**Bayero University Kano**

**Physical Sciences**

**Pure and Industrial Chemistry**

**BSc Chemistry**

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

**200 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Unit(s)** | **Status** | **LH** | **PH** |
| MTH 202 | Elementary Differential Equations | 2 | C | 30 |  |
| PHY 201 | General physics V (Elementary Modern Physics) | 2 | C | 30 |  |
| PHY 205 | Thermal Physics | 2 | C | 30 |  |
| PHY 206 | General Physics VII (Energy and Environment) | 2 | C | 30 |  |
| BUK-CHM 215 | Organic Chemistry II | 2 | C | 30 |  |
|  | **Total** | 10 |  |  |  |

**300 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Unit(s)** | **Status** | **LH** | **PH** |
| BUK-CHM 305 | Polymer Chemistry I | 2 | C | 30 |  |
| BUK-CHM 306 | Colour Chemistry and Technology I | 2 | C | 30 |  |
| BUK-CHM 307 | Natural Product Chemistry I | 2 | C | 30 |  |
| BUK-CHM 308 | Chemical Physics and Photochemistry | 2 | C | 30 |  |
| BUK-CHM 309 | Industrial Chemical Process I | 2 | C | 30 |  |
|  | **Total** | 10 |  |  |  |

**400 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Unit(s)** | **Status** | **LH** | **PH** |
| BUK-CHM 402 | Physical Organic Chemistry | 2 | C | 30 |  |
| BUK-CHM 403 | Organic Synthesis | 2 | C | 30 |  |
| BUK-CHM 404 | Electrochemistry | 2 | C | 30 |  |
| BUK-CHM 405 | Theory Of Molecular Spectroscopy | 2 | C | 30 |  |
| BUK-CHM 407 | Inorganic Reaction Mechanisms | 2 | C | 30 |  |
| BUK-CHM 408 | Nuclear & Radiochemistry | 2 | C | 30 |  |
| BUK-CHM 409 | Industrial Chemical Process Ii | 2 | C | 30 |  |
| BUK-CHM 411 | Textile Chemistry | 2 | C | 30 |  |
| BUK-CHM 412 | Polymer Technology And Rheology | 2 | C | 30 |  |
| BUK-CHM 414 | Material Science And Corrosion | 2 | C | 30 |  |
| BUK-CHM 415 | Applied Surface Chemistry And Colloids | 2 | C | 30 |  |
|  | **Total** | 21 |  |  |  |

**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;

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.

**PHY 201: General physics V (Elementary Modern Physics) (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Explain the notion of an inertial frame and the concept of an observer;

2. Relate the limitations imposed by and consequences of motion of bodies at the speed of light;

3. State the principles of Special Relativity and use them to derive relations for time dilation and length contraction;

4. Perform calculations using the Lorentz transformation formulae;

5. Derive relativistic energy and momentum and use these to solve problems in mechanics;

6. Apply the mathematical treatment of the wave function and Schrodinger’s equation;

7. Relate the atomic structure and energy associated with the particles of the atom;

8. Apply the ideas of wave-particle duality and the uncertainty principle to solve problems in quantum mechanics;

9. Apply the Bohr formula to calculate energies and wavelengths in the context of atomic hydrogen; and

10. Explain the interaction of photons and electrons with matter.

**Course Contents**

Defects in Newtonian Mechanics. Galilean relativity. The speed of light. Inertial frames and the concept of an observer. The principles of Einstein’s Special Theory of Relativity. Lorentz transformation. Time dilation and length contraction. Transformation of velocities. Doppler effect. Relativistic energy and momentum. Basic properties of atoms and molecules. Experimental basis of quantum theory. Electrons and quanta. Bohr's theory of atomic structure. Energy levels and spectra. De Broglie hypothesis. The uncertainty principle. Black body radiation. The momentum operator. Time-independent Schrödinger equation. The infinite square well. Simple applications in particle and nuclear physics. Compton effect. Thermionic emission. Radioactivity. Detection and measurement of charged particles (including the treatment of detectors). X-rays.

**PHY 205: Thermal Physics (2 Units C: LH 30)**

**Learning Outcomes**

At the end of the course, 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 206: General Physics VII (Energy and Environment) (2 Unit C: LH 30)**

**Learning Outcomes**

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

1. Explain the origin and sources of energy and power;

2. Describe the inter relation and transformation of energy sources and types;

3. Illustrate and explain the principles of generation of power;

4. Outline the concept of energy demand and supply;

5. Explain the economics, politics and problems associated with energy demand and supply;

6. Identify and assess categories of environmental pollutants;

7. Describe effect of carbon emission on global warming;

8. Describe the environmental effect of energy generation, supply, and consumption; and

9. Identify and evaluate the merits and demerits of power generation from different sources.

**Course Contents**

Energy sources and climate impacts. Energy requirements and consumption. Energy processing and conversion. Energy units and pricing. The greenhouse effect. Biological forms of energy (fossil fuels and biofuels). Basic nuclear physics. **T**he atom, radioactivity and decay laws. Interaction of radiation with matter. Nuclear fission principles and energetics. Chain reaction and dynamics. Reactor types and control. Current status of nuclear fission as a power source. Nuclear fusion principles and energetics. (Examples in stars and on earth). Thermonuclear fusion. Nuclear fuels. Ignition and the Lawson criterion. Magnetic and inertial confinement. Current status of nuclear fusion as a power source. Stellar fusion. Proton-proton chain and CNO cycle. Solar power technologies. Solar thermal. Solar photovoltaic. Wind energy. Nature of wind. Wind power and wind turbines. Betz criterion. Energy from waves and tides. Principles of water waves, energy, and power. Wave power extraction. Origin and properties of tides. Tidal stream power and tidal range power. Power from fluids. Hydro power. Energy transportation and storage. Thermal pollution. Energy costs, capacity, reserves, and efficiency. Emerging environmental effects of energy processing

**BUK-CHM 215: Organic Chemistry II (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Understand the preparations of Alcohols, Ethers, Epoxides, Aldehydes, Ketones, Carboxylic acids and their derivatives and α, β-unsaturated carbonyl compounds.

2. Describe the properties of Alcohols, Ethers, Epoxides, Aldehydes, Ketones, Carboxylic acids and their derivatives and α, β-unsaturated carbonyl compounds.

3. Propose reaction mechanisms of Alcohols, Ethers, Epoxides, Aldehydes, Ketones, Carboxylic acids and their derivatives and α, β-unsaturated carbonyl compounds.

**Course Contents**

Preparation, properties and reaction mechanisms of Alcohols, Ethers, Epoxides, Aldehydes, Ketones, Carboxylic acids and their derivatives and α, β-unsaturated carbonyl compounds.

**BUK-CHM 305 Polymer Chemistry I (2 Units C: LH 30)**

**Learning outcomes**

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

1. Understand polymerization and the processes involved in different polymerization reactions.
2. Describe polymer intermediates used in the synthesis of polymers
3. Prepare polymer intermediates for polymer synthesis
4. Describe the structures and properties of different types of polymers
5. Prepare and characterized the fibre forming polymers
6. Differentiate between thermoplastics, thermosetting and polyurethanes.
7. Test and characterize different types of polymers using standard methods.
8. Understand applications of different polymers.

**Course contents**

Polymer nomenclature, Polymer raw-materials and their sources, Polymerization processes, Preparation of polymer intermediates, Structures, properties, solubility and solution properties of polymers, Fiber forming polymers. Industrially important thermoplastics and thermosetting polymers, Polyurethanes, Rubber elasticity, Mechanical properties of polymers, Analysis and testing of polymers, Polymer degradation.

**BUK-CHM 306 Colour Chemistry and Technology I (2 Units C: LH 30)**

**Learning outcomes**

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

1. Describe the classification, properties and structures of some dyes and pigments.
2. Differentiate between the different types of dyes (such as acid, basic, reactive, vat, azoic, sulphur, etc).
3. Describe the processes involved in the dyeing of natural and synthetic fibres
4. Assess the colour fastness properties (such as fastness to light, rubbing, heat, wet, etc) of different dyes.
5. Assess different types of machines used in dyeing and printing
6. Describe the application of suitable dyes and colours on different substrates for different purposes.

**Course contents**

Chemistry and properties of dyes and pigments, Classification of dyes and fibres. Dyeing mechanism, Preparation and dyeing of natural and synthetic fibres, Vat, Azoic & Sulphur dyes on cellulose and Acid dyes on protein fibres, Colour fastness properties and assessment techniques. Dyeing and printing machineries, colouring matters for food, drugs and cosmetics, Dyes used in paper industries and colour photography.

**BUK-CHM 307 Natural Product Chemistry I (2 Units C: LH 30)**

**Learning outcomes**

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

1. Describe natural product compounds.
2. Explain the biosynthetic pathways leading to the formation of different natural products
3. Detect the presence or absence of different secondary metabolites in the sample
4. Isolate and characterize secondary metabolites
5. Use modern techniques (such as UV, IR, NMR and MS) in the characterization of natural product compounds.
6. Describe the synthesis of some natural product compounds.

**Course contents**

Biosynthesis and chemistry of Terpenoids, Carrotenoids, Steroids, Alkaloids, Flavonoids, Lipids, Prostaglandins and Chlorophylls. Mode of isolation and identification.

**BUK-CHM 308 Chemical Physics and Photochemistry (2 Units C: LH 30)**

**Learning outcomes**

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

1. Describe the theory of hydrogen molecule in its ground and excited states (Pauli Exclusive principles).
2. Describe the rotational and vibrational frequencies of hydrogen molecule
3. Explain the heat and specific heat capacities in crystal structures and crystal lattices
4. Describe the photochemical kinetics for 1st, 2nd order, pseudo first order reactions, etc.
5. Explain photochemical reactions leading to chemiluminescence.

**Course contents**

Chemical Physics: Theory of bonding in H2+1 and H2, Rotation and vibration of molecules, Heat capacities of crystals.

Photochemistry: Photochemical equivalence, light absorption by atoms and molecule, Photochemical kinetics and experimental studies, Photosynthesized gas reaction, flash photolysis, Photochemical equivalence, Chemiluminescence and radiation chemistry.

**BUK-CHM 309 Industrial Chemical Process I (2 Units C: LH 30)**

**Learning outcomes**

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

1. Have background information on chemical industries, their characteristics and economic values.
2. Carry out the synthesis of industrial organic chemicals such as simple polymers, dyes, adhesives, insecticides, pesticides, etc
3. Describe manufacture of industrial inorganic chemicals such as cement binders, fertilizers, etc
4. Explain some technical aspect of chemical industries such as back mixing, residence time, distribution and dispersion models, etc

**Course contents**

Characterization and importance of chemical industries, Conversion efficiency, Yield and rationalization. Economic and technical feasibilities as applied to production of primary intermediates and finished products.

Synthesis of industrial organic chemicals, polymers, adhesives, dyes, explosives, insecticides, pesticides, herbicides and pharmaceuticals. Manufacture of cement binding material and inorganic fertilizers

Flow characteristics: Back mixing, residence time, distribution and dispersion models, catalytic reactions, designed operation of gas/liquid and liquid/liquid phases.

**BUK-CHM402 PHYSICAL ORGANIC CHEMISTRY (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Describe organic reaction mechanism.
2. Describe Nucleophilic substitution reactions
3. Describe elimination and addition reactions
4. Describe re-arrangement reactions
5. Describe preparation and reaction of stereoisomers; stereoselectivity; neighbouring group effects
6. Describe Hammette equation

**Course Outline**

Methods for the study of organic reaction mechanisms. Nucleophilic substitution reactions, elimination and addition reactions, re-arrangement reactions, preparation and reaction of stereoisomers; stereoselectivity; neighbouring group effects. Hammette equation.

**BUK-CHM403 ORGANIC SYNTHESIS (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Explain application of basic concepts functional group chemistry through alkylation, acylation, acetylation, halogenation, oxidation, reduction through rearrangement and miscellaneous other reactions used in synthetic routes
2. Explain number of literature reactions will be examined and their synthesis scheme mastered.

**Course Contents**

Application of basic concepts of functional group chemistry through alkylation, acylation, acetylation, halogenation, oxidation, reduction through rearrangement and miscellaneous other reactions used in synthetic routes. A number literature reactions will be examined and their synthesis scheme mastered.

**BUK-CHM404 ELECTROCHEMISTRY (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Describe Electrical double layer, potential at zero charge, polarizable and non-polarizable interfaces, mass transport, concentration polarization, Fick’s Law, Levic equation.
2. Describe kinetics of electronic charge transfer.
3. Describe standard electrode potential, over potential, ohmic polarization, limiting and exchange current densities.
4. Describe redox reactions.
5. Describe Nernst equation.
6. Describe Tafel equation and i-v polarization principles.
7. Describe E½ wave potential, cyclic voltammetry, Electro-Analytical principles. Battery technology and gas production by electrolysis.
8. Describe Electro-organic equation.

**Course Contents**

Electrical double layer, potential at zero charge, polarizable and non-polarizable interfaces, mass transport, concentration polarization, Fick’s Law, levic equation. Electrodics: kinetics of electronic charge transfer, standard electrode potential, over potential, ohmic polarization, limiting and exchange current densities, redox reactions, Nernst equation, Tafel equation and i-v polarization principles. Polarography: E½ wave potential, cyclic voltammetry, Electro-Analytical principles. Battery technology and gas production by electrolysis. Electro-organic equation.

**BUK-CHM405 THEORY OF MOLECULAR SPECTROSCOPY (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Describe quantum theory of rotation and vibration of a molecule.
2. Describe the theory of microwave spectroscopy, infra-red spectroscopy, Raman spectroscopy, ultraviolet/visible spectroscopy, nuclear magnetic resonance spectroscopy.
3. Explain the general introduction to electron spin resonance.
4. Describe mossbauer Effect.
5. Describe the nuclear quadropole resonance and other modern techniques.

**Course Contents**

Quantum theory of rotation and vibration. Theory of microwave spectroscopy, infra-red spectroscopy, Raman spectroscopy, ultraviolet/visible spectroscopy, nuclear magnetic resonance spectroscopy. General introduction to electron spin resonance, mossbauer effect, nuclear quadropole resonance and other modern techniques.

**BUK-CHM407 INORGANIC REACTION MECHANISMS (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Define, understand the properties and structure of inert and labile complexes.
2. Describe substitution reaction of octahedral complexes and their kinetics.
3. Understand the outer sphere and inner sphere substitution reaction mechanism of square planar complexes.
4. Understand complimentary reactions.
5. Study experimental methods for fast and slow reactions.
6. Understand reaction mechanisms in some bioinorganic systems.

**Course Contents**

Complex definition, properties and structure, inert and labile complex, Substitution reaction of octahedral complexes and their kinetics, Substitution reaction square planar complexes, Outer

sphere and inner sphere reactions. Complimentary reactions, Experimental methods for fast and slow reactions. Reaction mechanisms in some bioinorganic systems.

**BUK-CHM408 NUCLEAR & RADIOCHEMISTRY (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Understand the development of nuclear chemistry, Fundamental particles and nuclear structure.
2. Describe Nuclear reactions and radioactivity, proportion of nuclear reactions.
3. Study the detection and measurement of nuclear radiation, production of isotopes.
4. Study the rate of radioactive decay, half-life, instruments for measuring radioactivity, application of radionuclides.

**Course Contents**

The development of nuclear chemistry, Fundamental particles and nuclear structure, Nuclear reactions and radioactivity, proportion of nuclear reactions. The detection and measurement of nuclear radiation, production of isotopes. Radiochemical methods: rate of radioactive decay, half-life, instruments for measuring radioactivity, application of radionuclides.

**BUK-CHM409 INDUSTRIAL CHEMICAL PROCESS II (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Describe Industrial electrochemistry, electroplating, food canning and preservation.
2. Describe chemical processing of minerals.
3. Describe metallurgical and hydrometallurgical processes.
4. Understand the manufacture of some heavy inorganic chemicals such as cement, binding materials, inorganic fertilizers etc.

**Course Contents**

Industrial electrochemistry, electroplating, food canning and preservation. Chemical processing of minerals. Metallurgical and hydrometallurgical processes, manufacture of some heavy inorganic chemicals: cement, binding materials, inorganic fertilizers.

**BUK-CHM411 TEXTILE CHEMISTRY (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Understand the textile fibres process with different chemical treatments.
2. Understand the methods used to control the environmental pollution from the textile industries effluents

**Course Contents**

Chemistry of textile fibres, chemistry of wet processing of textiles, Environmental control and energy conservation in textile industry, methods of treatment and disposal of effluents, principle and experimental techniques of various chemical processes and industrial Visits.

**BUK-CHM412 POLYMER TECHNOLOGY AND RHEOLOGY (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Describe the crystalline state of polymers. amorphous state of polymers. Mechanical properties of polymers. Visco elastic properties of polymers.
2. Understand Natural and synthetic rubbers, Elasticity, mastication, vulcanization and compounding of rubbers, uses of latex and rubber materials. Flow properties of molten polymers.
3. Describe anti-oxidants and anti-degradation additives, flame retardants, fillers, plasticizers; blowing agents; cross-linking agents; pigments and dye stuffs.
4. Describe polymer processing techniques: mixing, extrusion, injection moulding, compression moulding, calendaring, vacuum forming, casting and surface coatings, paints and adhesives.

**Course Contents**

The crystalline state of polymers. amorphous state of polymers. Mechanical properties of polymers. Visco elastic properties of polymers.

Rubbers (Elastomer): Natural and synthetic rubbers, Elasticity, mastication, vulcanization and compounding of rubbers, uses of latex and rubber materials. Flow properties of molten polymers.

Polymer additives: anti-oxidants and anti-degradation additives, flame retardants, fillers, plasticizers; blowing agents; cross-linking agents; pigments and dye stuffs.

Polymer processing techniques: mixing, extrusion, injection moulding, compression moulding, calendaring, vacuum forming, casting and surface coatings, paints and adhesives.

**BUK-CHM414 MATERIAL SCIENCE AND CORROSION (2 Units C: LH 30)**

**Learning Outcomes**

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

1. Understand the classification of industrial material, BCC, FCC and HCP structure with emphasis of industrial material. Atomic packing factor (APF).
2. Identify industrial materials, material defects and dislocation.
3. Describe Alloy manufacture and mineral chemistry.
4. Identify Nigeria’s industry and raw material requirement.
5. Understand corrosion principles and mechanism, types, factors and kinetics of corrosion monitoring, prevention, control of corrosion in petroleum, chemical industries and water works departments.
6. Describe corrosion stress and hydrogen embrittlement concept.
7. Understand Electroplating Technology: Electroplating principles, dendritic electroplating effect, throwing power of solution and Alloy electroplating.

**Course Contents**

Material science: classification of industrial material, BCC, FCC and HCP structure with emphasis of industrial material. Atomic packing factor (APF). Identification of industrial materials, material defects and dislocation. Alloy: manufacture, mineral chemistry. A survey of Nigeria’s industry and raw material requirement. Corrosion: principles and mechanism of corrosion, Types, factors and kinetics of corrosion monitoring, prevention, control of corrosion in petroleum, chemical industries and water works departments. Stress corrosion and hydrogen embrittlement concept. Electroplating Technology: Electroplating principles, dendritic electroplating effect, Throwing power of solution, Alloy electroplating.

**BUK-CHM415 APPLIED SURFACE CHEMISTRY AND COLLOIDS** **(2 Units C: LH 30)**

**Learning Outcomes**

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

1. Describe surface and interfacial tension. Surface thermodynamics, spreading and wetting and application to agriculture and animal husbandry. Detergents and soaps. Criteria for effective washing and dirt.
2. Describe the colloidal state, classification of colloidal systems, structure, preparation and purification. Lyophillic, lyophobic and hydrophilic systems, light scattering for particle size measurements.
3. Understand the adsorption isotherm, particle size measurement, BET application, Electrical potential of surface solid -gas interface and liquid -solid interface.

**Course Contents**

Surface Chemistry ; surface and Interfacial tension . Surface thermodynamics , spreading and wetting and application to agriculture and animal husbandry . Detergents and soaps. Criteria for effective washing and dirt

Colloids: the colloidal state, classification of colloidal systems , structure , preparation and purification . Lyophillic , lyophobic and hydrophilic systems , light scattering for particle size measurements

Adsorption isotherm, particle size measurement , BET application , Electrical potential of surface solid -gas interface and liquid -solid interface