recommended Readings:

- ❖ Tata McGraw-Hill Edition: Communication for business
- ❖ P.D.Chaturvedi&MukeshChaturvedi, Business Communication. Pearson
- ❖ Courtland Bovee&JohnThill , Business Communication Essentials. Pearson

Specialization in Analytical Chemistry

Course Code	Course Title	Credit Hours
ENG-611	English for Employment	3(3 – 0)
CHM-651	Electro-analytical Techniques	3(3 – 0)
CHM-653	Advanced Separation Techniques	3(3 – 0)
CHM-655	Atomic Spectroscopy	3(3 – 0)
CHM-657	Advanced Analytical Chemistry Practicals	2(0 – 2)
	Total	14

CHM-651 Electroanalytical Techniques 3(3-0)

Introduction: Electrochemistry, Electrochemical cells, Standard cell potential, Indicator electrode, Reference electrodes, Classification of electro analytical methods, Bulk method, Interfacial methods, static methods, dynamic methods

Potentiometric method of analysis: Potentiometric measurements, Indicator electrodes, Metallic indicator electrode, Membrane indicator electrode, 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.

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-653 Advanced Separation Techniques 3(3-0)

Chromatography: Classification of chromatographic techniques, Theoretical consideration of chromatographic separations, 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 to 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-655

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-657

Advanced Analytical Chemistry Practicals

2(0 - 2)

The experiments may be set making use of the following instruments depending upon

their availability. The Instructor should consult the “Journal of Chemical Education” for the innovative designing of experiments. Special experiments may also be designed for which a specimen list of instruments/techniques is given below.

Conductometry, Potentiometry, Coulometry, Electrogravimetry, Column Chromatography

Gas Chromatography, HPLC, Capillary Electrophoresis. Atomic Absorption Spectroscopy and Atomic Emission Spectroscopy.

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 1organic compounds.

Specialization in Inorganic chemistry

Specialization in Inorganic Chemistry

Course Code	Course Title	Credit Hours
ENG-611	English for Employment	3(3 – 0)
CHM-661	Main Group Organometallic and Organic Reagents	3(3 – 0)
CHM-663	Spectroscopic Methods of Analysis	3(3 – 0)
CHM-665	Organo-Transition Metal Compounds	3(3 – 0)
CHM-667	Advanced Inorganic Chemistry Practicals	2(0 – 2)

	Total	14
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CHM-661 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- 663 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-665 Organo-Transition Metal Compounds 3(3-0)

Introduction, Cluster Compounds: Nomenclature and Structural Patterns, Metal Carbonyl Type Clusters, Anionic, Hydrido, Larger and Superlarge Carbonyl Clusters, Non-Carbonyl Clusters, Heteroatom in Clusters, Electron Counting Rules (TEC, Wades, Capping). Metal to Carbon Single, Double and Triple bonds; Acyls, Alkylidene and Alkylidyne Complexes, Bonding to Olefins, Polyolefins, Allyl, Alkyne and Arene Complexes.

Recommended Books

F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, "Advanced Inorganic Chemistry", 6th Edition, John Wiley and Sons (2003).

G. L. Miessler and D.A. Tarr, "Inorganic Chemistry", 3rd Edition, Pearson Education, Inc., (2004).

W. W. Porterfield, "Inorganic Chemistry, A Unified Approach", 2nd Edition, Elsevier (1993).

B. Douglas, D. McDaniel, J. Alexander, "Concepts and Models of Inorganic Chemistry", 3rd Edition, John Wiley and Sons (2006).

CHM-667 Inorganic Chemistry Practicals

2(0-2)

1. Conductometry

- Titration of strong acid and weak acid with a strong base.
- Precipitation titration involving AgNO_3 and KCl .

2. Potentiometry

- Determination of K_1 , K_2 and K_3 for H_3PO_4
- Determination of chloride in the presence of iodide and evaluation of AgI and AgCl

3. Spectrophotometry

- Micro determination of Cr(III) by Di-phenylcarbazide.
- 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.

Specialization in Organic Chemistry

Course Code	Course Title	Credit Hours
ENG-611	English for Employment	3(3 – 0)
CHM-671	Spectroscopic Organic Techniques	3(3 – 0)
CHM-673	Rearrangements and Pericyclic Reactions	3(3 – 0)
CHM-675	Pharmaceutical Chemistry	3(3 – 0)
CHM-677	Advanced Organic Chemistry Practicals	2(0 – 2)
	Total	14

CHM-671 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, Principes & 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-673 Rearrangements and Pericyclic Reactions 3(3 – 0)

Classification of rearrangement, Pinacol Pinacolon 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 woodmard 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-675 Pharmaceutical Chemistry 3(3 – 0)

Alkolids

Introduction, occurrence, function of Alkolids 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- 677

Advanced Organic Chemistry Practicals

2(0-2)

Synthesis of Organic Compounds:

Students must be informed of MSDS of all compounds used in experiments.

The experiments may be arranged as per choice/requirement of instructor but should be designed from following categories;

Various experiments involving the development of amide, ester and ether linkages.

Experiments involving oxidation and reduction of organic compounds.

Synthesis of various dyes.

Recommended Books:

- 1- J. Fuhrhop, G. Penzlin, "Organic Synthesis Concepts, Methods, Starting Materials", 2nd Ed., Weinheim Germany (1983).
- 2- A. L. Vogel, "Elementary Practical Organic Chemistry Part III: Quantitative Organic Analysis", 1st Ed., Longman Group Ltd (1958).
- 3- F. A. Carey, R. J. Sundberg, "Advanced Organic Chemistry (Part B: Reactions and Synthesis)", 3rd Ed, Plenum Press, New York, USA (1990).
- 4- B. S. Fumiss, A. J. Hannaford, P.W.G. Smith, A. R. Tatchell "Vogel's Practical Organic Chemistry", 5th Ed, Addition Wesley Longman, Harlow, England(1989).

Specialization in Physical Chemistry

Course Code	Course Title	Credit Hours
ENG-611	English for Employment	3(3 – 0)
CHM-681	Kinetics of Complex Reactions	3(3 – 0)
CHM-683	Advanced Spectroscopy	3(3 – 0)
CHM-685	Material Chemistry	3(3 – 0)
CHM-687	Advanced Physical Chemistry Practicals	2(0 – 2)
	Total	14

CHM-681 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-683 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. Graybal, "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 Grahill Publishing Company, New Delhi, India, 1983.
- 4.

CHM-685

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-687

Advanced 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

Semester 4

Course Title: Introduction to Statistical Theory Credit Hours: 3(3-0)

Course Code: **STA-595**

Introduction and scope of statistics, Basic concepts of statistics, Different types of variables, types of data and methods of data collection, Scales of measurement, Data arrangement and presentation, formation of tables and charts, Measures of central tendency: mean, median and mode and quantiles from grouped and ungrouped data. Measures of dispersion: computation of range, variance, standard deviation, and coefficients of variation, Skewness and Kurtosis, Definition of probability, Different terminology used in probability, Different laws of probability, Discrete distributions (Binomial distribution, Poisson distribution, Negative Binomial distribution, geometric distribution, hyper geometric distribution with their properties and applications), Continuous distribution (Normal distribution with their properties and applications), Correlation and Regression, Survey sampling, Types of Sampling (probability and non probability sampling), Sampling Distribution of mean, Hypothesis testing: Z-test for single and difference between mean, Student's 't' test for single and difference between mean. Chi-square test of independence and goodness of fit, Analysis of variance and LSD.

Recommended Books

1. Ronald Walpole, Myers, Myers, Ye, "Probability & Statistics for Engineers & Scientists", 8th edition, 2008, Prentice Hall Publisher.
2. Sher M. Chaudhry, Shahid Kamal, "Introduction to Statistical Theory I and II".
3. Steel, R.G.D. and Torrie, J. H., 1980. Principles and procedures of statistics. McGraw Hill International Editions.
4. Zar, 1998. Biostatistics Analysis

Specialization in Analytical Chemistry

Course Code	Course Title	Credit Hours
CHM-652	Seminar	1(1 – 0)
STA-595	Introduction to Statistical Theory	3(3 – 0)
CHM-654	Nuclear Analytical Techniques	3(3 – 0)
CHM-656	Thermal Methods of Analysis	3(3 – 0)
CHM-658	Food and Drug Chemistry	3(3 – 0)
CHM-660	Standard Methods & Quality Assurance	3(3 – 0)
	Total	16

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 industries.

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 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-658

Food and Drug Chemistry

3(3-0)

Introduction to food analysis, food gradients and nutritional values, sampling of food, general methods of analysis. Analysis of milk, butter, wheat flour, meat, beverages, tea, coca, honey and soft drinks.

Pharmaceuticals: Classification of drugs, test for analysis of different pharmaceuticals, introduction to US and British pharmacopeia.

Forensics: History and scope of forensic Science, forensic ethics, forensic toxicology. Classification and analysis of narcotics & dangerous drugs, examination of crime scene evidences, fingerprinting, skeletal material to provide scientific opinion for legal.

Reference Books:

1. Yolanda Picó, Chemical Analysis of Food: Techniques and Applications Academic Press, ELSEVIER, Spain, 2012.
2. Leo M. L. Nollet. Handbook of Food Analysis: Physical characterization and nutrient analysis. CRC Press, Technology & Engineering, New Yourk USA, 2004.
3. David E. Newton, Forensic Chemistry, United States of America, (2007).

CHM- 660

Standard Methods and Quality Assurance

3(3– 0)

Method development and validation: Selection of analytical methods for problem solving, Optimizing the experimental procedures, Single operator characteristics, Blind analysis of standard samples, Ruggedness testing, Equivalency testing, Sensitivity of instruments, Limits of detection and Signal-to-noise ratio.

Quality Control: Introduction and concept of quality control and quality assurance, Development of quality standards in industries, Quality control chart, Quality control in some industries, General safety practices, Good laboratory practices

Quality Assurance: Internal Methods of Quality Assessments, External Methods of Quality Assessments, Evaluation of quality assurance data, Prescriptive approach, Performance-based approach.

Automation in analytical methods; Automatic, automated and smart instruments and their applications with special emphasis on clinical, industrial and quality control aspects

Books Recommended:

1. Christian, G.D. 2003. Analytical Chemistry. Sixth edition, John Wiley and Sons, New York
2. Harvey, D. 2008. Modern Analytical Chemistry. The McGraw Hill Companies, Inc. USA.
3. Bender, G.T. 1987. “Principles of Chemical Instrumentation” W.B. Saunders Co., London
4. Hargis, L.G. 1988. “Analytical Chemistry: Printice Hall Publishers, London
5. Skoog, D.A. and J.J. Leary. 1992. “Principles of Instrumental Analysis. Saunders College Publishing Co., London
6. FAO and WHO (2000). Codex Alimentarius General Requirement Vol. 14
7. Bender, G.T. 1987. “Principles of Chemical Instrumentation” W.B. Saunders Co., London.
8. Reilley, C. 1993. Laboratory Manual of Analytical Chemistry. Allyn& Bacon, London.

International, USA (1998).

5. F. A. Cary, "Organic Chemistry" 7th Ed, The McGraw-Hill Company, USA (2008).

CHM-666 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-668 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.

- C. W Rees, T.I. Gilehrst, "Carbenes, Nitrenes Arynes," Nelson, London, UK (1973).

CHM – 676

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 Annelation, 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:

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

CHM – 678

Organic Catalyst and Protective Group

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. Protecting Groups for alcohols, aldehydes, carboxylic acid and amines

Recommended Books:

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

Specialization in Physical Chemistry

Course Code	Course Title	Credit Hours
CHM-652	Seminar	1(1 – 0)
STA-595	Introduction to Statistical Theory	3(3 – 0)

CHM-682	Applications of Symmetry and Group Theory	3(3 – 0)
CHM-684	Quantum Mechanics	3(3 – 0)
CHM-686	Nuclear and Radiation Chemistry	3(3 – 0)
CHM-688	Electrochemical Aspects of Solutions	3(3 – 0)
	Total	16

CHM-682 Applications of Symmetry and Group Theory 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-684 Quantum 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).
6. K. J. Laidler, "The World of Physical Chemistry" 1st Ed., Oxford University Press, USA (1993).
7. K. J. Laidler, H. M. John, C. S. Bryan, "Physical Chemistry" 4th Ed., Houghton Mifflin Publishing Company Inc. (2003).
1. E. Thomas, P. Reid, "Thermodynamics, Statistical Thermodynamics", and Kinetics 1st Ed., Benjamin Cummings, (2006).

CHM-686 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., Pergamon 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-688 Electrochemical Aspects of Solutions 3(3-0)

Electrochemistry of Solution

Introduction to solution and its units, 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

Electrochemistry of Colloidal Solution

Colloids, classification, preparation of colloidal solution, peptisation, coagulation, flocculation, peptisation, Dialysis, Electrophoresis, Zeta potential, Solutions of Surfactants.

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).
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