**Bayero University, Kano**

**Physical Sciences**

**Pure and Industrial Chemistry**

**B. Sc. Industrial Chemistry**

**30% Addition to CCMAS Course Structure/Summary**

**L100**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CourseCode | Course Title | **Credit(s)** | **Status** | **LH** | **PH** |
| BUK-BIO101 | General Biology I | 2 | C | 30 | - |
| BIO102 | General Biology II | 2 | C | 30 | - |
| BIO107 | General Biology Practical I | 1 | C | - | 45 |
| BIO108 | General Biology Practical II | 1 | C | - | 45 |
| STA112 | Probability I | 3 | C | 45 | - |
| MTH103 | Elementary Mathematics III | 2 | C | 30 | - |
|  | Sub-total | **11** |  |  |  |

**L200**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CourseCode | Course Title | **Credits** | **Status** | **LH** | **PH** |
| CHM 214 | Structure and Bonding | 2 | C | 30 | - |
| CHM213 | Macromolecular Chemistry I | 2 | E | 30 | - |
| PHY205 | Thermal Physics | 3 | E | 45 | - |
| PHY211 | Workshop Practice | 2 | E | 15 | 45 |
| MTH201 | Mathematical Methods I | 2 | E | 30 | - |
| MTH202 | Elementary Differential Equation | 2 | E | 30 | - |
| MTH204 | Linear Algebra I | 2 | E | 30 | - |
|  | **Sub-total** | **15** |  |  |  |

**L300**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CourseCode | Course Title | **Credits** | | **Status** | | **LH** | | **PH** | |
| BUK-ICH 301 | Separation Method of Analysis | 3 | C | | 30 | | 45 | |
| CHM 316 | Applied Spectroscopy | 2 | E | | 30 | | - | |
| CHM 319 | Environmental Chemistry | 2 | E | | 30 | | - | |
| BUK-ICH 302 | Introductory Material Science | 2 | E | | 30 | | - | |
| BUK-ICH 303 | Colour and Textile Chemistry | 3 | E | | 30 | | 45 | |

**L400**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CourseCode | Course Title | **Credits** | **Status** | **LH** | **PH** |
| CHM 406 | Reaction Kinetics | 2 | C | 30 | - |
| BUK-ICH 407 | Electrochemistry | 2 | C | 15 | 45 |
| CHM 410 | Analytical Chemistry II | 2 | C | 30 | - |
| BUK-ICH 404 | Group Theory and Symmetry | 2 | E | 30 | - |
| CHM 424 | Coordination Chemistry | 2 | C | 30 | - |
| BUK-ICH 415 | Polymer Technology | 2 | E | 30 | - |
| BUK-ICH 408 | Organic Synthesis | 2 | E | 30 | - |
| BUK-ICH 409 | Food Chemistry | 2 | E | 30 | - |
| BUK-ICH 411 | Agrochemical & Chemotherapeutic Agents | 3 | E | 45 | - |

**100 LEVEL**

**BIO 101: General Biology I (2 units C: LH 30)**

**Learning Outcomes**

At the end of lectures, students should be able to:

1. explain cells structures and organisations;

2. summarize functions of cellular organelles;

3. characterize living organisms and state their general reproduction;

4. describe the interrelationship that exists between organisms;

5. discuss the concept of heredity and evolution; and

6. enumerate habitat types and their characteristics.

**Course Contents**

Cell structure and organisation, functions of cellular organelles. Characteristics and classification of living things. Chromosomes, genes; their relationships and importance. General reproduction. Interrelationships of organisms (competitions, parasitism, predation, symbiosis, commensalisms, mutualism, saprophytism). Heredity and evolution (introduction to Darwinism and Lamarkism, Mendelian laws, explanation of key genetic terms). Elements of ecology and types of habitat.

**BIO 102: General Biology II (2 Units C: LH 30)**

**Learning Outcomes**

At the end of the lectures, students should be able to:

1. List the characteristics, methods of identification and classification of viruses, bacteria and fungi;

2. state the unique characteristics of plant and animal kingdoms;

3. describe ecological adaptations in the plant and animal kingdoms;

4. explain nutrition, respiration, excretion and reproduction in plants and animals; and

5. describe growth and development in plants and animals.

**Course Contents**

Basic characteristics, identification and classification of viruses, bacteria and fungi. A generalized survey of the plant and animal kingdoms based mainly on the study of similarities and differences in the external features. Ecological adaptations. Briefs on physiology to include nutrition, respiration, circulatory systems, excretion, reproduction, growth and development.

**BIO 107: General Biology Practical I (1 Unit C: PH 45)**

**Learning Outcomes**

At the end of this course students should be able to:

1. outline common laboratory hazards;

2. provide precaution on laboratory hazards;

3. state the functions of the different parts of the microscope;

4. use the microscope and describe its maintenance;

5. draw biological diagrams and illustrations; and

6. apply scaling and proportion to biological diagrams.

**Course Contents**

Common laboratory hazards. prevention and first aid. measurements in biology. uses and care of microscope. compound and dissecting microscope. Biological drawings and illustration, scaling, accuracy and proportion. use of common laboratory apparatus and laboratory experiments designed to illustrate the topics covered in **BIO 101.**

**BIO 108: General Biology Practical II (1 Unit C: PH 45)**

**Learning Outcomes**

At the end of this course, students should be able to:

1. describe the anatomy of flowering plants;

2. differentiate types of fruits and seeds;

3. state ways of handling and caring for biological wares;

4. describe the basic histology of animal tissues; and

5. identify various groups in the animal kingdom.

**MTH 103: Elementary Mathematics III (Vectors, Geometry and Dynamics)**

**(2 Units C: LH 30)**

**Learning Outcomes**

At the end of the course, students should be able to:

1. solve some vectors in addition and multiplication;

2. calculate force and momentum; and

3. solve differentiation and integration of vectors.

**Course Contents**

Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, scalar, multiplication of vectors, linear independence. Scalar and vector products of two vectors. Differentiation and integration of vectors with respect to a scalar variable. Two-dimensional co-ordinate geometry. Straight lines, circles, parabola, ellipse, hyperbola. Tangents, normals. Kinematics of a particle. Components of velocity and acceleration of a particle moving in a plane. Force, momentum, laws of motion under gravity, projectiles and resisted vertical motion. Elastic string and simple pendulum. Impulse, impact of two smooth spheres and a sphere on a smooth surface.

**STA 112: Probability I (3 Units C: LH 45)**

**Learning Outcomes**

At the end of the course students should be able to

1. explain the differences between permutation and combination;

2. explain the concept of random variables and relate it to probability and distribution functions;

3. describe the basic distribution functions; and

4. explain the concept of exploratory data analysis.

**Course Contents**

Permutation and combination. Concepts and principles of probability. Random variables. Probability and distribution functions. Basic distributions: Binomial, geometric, Poisson, normal and sampling distributions; exploratory data analysis.

**200 LEVEL**

**CHM213: Macromolecular Chemistry (2 units, E: LH 30)**

Classification of macromolecules; polymers and copolymers as natural, modified natural or synthetic substances. Polymer formation processes; methods, kinetics and mechanisms. The characterization of macromolecules; molar mass and distribution, molecular size and shapes, stereochemistry. Crystallinity and methods of determination. Structural classification in natural macromolecules. Bulk structure, crystalline, amorphous, glassy and rubbery states. Inter-relation of structure and properties.

**CHM 214: Structure and Bonding (2 Units C: LH 30)**

**Learning Outcomes**

At the end of this course, the students will be able to:

1. explain the idea of quantum states, orbital, shape and energy;

2. explain simple valency theory, electron repulsion theory and atomic spectra;

3. explain symmetry, molecular geometry and structure, and molecular orbital theory of bonding;

4. sketch to illustrate with specific examples for item (3) above;

5. express how molecular orbital theory of bounding explains the magnetic properties in main group compounds;

6. explain the methods used in the determination of molecular shapes, bond lengths and angles; and

7. explain with the use model the structure and chemistry of some of the representatives of main group elements.

**Course Contents**

Idea of quantum states, orbitals, shape; and energy. Simple valence theory, electron repulsion theory, atomic spectra. Symmetry, molecular geometry and structure, molecular orbital theory of bonding. Methods of determining molecular shape, bond lengths and angles. The structure and chemistry of some representative main group element compounds.

**PHY 205: Thermal Physics (3 Units C: LH 45)**

**Learning Outcomes**

On completion, the students should be able to:

1. discuss the concept of heat and temperature;

2. explain and determine thermodynamic processes;

3. explain and evaluate properties of real and ideal gases;

4. evaluate the consequences of the thermodynamic laws;

5. describe the basis of the kinetic theory; and

6. describe the statistical behaviour of gases with applications.

**Course Contents**

The foundations of classical thermodynamics including the definition of temperature. The first law. Work, heat and internal energy. The second law. Carnot cycles and Carnot engines. Zeroth law. Entropy and irreversibility. Thermodynamic potentials and the Maxwell relations. Ideal gas equation. Internal energy and internal molecular modes. Qualitative discussion of phase transitions. Gibbs free energy. Clausius-Clapeyron equation. Examples of phase transitions. Van der Waals gas. Kinetic theory. Mean free path. Equi-partition of energy. Heat transfer. Diffusion rate.

**PHY 211: Workshop Practice (2 Units C: LH 15; PH 45)**

**Learning Outcomes**

On completion, the students should be able to:

1. identify safety signs for various workshop types and abide by the underlining regulations while working in the workshop;

2. handle workshop tools and machineries;

3. illustrate simple metal processing methods;

4. describe the criteria for selection of construction materials;

5. identify electrical and electronic devices and explain some instrumentation techniques for measuring parameters; and

6. explain types and methods of wood and plastic processing.

**Course Contents**

Workshop layout and safety. Basic hand tools and bench work practices. Measurement and gauging. Sheet metal operations. Casting. Cutting, drilling, turning, and milling. Metal joining devices and adhesives in common use. Soldering techniques and wrap joints. Plain and cylindrical generation of smooth surface using power operated machines. Criteria for selection of materials used for construction (metallic and non-metallic). Instrumentation and measuring techniques. Multi-meters and oscilloscopes. Extension of instrument range. A survey of the use of electronic circuit devices (e.g., diodes, transistors including FET, integrated circuits). Photocells. Basic circuit development and analysis. Wood logging. Wood types and processing. Plastic types and working. Plastic moulding, bending, and encapsulation.

**MTH 201: Mathematical Methods 1 (2 Units C: LH 30)**

**Learning Outcomes**

At the end of the course, students should be able to:

1. explain real-valued functions of a real variable;

2. solve some problems using mean value theorem and Taylor series expansion; and

3. evaluate line integral, surface integral and volume integrals.

**Course Contents**

Real-valued functions of a real variable. Review of differentiation and integration and their applications. Mean value theorem. Taylor series. Real-valued functions of two and three variables. Partial derivatives chain rule, extrema, lagrangian multipliers. Increments, differentials and linear approximations. Evaluation of line integrals. Multiple integrals.

**MTH 202: Elementary Differential Equations (2 Units C: LH 30)**

**Learning Outcomes**

At the end of the course, students should be able to:

1. define the following: order and degree of a differential equation;

2. describe some techniques for solving first and second order linear and non-linear equations; and

3. solve some problems related to geometry and physics.

**Course Contents**

Derivation of differential equations from primitive geometry, physics etc. Order and degree of differential equation. Techniques for solving first and second order linear and non-linear equations. Solutions of systems of first order linear equations. Finite linear differential equations. Application to geometry and physics.

**MTH 204: Linear Algebra I (2 Units C: LH 30)**

**Learning Outcomes**

At the end of the course, students should be able to:

1. explain vector space;

2. describe linear transformations and their representation by matrices; and

3. calculate algebra of various matrices.

**Course Contents**

Vector space over the real field. Sub-spaces, linear independence, basis and dimension. Linear transformations and their representation by matrices – rings, null space, rank. Singular and non-singular transformation and matrices. Algebra of matrices.

**300 LEVEL**

**BUK-ICH 301: Separation Methods and Analysis (3 Units: LH 30: P 45)**

Intermediate theory and laboratory techniques in analytical and physical chemistry. Advanced data analysis methods and goodness-of-fit criteria Spectroscopic methods and instrumentation. Separation methods: ion exchange, gas, paper, liquid and column chromatography; electrophoresis. Atomic and molecular absorption, emission and fluorescence spectrophotometry. Electroanalytical techniques. Quantitative analysis. X-ray methods. Refractometry, Interferometry, Polarimetry, Polarography & Calorimetry.

**BUK-ICH 302: Introductory Material Science (2 Units: LH 30)**

Classification and properties of industrial materials. Type of bonding and its influence on both structure and properties of materials. Manufacture and properties of solid solutions (alloys). Structure of crystalline materials, coordination number, Crystallography.

Stress-strain relationship in materials, elastic an inelastic regions, mechanical, thermal and electrical properties of materials. Crystal growth and imperfections (defects). Material transformation-deformation, strengthening, electroplating and corrosion.

**BUK-ICH 303: Colour and Textile Chemistry (3 Units: LH 30; PH 45)**

Classification of dyes and textile fibres. Natural regenerated and synthetic fibres. Physical and structural properties of fibres. Preparatory processes: Singeing, desizing, scouring, bleaching, mercerization and optical brightening. Colour and constitution. Theory of dyeing. Dyeing preparation, structure, and application of dyes. After treatments and quality control: Colour fastness.

**CHM 316: Applied Spectroscopy (2 Units C: LH 30)**

**Learning Outcomes**

At the end of this course, the students should be able to:

1. characterise spectroscopical molecules and materials with the infrared; UV; NMR and mass spectrometry;

2. discuss the general principles of the analytical instruments listed above;

3. describe the applications of spectroscopy, such as the study of the atmosphere; cultural heritage, astrophysics, and materials;

4. describe the theoretical principle of GC-MS; LC-MS; LC-NMR;

5. study and characterise molecules and materials with the listed instruments in (4) above; and

6. list the application of these instruments in Industry and medicine.

**Course Contents**

Principles and applications of UV, IR, NMR and mass spectroscopy in the determination and elucidation of structures of organic compounds. Brief mention of hyphenated systems: GC-MS, LC-MS and LC-NMR, and diagnostic use of NMR in medicine.

**CHM 319: Environmental Chemistry (2 Units C: LH 30)**

**Learning Outcomes**

At the end of this course, students should be able to:

1. explain the elementary circle of the following elements oxygen, nitrogen, sulphur and many others;

2. describe the stratification of the earth atmosphere and state characteristics of each strata;

3. state and describe different sources of environmental pollution;

4. state and describe different types of environmental pollution and their effect on the environment;

5. describe water and state qualities that define the uses of water;

6. describe and explain different sources of water contamination and its impact on agricultural land crops and many others;

7. state and describe different methods used in treatment of waste water – chemical, biological and physical methods;

8. state and justify chemical and physical instrumentation in environmental chemistry;

9. describe environmental impact assessment; and

10. state and describe twelve principles of green chemistry and its practical applications.

**400 LEVEL**

**CHM 406: Reaction Kinetics (2 Units C: LH 30)**

**Learning Outcomes**

At the end of this course, students should be able to:

1. identify the first, second and third order rate equations;

2. use the coefficients of a balanced chemical equation to express the rate of reaction in terms of the change in concentration of a reactant or product over time;

3. distinguish between instantaneous rates and average rates from a graph; and

4. determine the rate law from initial rate data and be able to determine: • the order of reaction with respect to each reactant;

* + • the overall order of reaction; and
  + • the rate constant with units.

5. recognise the integrated rate laws and be able to: • use integrated first-order and second-order rate laws to find the value of one variable, given;

* + • values of the other variables;
  + • explain the concept of reaction half-life and describe the relationship between half-life and rate;
  + • constant for first order and second-order reactions;
  + • determine the order of the reaction from plots of concentration as versus time, in (concentration); versus time, and 1/(concentration) as versus time.

6. use collision theory to explain how reactions occur at the molecular level, and • explain the concept of activation energy and how it relates to the variation of reaction rate with temperature;

* + • be able to interpret potential energy profiles and use them to determine the activation energy;
  + • potential energy changes for a reaction;
  + • be able to use the Arrhenius equation to calculate a rate constant, activation energy, and
  + • frequency factor.

7. define a catalyst and • give a reaction mechanism, identify the reaction intermediate(s) and catalyst(s), write the overall;

* + • and determine the molecularity of each step;
  + • describe the effect of a catalyst on the energy requirements for a reaction;
  + • sketch a potential energy profile showing the activation energies for the forward and reverse;
  + • reactions and show how they are affected by the addition of a catalyst;

8. explain how enzymes act as biological catalysts and how they interact with specific substrate molecules.

9. explain why enzymatic reactions respond differently to temperature changes compared to nonenzymatic processes.

10. chemical warfare: • recognise selected classes of toxic agents of military importance: blister agents, (mustard,

* 1. • lewisite), nerve agents (sarin, VX), choking agents (chlorine, phosgene), blood agents (HCN), riot.
  2. • control agents

11. explain the mechanism by which sarin inhibits acetylcholinesterase ; and

12. identify photochemical reaction mechanism.

**Course Contents**

Review of first, second and third order rate equations. Rate constants and equilibrium constants. Collision theory. Transition state theory. Reaction co-ordinates. Unimolecular reaction mechanisms. Bimolecular reaction mechanisms. Chain reaction mechanisms. Chemical warfare, catalysis and heterogeneous reactions. Photochemical reaction mechanisms.

**BUK-ICH 404: Group Theory and Symmetry (2 Units: LH 30)**

Review of molecular symmetry operations. Definition of groups. Molecular symmetry groups. Introduction to the mathematical structure of groups. Group representations. Detailed study of groups Cn, Dn, and full rotation group. Applications. General symmetry applications. Symmetry of crystal lattices, Block orbitals for infinite system. Cv∞

**BUK-ICH 407: Electrochemistry (2 Units: LH 15; PH 45)**

Chemical Equilibria: Ionic equilibria, Conductance, theory and measurement, interpretation of data for strong and weak electrolytes, Conductance and transport processes. Thermodynamics and galvanic cells. Standard electrode potentials. Practical electrode. Molecular forces in solids and liquids: Dipole moments. Interaction potentials and . forces. Reversible galvanic cells, measurement of e.m.f. Electrode potentials and the electrochemical series. Standard state and the Nernst equation. Applications of e.m.f. measurements (excluding thermodynamic relationships). Potentiometric titration including measurement of pH. Redox reactions. The electrical double layer and its applications.

**BUK-ICH 408: Organic Synthesis (2 Units: LH 30)**

Reduction methods. Catalytic hydrogenation. Reduction with boron and aluminum hydrides and their analogues and derivatives. Metal reductions. Selective reduction in polyfunctional compounds. Oxidation methods. Epoxidation, hydration and Hydroxylation of alkenes, oxidative cleavage of glycol. Peroxyacids and coupling and relevance to biosynthesis. Survey of synthetic applications of organometallic compounds. Construction of synthetic routes (disconnection approach); molecular self assembly in synthesis. Hydroboration oxidation to ketones. Carboxylation reactions and protonolysis phosphorus halides and their applications. Enamines: synthesis and applications. Formation of polycyclic compounds. Aldol type reactivity and reaction of iminium salts with nucleophile. Synthesis of complex molecules. Pericyclic reactions. Methodology for the construction synthetic routes. Applications for synthesis of important and complex organic compounds.

**BUK-ICH 409: Food Chemistry (2 Units: LH 30)**

The nature of food; vitamins, additives and adulterants; chemistry and microbiology of production processes and control; food preservation and spoilage; processing and preservation of local food stuffs; formulation and practice of food standards.

**CHM 410: Analytical Chemistry II (2 Units C: LH 30)**

**Learning Outcomes**

At the end of this course, students should be able to:

1. describe different thermal methods of analyses: TG, DTG, DTA, DSC;

2. describe the potentiometric method of analysis using pH;

3. describe the conductometric method analysis;

4. describe the colorimetric method analysis;

5. describe the polarography methods analysis;

6. explain and perform calculation using chromatography principles;

7. explain principles of different chromatographic technique; and

8. explain the principle of radiochemical method in environmental analysis.

**Course Contents**

Potentiometric and pH methods. Conductometric, electroanalytical, amperometric, colorimetric methods of analysis. Coupled methods of analysis e.g. GC-MS, LC-MS. Radio-chemical methods, chromatography.

**BUK-ICH 411: Agrochemical & Chemotherapeutic Agents (3 Units: LH 45)**

Pesticides, fungicides, and insect sex attractants. Survey of modern approaches to pest and fungal growth control. Naturally occurring pesticides – rotenoids, pyrethrenoids. Survey of synthetic chlorinated hydrocarbon insecticides. Insect pheromones – techniques of identification, isolation and structural determination and configuration – some synthetic analogues. Herbicides and growth regulation substances. Review of chemical groups used in growth control. Plant growth regulators. Some nitrogen containing herbicides – a review. Synthesis of selected nitrogen containing herbicides.

*Chemotherapeutic Agents***:** General antibiotic types. Their mode of activity. The tetracyclines or B-lactam antibiotics will be discussed with regard to source, synthetic routes, synthetic analogues, biosynthesis and mode of action. Prostaglandins. Biosynthesis of prostanoic acid, derivatives of E.F.A. and B series of prostaglandins. Synthetic approaches.

**BUK-ICH 415: Polymer Technology (2 Units: LH 30)**

Large scale industrial polymerisation processes. Polymer characterization, criteria for polymer solubility, chain conformation, thermodynamics and phase equilibrium. Molecular weight size and distribution: Rheology of polymers: Mechanical properties and viscoelasticity, structure-property relationships. Polymer types. Polymer processing, injection, extrusion, compression and transfer moulding of thermoplastics. Polymer additives. Polymeric surface coatings and adhesives. Thermosetting elastomers, plasticizers, resins and extrusion, spinning, vulcanization and reinforcement. Casting, testing and quality control: Chemical analysis. Birefringence measurement physical testing.

**CHM 424: Coordination Chemistry (2 Units C: LH 30)**

**Learning Outcomes**

At the end of this course, students should be able to:

1. define coordination compounds;

2. recognise coordination compounds and their application;

3. identify the nomenclature, coordination formula and isomerism in complexes;

4. explain the stereochemistry of complex molecules;

5. identify theories of bonding: Werner, valence bond, crystal field/ligand field and molecular bond theories;

6. discuss their advantages, disadvantages, and their limitations;

7. discuss the physiochemical methods for structural elucidation of coordination compounds;

8. identify spectrochemicalseries, nephelauxetic series and Jahn-Teller distortions;

9. identify stabilisation of unusual oxidation states by complex formation, thermodynamic stability of complex compounds, the stability constant, the chelate effect;

10. discuss preparation and reactions of complexes. Kinetics and mechanisms;

11. discuss domain structures, magnetostrictions, magnetic relaxation, magnetohydrodynamics and many others; and

12. identify technological applications of magnetohydrodynamics.

**Course Contents**

Definition, recognition and applications of co-ordination compounds. Nomenclature, co-ordination formula and isomerism in complexes. Stereochemistry of complex molecules. Theories of structure and bonding. Physical methods of structural investigation. Magnetic properties. Absorption and vibrational spectra. The spectrochemical series. The Nephelauxetic series and the Jahn-Teller distortions. Stabilisation of unusual oxidation states by complex formation. Thermodynamic stability of complex compounds, the stability constant, the chelate effect. Preparation and reactions of complexes. Kinetics and mechanisms.