DEPARTMENT OF CHEMISTRY
DEGREE PROGRAMME (COURSE OUTLINE)

DEGREE 1 HARMATTAN SEMESTER)

CHM 101: Introductory Chemistry 1: 3 + 1 + 0 (4 Units)

Introduction
Methods of Science Measurement and precision. Significant figures errors in quantitative measurements; nature of matter: elements and compounds. Types of chemical reactions.

Atomic Theory and Nature of Atoms
Dalton atomic theory, Atomic weight, Avogadro's number: structure of the atom: Divisibility of atom. Cathode rays: mass spectrometer: contributions to atomic structure by Bohr. Thompson, Morseley and Rutherford: Discovery of nucleus: electronic energy levels and periodic table atomic size: lionization potentials, electron affinity ionic radii and electronic configuration.

Stoichiometry I
Chemical Formulae and equations, simplest formulae, molecular formulae, mole concept, calculation of formulae and equations from gravimetric data and vice-versa, ionic equations for neutralization and precipitation reactions. Concentrations, morality and volumetric calculations based on stoichiometric coefficients; Oxidation and reduction as electron transfer, oxidation number, balancing of equations including balancing of redox equations by electron transfer equality.

Stoichiometry II
Volumetric analysis including relevant calculations, preparation of standard solutions, molarities and volumetric coefficients in neutralization, redox precipitation and complexation reactions.

Chemical Equilibrium
The equilibrium state, Mass action, equilibrium constant, calculations; Equilibrium changes, Dissociation of water, pH of acids and bases, buffer solutions, indicator theory, solubility of ionic solids, solubility products, precipitation reactions (using solubility products) calculations as applied to qualitative and quantitative analysis. Common ion effect.

Thermo chemistry
Balancing of intermolecular forces. Hydrogen bonding, order-disorder phenomenon, entropy, free energy, energy effect, exothermic and endothermic changes, enthalpy of reaction. Hess's law of enthalpy summation, relevant calculations, heats of neutralization, combination and formation, bond dissociation energies, relevant calculations, free energy and spontaneous change.

Electrochemistry

Electrical units: Ohm's law, Faraday's laws of electrolysis. Galyvanic cells. Standard Half-Cell potentials and reactions. Concentration effects (Nernst equation) Redox reactions, oxidation potential treated in terms of free energy change, cells and batteries.

Kinetics

Introduction to chemical Kinetics, Basic definitions of order of reaction, Molecularity, reactions rates and simple reaction mechanism. Activation energy and kinetic theory.

Radioactivity

Types of radioactive disintegration. Nuclear fission and nuclear fusion. Detection of radioactivity. Uses of radioisotope.

No Pre-requisite.

CHM 103: Practical (1 Unit) Experimental Chemistry

1. Accuracy and precession
2. Classification of errors
3. Gravimetric analysis
4. Calculation of yield
5. Indicator and theory of indicator
6. Acid base titration
7. Oxidation-reduction titrations
8. Precipitation titration

DEGREE 1: (RAIN SEMESTER)

CHM 102: Introductory Chemistry II: 3+0+1 (4 units)

1. **Qualitative Analysis (Inorganic)-** Test for simple cations and anions
2. **Identification of Organic Compounds** to include:
   (i) Isolation and Purification
   (ii) Qualitative analysis: Test for common elements e.g. carbon, hydrogen, nitrogen, sulphur, halogens etc.
   (iii) Quantitative analysis using Dumas, Kjeldah's and Carius methods
3. **(a) Chemical Bonding**
   Why and how do atoms combine? The molecule and ' chemical bonding; electrons in molecules; ionic, covalent, dative and complex bonding; polarity of bonds; co-ordinate bonds; metallic bonds; basic crystalline structure e.g. NaCl and Metallic lattices. Hybridization and resonance in chemical bonding.
   (b) Chemistry of hydrogen, noble gases, Alkali metals (Group I) and the alkali earth metals (Group II)

4. **Introduction to Organic Chemistry:**
   Introduction to the term ''Organic Chemistry'
   Hybridization in Carbon –**sp3, sp2 and sp** hybridization Physical properties as related to structures – bond length, strength, rotation etc.
   Electrophiles and Nucleophiles – Examples to include acids and bases:

   Homolytic and Heterolytic fission of bonds
   Factors influencing organic reactions – inductive and mesomeric effects, steric factors etc.

5. **(a) Homologous series and Functional groups' chemistry**
   (b) Types of organic reactions:
   (c) Isomerism – Structural, Geometric and Optical Isomers:
   (d) Chemistry of Hydrocarbons (alkanes, alkenes, alkynes, alkyl halides and Grignard reagents) to include
   (i) Nomenclature (IUPAC rules to be treated under alkanes)
   (ii) Preparation
   (iii) Physical properties
   (iv) Chemical reactions with simple mechanisms where applications
   (v) Applications
   These subheadings are to be applied to each of the families above
6. **Main Group Chemistry (Group II - V)**
   Trends in properties of elements (Structures, ionization energy, physical and chemical properties). Properties of selected types of compounds – hydrides, Oxides, acids and bases; Chemistry of B and Al; C and Pb; N and Bi.
7. **Main Group Chemistry (Group VI,VII and Transition Metal Chemistry)**
   (a) Main Group Chemistry (Group VI and VII)
   (i) Trend in properties elements
   (ii) Properties of selected types of compounds:
   (iii) Chemistry of O and S; F and Cl
   (b) Transition Series

(i) Properties of elements and compounds of d-block elements, lanthanides and actinides.

(ii) Electronic configuration: Complexes and IUPAC nomenclature of complexes

(iii) Chemistry of Cr, Fe, Co, Ni and Cu; particularly of the most common oxidation states.

8. **Chemistry of Alcohols, Ethers, Aldehydes and Ketones; Carboxylic Acids, Derivatives and Amines**

Nomenclature (IUPAC)

Preparation, Structure, Physical properties and general reactions

Introduction to Aromatic Compounds.

9. **Carbohydrates, Proteins and Lipids**

Simple treatment of Carbohydrates –monosaccharides (e.g. glucose and fructose), Disaccharides and Polysaccharides:

Proteins-amino acids, peptide bonds etc

Lipids – Fats and Oils, Soap and Detergent

CHM 104: Practical Chemistry II (1 Unit)

1. Solubility Tests
2. Qualitative inorganic analysis
3. Identification of Anions (Cl^-, I^-, Br^-, C03-, $N0_3^-$, S^{2-}, $S0_4^{2-}$,$S0_3^{2}$-, $N0_2^-$,)
4. Preliminary test
5. Flame test
6. Confirmatory tests
7. Identification of cations (Na^+, K^+, Ca^{2+}, Fe^{2+}. Fe^{3+}, Pb^{2+}, Al^{3+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Ag^+, NH_4^+)
8. Confirmatory tests

DEGREE II

CHM 201: Basic Inorganic Chemistry: 3 + 1 + 0 (4 Units)
Harmattan Semester

A quantitative introduction to the basic principles of inorganic chemistry, particularly atomic structure, periodicity of chemical properties, chemical bonding and reactivity. Sub-sections comprise: electronic structures of the elements, the covalent bond: the ionic bond; introductory symmetry; inorganic applications of standard reduction potentials, general properties of the elements in relation to the periodic table, introduction to complex-ions including nomenclature and isomerism.

Pre-requisite CHM 101 or A level Chemistry.

CHM 203: Basic Physical Chemistry: 3 + 1 + 0 (4 Units).
Harmattan Semester

The aim of the course is to provide a firm foundation in basic thermodynamics and kinetic treated under the following headings Kinetic theory, energetic, the first law of thermodynamics, free energy, entropy and the second law of thermodynamics, phase changes equilibrium, reaction kinetics, electrochemistry.

Pre-requisite CHM 101 or A. Level Chemistry and Maths or physics.

CHM 205: Experimental Physical & Inorganic Chemistry: 0 + 0 + 1 (1 units)
Harmattan Semester

A basic practical chemistry course designed to:

a) develop good experimental expertise

b) illustrate the principles of the topics covered in the CHM 200 level courses.

c) demonstrate the empirical nature of chemistry

Basic techniques to be developed are in physical and inorganic chemistry, and shall include:

i) Estimation of errors, theoretical processing of experimental data to yield best curve or linear fits and error limits.

ii) Quantitative inorganic analysis by volumetric and gravimetric methods including:
- (a) Measurement of pH and preparation of buffer solutions:
- (b) Oxidation reduction titrations
- (c) Mixed base titrations requiring the use of more than one indicator
- (iii) Thermal analysis, including:
- (a) Measurement of heat of reaction
- (b) Measurement of heat of solution and mixing
- (iv) Analysis of intermolecular forces
- (v) Chemical Kinetics
- (a) Measurement of reaction rates:
- (b) Measurement of activation energy
- (vi) Electrochemistry
- (vii) Simple inorganic synthesis

Pre-requisite CHM 101 or 'A' Level Chemistry Co-requisite CHM 201, 203, or 207.

CHM 202: Basic Organic Chemistry: 3+1+0 (4 units)
Rain Semester

Revision of Chemistry of common functional groups covering the material of CHM 102. Extension of aliphatic chemistry, including hydrocarbons, alkenes, the carbonyl group,the Hydroxyl group, the amino group, carboxylic acids and their derivatives. Survey of aromatic Chemistry, topics including benzene and its monosubsitution products.
Bifunctional Compounds. Introduction to lipids, carbohydrates, amino-acids and proteins, and to Chromatographic and spectroscopic methods of investigating organic structures. Synthesis Of some organic compounds.

Pre- requisite: CHM 102 (or) ''A'' level Chemistry.

CHM 206: Experimental organic Chemistry: 0 + 0 + 1 (1unit)
Rain Semester

A course designed to illustrate the principles covered in lecture course CHM 202. Topics include separation, purification and identification of organic compounds by solvent extraction distillation, crystallization followed by determination of physical constants simple organic synthesis and qualitative analysis by chemical methods.

Pre-requisite: CHM 102 or A-level Chemistry.
Co-requisite: CHM 202.

CHM 208: Introductory Analytical Chemistry: 2 + 0 + 0 (2 unts)
Rain Semester

1. Review of steps in and applications of quantitative chemical analysis.
   Expressions of concentrations, to include units used in instrumental work (ppm etc).
2. Statistics. Data treatment, potential sources of error in chemical analyses Sampling, and sample size, and sample collection.
3. Laboratory Techniques
   General operations and tools of the trade.
4. Gravimetric Methods: Applications of organic precipitating agents e.g. oxine, -8-hydroxyquinoline, drug and sodium.
5. Volumetric Methods
   i) Acid-Base Titrations
   ii) Precipitation Titrations-Villard. Mohr & Fajan
   iii) Redox Titration's and indicators and
   iv) Complexometric Titrations-Equilibrium and analytical uses of complexes.
6 Electro analytical Techniques
   Potentiometer and non-potentiometer electro analysis.

   Karl Fischer titrations as examples of amperomotric titrations.
   Theory and applications of ion-selective electrodes

DEGREE III

CHM 305: Chemical Kinetics: 1 + 1 + 0 (2 Units)
Harmattan Semester

Topics covered include: review of reaction rates, rate equations, order of reactions and their determination calculations; experimental methods for studying slow and fast reactions, theories of reaction rates, reactions in solution, complex reactions, heterogeneous catalysis.

Pre-requisite: CHM 203.

CHM 307: Application of Spectroscopic Methods: 2 + 1 + 0 (3 units)
Harmattan Semester

A survey of spectroscopic and optical methods with emphasis on their application in elucidation of structures of organic, inorganic and organometallic compounds. Principles and applications of ultraviolet, infrared, nuclear magnetic resonance and mass spectroscopy of optical complementary nature of spectroscopic and chemical methods of structure elucidation exemplified by applications in nature product chemistry. Spectroscopy of inorganic compounds and organometallic complexes. Tutorial work involves the interpretation of spectra.

Pre-requisite: CHM 202 and CHM 201.

CHM 309: Experimental Physical Chemistry: 0 + 0 + 2 (2units)
Harmattan Semester

A selection of experimental exercises, designed, to illustrate principles discussed in CHM 204/305 lectures, to provide practice in making measurements and analyzing data, and to inculcate a critical approach to laboratory work. Topics covered include: equilibria, colligative properties, surface phenomena, thermodynamic principles, gas- and liquid-phase kinetics, electrochemistry, molecular spectroscopy, properties of macromolecules.

Pre-requisites: CHM 203 and CHM 205.

CHM 302: Structural and Main group inorganic Chemistry:3 + 1 + 0 (4 units)
Rain Semester

Structural topics covered in the course include structures of metals and ionic crystals of types AB, AB2, AB3, A2**:** **in**troduction to diffraction methods: X-ray, neuron and electron abreaction; lattices and crystal defects; introduction to crystal growth; structures of introduction to the structure of transition metal complexes ions of main-group elements; introduction to the structure of transition metal complexes. Main-group elements classified by anions, are surveyed in terms of preparative methods, general properties, reactions, and structures, with particular attention to hydrides, halides and pseudo halides, oxides, chalconides, and oxidations. Properties and group trends are surveyed for elements of Groups 1 to V.

Pre-requisite: CHM 201.

CHM 312: Experimental Organic Chemistry II: 0 + 0 + 2 (2units)
Rain Semester

A more advanced course in experimental-organic chemistry, designed to prvide experience in single and multi-stage synthesis, in separation and purification procedures, and in the identification of organic compounds with the aid of spectra in conjunction with chemical tests. The exercises are designed to involve deductive reasoning, based upon principles discussed in lecture.

Pre-requisite: CHM 202.

CHM 314: Alicyclic, Bi-functional Aliphatic and Terpenoid compounds: 1 + 1 + 0 (2 units)
Rain Semester

(a) Chemistry, stereochemistry and synthetic application of bi-functional organic diols, hydroxyl-acids, keto-acids, keto-esters and amino acids.
(b) Alicyclic chemistry, including the reactions and stereochemistry of small and large ring compounds and important naturally occurring derivatives like steroids and terrenes;
(c) Introduction to the Chemistry of Organo-Phosphorus and organo-sulphur compounds.

Pre-requisite: CHM 202

CHM 304: Chemical Thermodynamics: 2 + 1 + 0 (3units)
Rain Semester

The first, second and third laws of thermodynamics are given a more rigorous treatment in CHM 203. Thermodynamics principles are considered in relation to chemical potential; inter-relationships of the thermodynamic functions; phase equilibria, gaseous and liquid mixtures; colligative properties of solution; chemical equilibrium; electrolyte solutions; thermodynamics of surfaces.

Pre-requisite: CHM 203

CHM 306: Aromatic and Heterocyclic Chemistry: 1 + 1 + 0 (2 units)
Rain Semester

This is a broad-based course in general organic chemistry. The topics to be covered include.
(a) Some leading features of benzenoid chemistry together with bifunctional benzene derivatives including examples of naturally occurring oxygen compounds.

(b) Polycyclic aromatic hydrocarbons such as naphthalene, phenanthrene and anthracene.
(c) Aromatic heterocyclic exemplified by pyrole, furan, throphene, pyrone, indole, quinoline and benzopyrone systems including introduction to alkaloid chemistry.

Pre-requisite: CHM 202.

DEGREE IV

CHM 401: Transition Metal Chemistry: 3 + 1 + 0 (4unts)
Harmattan Semester

Transition – metal (d-block) Chemistry is discussed in terms of: electronic configuration, oxidation states, co-ordination chemistry and complex ions; the hard/soft, acid/base concept; ligand-field splitting crystal-field stabilization energy, and electronic spectra of octahedral and tetrahedral complexes. ACFT and MO theory, magneto chemistry. The group chemistry of these elements is briefly discussed with comparison of 3d-, 4d-, and 5d- types. Lanthanide and actinide (f-block) chemistry is discussed in terms of electronic configuration, characteristic oxidation states; spectroscopy magnetic properties; complex formation; separation processes; comparison between actinides lanthanides and d-block elements. Application of IR, Raman, NMR, NGR, ESR and Mossbauer spectroscopy to the study of transition metal complexes. The lanthanide shift reagents, and their use in interpreting complex spectra.

Pre-requisites: CHM 302 & CHM 307.

Pre-requisite: CHM 101.

CHM 308: Natural and Synthetic macromolecules: 1 + 1 + 0 (2 units)
Natural Polymers
Rain Semester

(a) Carbohydrates – glucose, starch-cellulose-structure, reactions, molecular weight determinations and various uses, Ligrin0structure and products of degradation.

(b) Amino acids and proteins; structures and reactions. Determination of protein structure, primary, secondary and tertiary structure. Peptide and protein synthesis.
(c) Nucleic acid: Classification, structures and functions, DNA & RNA. Synthesis of polynucleotide.

Synthetic Polymers
(i) Definitions and glossary terms. Classification according to use, origin and reaction to stress and temperature. Physical and chemical properties of common polymers including molecular structure. Fiber forming polymers, natural, synthetic regenerated. Principles of fibre making processes.
(ii) Brief over-view of other uses of polymers e.g. on paints, plastic ware etc.

Pre-requisite: CHM 202.

CHM 316: Experimental Inorganic Chemistry: 0 + 0 + 2 (2units)
Rain Semester

A more advanced course in experimental inorganic chemistry, designed to illustrate preparative methods and the use of physical methods, such as chromatography, infrared and electronic spectroscopy, and magnetro-chemistry, for the characterization of inorganic compounds.

Pre-requisite: CHM 201 and CHM 205.

CHM 402: Organometallic Chemistry: 2 + 1 + 0 (3 units)
Rain Semester

Classification of organometallic compounds. Preparation, structure and reactions of organometallic compounds. Classification of ligands, 18-electron rule bonding in transition metal organometallic compounds. Metal-metal bonds and transition metal clusters. Organometallic catalysis, and applications of organometallic compounds to organic synthesis.

Pre-requisites: CHM 201 & CHM 302.

CHM 408: Organic Reactions and Synthesis: 2 + 1 + 0 (3 units)
Rain Semester

Selected types of reactions are discussed in relation to mechanistic concepts and to the utility of the processes in modern organic chemical practice. Discussion includes: alkylation and acylation processes, aldol-type condensations; synthesis with organometallic compounds. Applications of those operations are exemplified by reference to syntheses in the literature

Pre-requisite: CHM 306.