PRINCIPAL SUBJECT AREA

CHEMISTRY

Compulsory courses for the General degree: CH 101, CH 102, CH 108, CH 109**,** CH 211, CH 218, CH 221, CH 228, CH 231, CH 238, CH 328, CH 331, CH 338, CH 348

Compulsory courses for the Special Degree: CH 101, CH 102, CH 108, CH 109, CH 211, CH 212, CH 218, CH 221, CH 222, CH 228, CH 231, CH 232, CH 238, CH 317, CH 319,CH 321, CH 324, CH 326, CH 329, CH 330, CH 331, CH 332, CH 339, CH 341, CH 342, CH 351, CH 369, CH 416, CH 417, CH 425, CH 426, CH 435, at least two out of (CH 436, CH 437, 438), CH 443, CH 448, CH 455, CH 491, CH 492, CH 499.

400 LEVEL COURSES

CH 411 Advanced Radiochemistry (1 credit)
(Prerequisites: CH 211, CH 212)
Radiation detectors, particle accelerators (linear accelerators, cyclotron, synchrocyclotron, betatron); Nuclear models (shell model and liquid drop model), stability of isobars; Radioanalytical techniques (isotope dilution analysis, neutron activation analysis)

Recommended Texts:
1. S.Glasstone (1964) *Sourcebook on Atomic* Energy, Chapman and Hall
2. DA Skoog,, FJ Holler and TA Neiman (1998), Principles of Instrumental Analysis , Saunders Golden Series.

CH 414 Bio-Inorganic Chemistry (1 credit)
(Prerequisites: CH 211)
Role of metals in biological systems, electron transfer catalysts, cytochromes, iron sulphur proteins, molybdoenzymes, zinc and copper containing enzymes, oxygen carriers, nitrogen fixation, iron metabolism

Recommended Texts:
1. DE Fenton (1997) *Bio-coordination Chemistry*, Oxford University Press
2. SJ Lippard and JM Berg *Principles of Bio-inorganic Chemistry*, University Science Books, Mill Valley California
3. F.A. Cotton and G.Wilkinson, *Advanced Inorganic Chemistry*, Fifth edition,1988.

CH 416 Advanced Inorganic Chemistry II (2 credits)
(Prerequisite: CH 317)
Organometallic Chemistry: Complexes of olefines, carbonyls, nitrosyls, arenes, and other organic ligands, organometallic complexes as catalysts.
Reaction Mechanisms in Inorganic Chemistry: Substitution reactions of octahedral and square planar complexes, trans effect, electron transfer reactions, Frank-Condon principle, Marcus theory, photochemical reactions

Recommended Texts:
1. GE Coates, MLH Green, P Powell and K Wade (1988)*Organometallic Chemistry*, Chapman and Hall;
2. F.Basolo and RG Pearson*, Inorganic Reaction Mechanism*.

CH 417 Topics in Solid State Chemistry (2 credits)
(Prerequisite: CH 211)
Advanced ceramics, inorganic polymers, conducting polymers and their applications, solid state batteries, nanostructures, sol-gel technology, semiconductor catalysts, photoelectrochemical solar cells, photovoltaics (15 L).
Crystal Lattices, metallic elements, alloys, ionic solids, defects, ceramics, glasses, layered MS_2 structures, Chevural phases, solid state electrolytes, solid state batteries, solid state synthesis**, t**hermal techniques (15 L).

Recommended Texts:
1. Chapman and Hall Ltd; G.H. Stout & L.H. Jensen, *X-ray Structure Determination*; C. Giacovazzo, *Fundamentals of Crystallography*; Edited by F.M. Henry, *International Tables for Crystallography, Volume A*, The Kynoch Press, Birmingham.
2. IS Butler and JF Harrod , (1989*)Inorganic Chemistry,* Benjamin/Cummings publishing company.
3. N.Serpone (ed.) (1989) *Photocatalysis and Phtoreactors*: NATO-SCI series

CH 424 Special Topics in Organic Chemistry (1 credit)
(Prerequisites: CH 221, CH 326)
Supramolecular chemsitry, stereoelectronic effects, reactive intermediates, insect related chemistry, biomolecules of interest, Molecular modeling for organic chemistry (Topics may vary each year)

CH 425 Advanced Organic Chemistry II (3 credits)
(Prerequisites: CH 324, CH 326)
Physical Organic Chemistry (15 L): Analysis of factors that influence the rates and mechanisms of organic reactions
Advanced Stereochemistry (15 L): Stereochemical control in cyclic and acyclic systems. Chiral catalysis.
Problem Solving (15 L): Application of principles of strereochemistry, reaction mechanisms, organic synthesis and spectroscopy in solving problems in organic chemistry

Recommended Texts:
1. NS Isaacs (1995) *Physical Organic Chemistry*, Longman
2. EL Eliel and SH Wilen *(1994) Stereochemistry of Organic Compounds*, John Wiley & Sons Inc.

CH 426 Natural Product Chemistry (3 credits)
(Prerequisite: CH 324)
Carbohydrates (10 L): Conformations of carbohydrates and conformational effects. Reactions of carbohydrates. Synthesis of modified carbohydrate molecules and other natural products
Steroids and Terpenoids (5 L): Studies of steroids, structure and reactions; Terpenoids, classes of terpenoids, structural elucidation, saponins
Alkaloids (7 L): Classification, chemical and spectrosocopic methods in structure elucidation, reactions and synthesis
Oxygen heterocylces (8 L): Characterization, synthesis and reactions of pyrylium salts, anthocyanins, α-pyrones, γ-
Biosynthesis (15 L): Basic structural units, precursors and common reactions in biosynthesis; Acetate, shikimate and mevalonate pathways; Biosynthesis of alkaloids; Investigation of biosynthetic pathways.

Recommended Texts:
1. PM Collins and RJ Ferrier (1995) *Monosaccharide chemistry,* John Wiley and Co.
2. J Mann, RS Davidson, JB Jacobs, DV Banthorpe and JB Harborne (1994) *Natural Products, their Chemistry and Biological significance* Addison, Wesley Longman Ltd.
3. J Mann (1995) *Chemical Aspects of Biosynthesis,* Oxford University Press
4. P M Derwick (1997), *Medicinal Natural Products,* Wiley.

CH 435 Advanced Physical Chemistry II (2 credits)
(Prerequisite: CH 331)
Advanced Electrochemistry (15 L): Solvents, electrolyte solutions, non-ideal nature of electrolyte solutions, ion-solvent interactions, ion-ion interactions; The Debye-Huckel theory, ideal polarized electrodes, electrocapillary curves, determination of surface charge density, surface excess concentrations of ionic and neutral species at electrode surfaces, AC methods, theories of electrode/solution interfaces, electrode kinetics, mass transfer, charge transfer and other processes, Tafel plots, mass transfer-controlled electrode kinetics.
Advanced Topics in Kinetics and Reaction Dynamics (15 L): Review of fundamental laws of kinetics, fast chemical reactions and experimental methods for studying rates of such reactions, relaxation methods, collision theory, activated complex theory, Eyring equation, thermodynamic parameters, potential energy surfaces, applications in surface science and catalysts.

Recommended Texts:
1. PW Atkins and Julio de Paula, (2006), *Physical Chemistry*, Freeman and Co., New York.
2. KJ Laidler (1965), AJ Bard, *Fundamentals of Electrochemistry*, Chemical Kinetics, McGraw Hill, London, Inc.

CH 436 Advanced Physical Chemistry III (2 credits)
(Prerequisite: CH 331)
Surface and Colloid Chemistry (15 L)**: G**rowth and structure of soild surfaces, surface defects, Adsorption isotherms: BET, Temkin and Freundlich; rates of surface processes; mobility on surfaces; Catalytic activity of surfaces: Adsorption and catalysis, Herkins Jura isotherms, equation of states Eley-Rideal mechanism, Langmuir-Hinshelwood mechanism, molecular beam studies, examples of catalysis,. Colloidal systems: classification and purification, stability of collids, zeta potential, isoelectric point; Industrial applications.
Polymer Chemistry (15 L): Introduction to polymers, Polymerization processes; Carother's equation for linear and non linear step-growth polymerization; Kinetics of addition polymerization; Kinetics of step-growth polymerization; Melting point and glass-transition temperature, the relationship between the chemical structure and properties of polymers; Statistical thermodynamics of polymer solutions; Characterization of polymers

Recommended Texts:
1. JM Thomas and WJ Thomas, (1996), *Principles and Practice of heterogeneous catalysis*, John Wiley
2. M.Camphbell (1996), *Catalysis at surfaces,* Oxford University Press.
3. RJ Young and PA Lovell (1997) *Introduction to polymers*, John Wiley

CH 437 Modern Topics in Physical Chemistry (2 Credit)
(Prerequisite: CH 330)
Molecular Quantum Mechanics (10 L)**:** Reivew of Born-Oppenheimer approximation and quantum mechanical approach for simple molecules; Ab-initio treatment of polyatomic molecules: Electronic term symbols, SCF-MO method, basis functions, reduction of the number of integrals, delocalized molecular orbitals, some examples; Semiempirical treatment of polyatomic molecules: The free electron molecular orbital method, the Huckel molecular orbital method, conjugated polyenes, delocalization energy and aromaticity, heteroatomic conjugated molecules, methods such as INDO, NDDO and PRDDO; Molecular mechanics method; Interpretation of chemical reactions.
Nano Technology (10 L)**:** Introduction to Nano technology; nano- and micro- particles, Thin films, Carbon nano tubes, nano catalysts, gold particles, nano bimetalics; Characterization and applications.
Molecular Modeling in Chemistry (10 L): Molecular modeling: Introduction, applications, limitations and scope; Potential energy surfaces, force field models, minima, geometry optimization, method of steepest descent, applications to molecular vibrations; Molecular dynamics and Monte-Carlo method.

Recommended Texts:
1. R. Leach, (2001), *Molecular Modelling Principles and Applications,* Longman
2. D. Frenkel and B. Smit, *Understanding Molecular Simulation, from Algorithms to Applications,* Academic Press
3. M. P. Allen and D. J. Tildesley, *Computer Simulation of Liquids,* Clarendon Press
4. K. J. Klabunde, *Nanoscale Materials in Chemistry,* Zhong Lin Wang, *Characterization of Nanophase Materials*

CH 438 States of Matter: (2 credits)
(Prerequisites: CH 317, CH 330)
Gas laws, intermolecular forces and potential energy functions, theories and models of liquids, properties of liquids, ionic liquids; Liquid crystals: Types, properties and applications. Bonding in solids: ionic forces, gadwalls forces, covalent bonding, H-bonding and metallic bonding; Cohesive energy of ionic crystals, calculation of crystal energies, heat capacity of crystals. Theories of solids: Classical theory, Einstein model, Debye model, free electron theory of metals; Properties of solids: conductance, thermal, mechanical, optical and magnetic properties, crystal engineering.

Recommended Texts:
1. A.R. West (2000), *Basic Solid State Chemistry*, John Wiley and Sons, Second Edition
2. A J. Stone, (2002) *Theory of Inter-molecular Forces*, Oxford University Press
3. K.J. Laidler, J. H. Meiser, (2003) *Physical Chemistry*, Houghton Mifflin, Third Edition

CH 443 Advanced Analytical Chemistry (3 credits)
(Prerequisites: CH 341)
Spectroscopic Instrumentation and Spectrochemical Analysis (20 L): Optical components of spectrophotometers: sources, transducers, measurement systems, signal-to-noise ratio; Spectrochemical measurements: methodology and errors in spectrochemical analysis, sensitivity and detection limits, automated spectrochemical measurements; Advanced atomic spectral methods: Plasma, Arc and Spark methods; Atomic fluorescence spectrometry; Infrared and luminescence molecular spectroscopic methods.
Surface Analytical Techniques (10 L**)**: X-ray and UV photoelectron spectroscopies, Auger spectroscopy, Low enery electron diffraction, X-ray microscopy, etc.
Advanced Electroanalytical Techniques (5 L)**:** Preparation and applications of chemically modified electrodes; Spectroelectrochemical methods.
Advanced Separation Techniques (10 L): Capacity factor and selectivity ratio as applied to gas chromatography and liquid chromatography, high performance liquid chromatography, size exclusion chromatography, supercritical fluid chromatography, affinity chromatography, Capillary electrophoresis and electrochromatography.

Recommended Texts:
1. DA Skoog, (1988) *Instrumental Analysis Chemistry*, Saunders College Publishing Co.

CH 448 Analytical/Instrumental Chemistry Laboratory (1 credit)
(Prerequisite: CH 443)
Experiments in advanced analytical chemistry: Error Analysis as applied to instrumental techniques, Analytical atomic spectrometric methods, Analytical Molecular spectroscopic methods, Advanced electrochemical methods:Cyclic voltammetry and Amperometry , Gas liquid chromatographic and High Performance Liquid Chromatographic techniques in analysis.

Recommended Texts:
1. DA Skoog, (1988) *Instrumental Analysis Chemistry*, Saunders College Publishing Co.

CH 455 Biological Chemistry 1I (2 credits)
(Prerequisite: CH 351)
Bioanalytical Chemistry & Biophysical Chemistry (10L): Biochemical techniques, centrifugation and chromatography; Topics in physical chemistry pertinent to biology - conformations of macromolecules, spectroscopy, thermodynamics, dynamics and transport processes, Donan equilibrium; Biological spectroscopy
Food chemistry (10L): Methods in food processing
Toxicology and Reactive species in biology (10L): Natural toxins, environmental pollutants, drug abuse, fats and toxic effects of xenobiotics in biological systems; Reactive oxygen species, lipid peroxidation, free radicals and toxicology, free radical reactions in living systems, diseases associated with free radical damage.

Recommended Texts:
1. A Lehninger, DL Nelson and MM Cox (1993), *Principles of Biochemistry* Worth Publishers Inc.
2. L Stryer (1995) *Biochemistry* WH Freeman and Co.

CH 456 Proteins (1 Credit)
(Prerequisite: CH 321)
Biosynthesis and chemical synthesis of proteins. Biological functions of some selected proteins and their 3D structures. Interaction of proteins with other proteins, carbohydrates, lipids and nucleic acids. Membrane proteins and their functions in transport across membranes.

Recommended Texts:
1. *Biochemistry*. (1994) D. Voet and J.G. Voet. John Wiley and Sons.
2. A Lehninger, DL Nelson and MM Cox (1993), *Principles of Biochemistry* Worth Publishers Inc.

CH 458 Biological Chemistry Laboratory (1 credit)
(Prerequisite CH 351)
Detection, isolation and analysis of amino acids, proteins, carbohydrates and nucleic acids.

MB 416 Environmental Biotechnology (2 credits)
Living organisms as pollution indicators; biodegradation; waste management; pollution treatment; biomining; biogas production; microbes in environment management

Recommended Texts:

1. RB King, GM Long, JK Sheldon (1997) *Practical Environmental Bioremediation: The Field Guide*, CRC Press
2. SJ Ergas, DPY Chang; ED Schroeder, JB Eweiss (Ed.) (1998) *Bioremediation Principles*, McGraw-Hill
3. GM Evans, JC Furlong (2002) *Environmental Biotechnology: Theory and Application*, John Wiley & Sons.

MB 421 Fermentation Technology (2 credits)
Microorganisms used in industrial fermentation; isolation and preservation of pure cultures; mutants, factors influencing rate of mutation; bioreactors design and operation; culture media; sterilization; control of different parameters; process monitoring; isolation of products; current applications

Recommended Texts:

1. RW Old, SB Primrose (1994) *Principles of Gene Manipulation*, Blackwell Science
2. BR Glick, JJ Pasternak (1998) *Molecular Biotechnology*, American Society for Microbiology

CH 491 Seminar (1 credit)
(***Compulsory for all special degree students***)
Each student is required to present a seminar on a topic assigned by the Department.

CH 492 General Aspects and Recent Developments in Chemistry (1 credit)
(***Compulsory for all special degree students***)
The students will be evaluated on their knowledge and understanding of the principles of chemistry covered in the compulsory courses, and on general chemistry introduced through seminar- and industrial-presentations.
The three-hour question paper will also include an essay on a topic of general chemical interest.

CH 499 Research Project (6 credits)
(***Compulsory for all special degree students***)
Each student will carry out a research project during the final year under the supervision of a staff member. The student is required to give a seminar, based on the research project, and submit a report.