**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

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

**100 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-GEY 101 | General Biology | 2 | C | 30 | 20 |
| BUK- GEY 102 | General Biology II | 2 | C | 30 | 20 |
| BUK - GEY 103 | General Chemistry I | 2 | C | 30 | 20 |
| BUK - GEY 104 | General Chemistry II | 2 | C | 30 | 20 |
| BUK - GEY 105 | General Physics I (Mechanics) | 2 | C | 30 | 20 |
| BUK - GEY 106 | General Practical Physics I | 1 | C | - | 30 |
| BUK - GEY 107 | Probability I | 3 | C | 45 | - |
| BUK- GEY 108 | Introduction to Field Geology | 2 | C | 30 | 20 |
|  | **Total** | **16** |  |  |  |

**200 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK - GEY 213 | Analytical Chemistry I | 2 | C | 30 | 20 |
| BUK-GEY 204 | Optical Mineralogy | 2 | C | 30 | 20 |
| BUK-GEY 216 | Introduction to Geology and Mineral Resources of North-western Nigeria | 2 | C | 30 | 20 |
| BUK- GEY 215 | Environmental Geology and Mineral Resources of North-western Nigeria | 3 | C | 45 | - |
| BUK- GEY 214 | GIS Application in Geosciences | 2 | C | 30 | 20 |
|  | **Total** | **11** |  |  |  |

**300 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK- GEY 303 | Igneous and Metamorphic Petrology | 3 | C | 45 | 20 |
| BUK- GEY 317 | Georesources Exploration and Characterization | 3 | C | 45 | - |
|  | **Total** | **6** |  |  |  |

**400 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK- GEY 401 | Advanced Igneous petrology | 2 | C | 30 | 20 |
| BUK- GEY 403 | Advanced Metamorphic petrology | 2 | C | 30 | 20 |
|  | **Total** | **4** |  |  |  |
|  | **GRAND TOTAL** | **37** |  |  |  |

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 101 General Biology (2 units, LH 30, PH 20)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in handling and analysing biological data as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course contains the basic concepts and principles of Biology from the simple structure and function of the cell to more complex tissues, organs, systems, organisms and their relationships with the biosphere. Emphasis is given to basic units of life, the interaction of these units and the challenges encountered and their adaptiveness to our ecosystem, in an evolutionary manner.

General biology prepares the graduates of geology to be able to handle and improve on their knowledge of palaeontology and biostratigraphy. This highlights the significance of preparing the students with the prerequisite knowledge and skills to understand biological concepts in their study of palaeontology and biostratigraphy.

**Objectives**

The objectives of this course are to:

1. describe to the students the foundation of biological knowledge and practical skills;
2. explain to the students how to apply knowledge and skills to solving theoretical and practical problems as it relates to biology;
3. discuss to the students the fundamental of biology as well as other multi-disciplinary areas involving biology;
4. highlight the importance of biology in industrial, economic, environmental, technological and social development to the students
5. explain to the students how to apply basic biological principles in different geological contexts that include paleontology and biostratigraphy

**Learning Outcomes**

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

1. explain cell structure and organizations;
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 organization, 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 habitats.

**Minimum Academic Standards**

Biology laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 102: General Biology II (2 units, LH 30, PH 20)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in handling and analysing biological data as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course contains the basic concepts and principles of Biology from the simple structure and function of the cell to more complex tissues, organs, systems, organisms and their relationships with the biosphere. Emphasis is given to basic units of life, the interaction of these units and the challenges encountered and their adaptiveness to our ecosystem, in an evolutionary manner.

General biology prepares the graduates of geology to be able to handle and improve on their knowledge of palaeontology and biostratigraphy. This highlights the significance of preparing the students with the prerequisite knowledge and skills to understand biological concepts in their study of palaeontology and biostratigraphy.

**Objectives**

The objectives of this course are to:

1. describe to the students the foundation of biological knowledge and practical skills;
2. explain to the students how to apply knowledge and skills to solving theoretical and practical problems as it relates to biology;
3. Discuss to the students the fundamental of biology as well as other multi-disciplinary areas involving biology;
4. highlight the importance of biology in industrial, economic, environmental, technological and social development to the students
5. Explain to the students how to apply basic biological principles in different geological contexts that include paleontology and biostratigraphy

**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.

**Minimum Academic Standards**

Biology laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 103: General Chemistry I (2 units, LH 30, PH 20)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in handling and analysing chemical data as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course is a study on the nature of chemistry and all its forms, this includes areas of core analytical, forensic, inorganic and physical chemistry, and a broad spectrum of organic related chemistry. The chemistry course is designed to enable graduates acquire broad based knowledge on chemical processes in living and non-living organism which spread through the areas of organic, inorganic, physical and material elements.

The course is designed to give students a broad knowledge of both the science and the application of chemistry, to develop problem solving skills and to prepare students in their study of mineralogy, crystallography and geochemistry.

**Objectives**

This chemistry course is specifically designed to:

1. highlight the fundamental of chemistry and its applications;
2. teach students the chemistry principles that are required for geological studies and research;
3. describe to the students how to use chemistry in the geochemical exploration of rocks and minerals;
4. discuss the fundamental principles of Chemistry to geosciences and environment, and
5. expatiate on a broad and balanced base of chemical knowledge and practical skills;

**Learning Outcomes**

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

1. define atom, molecules and chemical reactions;
2. discuss the Modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. justify the trends of atomic radii, ionization energies, electronegativity of the elements based on their position in the periodic table;
5. identify and balance oxidation – reduction equation and solve redox titration problems; 6. illustrate shapes of simple molecules and hybridized orbitals;
6. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
7. apply the principles of equilibrium to aqueous systems using LeChatelier’s principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
8. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
9. determine rates of reactions and its dependence on concentration, time and temperature.

**Course Contents**

Atoms, molecules, elements and compounds and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridization and shapes of simple molecules. Valence Forces; Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

**Minimum Academic Standards**

Chemistry laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 104: General Chemistry II (2 units, LH 30, PH 20)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in handling and analysing chemical data as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course is a study on the nature of chemistry and all its forms, this includes areas of core analytical, forensic, inorganic and physical chemistry, and a broad spectrum of organic related chemistry. The chemistry programme is designed to enable graduates acquire broad based knowledge on chemical processes in living and non-living organism which spread through the areas of organic, inorganic, physical and material elements.

The course is designed to give students a broad knowledge of both the science and the application of chemistry, to develop problem solving skills and to prepare students in their study of mineralogy, crystallography and geochemistry.

**Objectives**

This chemistry course is specifically designed to:

1. discuss the fundamental of chemistry and its application to the students
2. provide students with a broad and balanced base of chemical knowledge and practical skills;
3. describe to the students a solid base of chemical knowledge and skills that are required for geological studies and research;
4. discuss to the students an application of chemistry in the geochemical exploration of rocks and minerals;
5. highlight fundamental principles of Chemistry to mineralogy, crystallography and geochemistry, and

**Learning Outcomes**

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

1. state the importance and development of organic chemistry;

2. define fullerenes and their applications; 3. discuss electronic theory;

4. determine the qualitative and quantitative of structures in organic chemistry;

5. describe rules guiding nomenclature and functional group classes of organic chemistry;

6. determine rate of reaction to predict mechanisms of reaction;

7. identify classes of organic functional group with brief description of their chemistry;

8. discuss comparative chemistry of group 1A, IIA and IVA elements; and

9. describe basic properties of Transition metals.

**Course Contents**

Historical survey of the development and importance of Organic Chemistry; Fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds. Determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry. Nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The Chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

**Minimum Academic Standards**

Chemistry laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 105: General Physics I (Mechanics) (2 units, LH 30, PH 20)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in applying basic concepts of physics as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course is designed to provide basic foundation of Physics through covering areas of classical physics, dynamics, and kinematics, as well as underlining mathematical concepts that underpin a better understanding of the course. The scope of energy and environment was included in line with the global concern on sustainable development.

This course trains students in both theoretical knowledge and experimental skills in physics, to prepare them for academic pursuit, research, or work in areas of Geophysics, Geomechanics, and Engineering Geology.

**Objectives**

The objectives of the course are to;

1. teach students a wide-ranging and balanced foundation of theoretical physics and practical skills;
2. highlight to the students the application of physics principles in geological contexts that include Structural Geology, Geophysics, Geomechanics, Engineering Geology and Rock physics
3. explain to the students how to apply their knowledge and skills in Physics to resolving problems encountered in field campaigns and geological data interpretation;
4. highlight to the students through an education in Physics a range of transferable skills of value in physics and relevant areas in Geology; and
5. enumerate to the students a knowledge and skills base in physics that will be useful for further studies in multi-disciplinary areas involving Geophysics, Geomechanics, and Engineering Geology.

**Learning Outcomes**

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

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics.
4. apply Newton’s laws to describe and solve simple problems of motion.
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects.
6. explain and apply the principles of conservation of energy, linear and angular momentum.
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity

**Courses Contents**

Space and time. Units and dimension, Vectors and Scalars. Differentiation of vectors: displacement, velocity and acceleration. Kinematics. Newton laws of motion (Inertial frames, Impulse, force and action at a distance, momentum conservation). Relative motion. Application of Newtonian mechanics. Equations of motion. Conservation principles in physics. Conservative forces. Conservation of linear momentum. Kinetic energy and work. Potential energy. System of particles. Centre of mass. Rotational motion:Torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates. Conservation of angular momentum. Circular motion. Moments of inertia. gyroscopes and precession. Gravitation: Newton’s Law of Gravitation. Kepler’s Laws of Planetary Motion. Gravitational Potential Energy. Escape velocity. Satellites motion and orbits.

**Minimum Academic Standards**

Physics laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 106: General Practical Physics I (2 units, LH 30, PH 40)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in applying basic concepts of physics as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course is designed to provide the students with the basic laboratory skills and techniquesof Physics.This course trains students in experimental skills in physics, to prepare them for academic pursuit, research, or work in areas of Geophysics, Geomechanics, and Engineering Geology with regards to laboratory procedures and measurements, experimental techniques, numerical and graphical data analysis, interpretation and presentation.

**Objectives**

The objectives of the course are to;

1. explain to the students a wide-ranging and balanced foundation of practical skills in Physics;
2. highlight to the students the application of physics principles in geological contexts that include Structural Geology, Geophysics, Geomechanics, Engineering Geology and Rock physics
3. explain to the students how to apply their knowledge and skills in Physics to resolving problems encountered in field campaigns and geological data interpretation;
4. highlight to the students through an education in Physics a range of transferable skills of value in physics and relevant areas in Geology; and
5. enumerate to the students a knowledge and skills base in physics that will be useful for further studies in multi-disciplinary areas involving Geophysics, Geomechanics, and Engineering Geology.

**Learning Outcomes**

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

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

**Course Contents**

This introductory course emphasizes quantitative measurements, the treatment of measurement errors and graphical analysis. A variety of experimental techniques should be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity etc., covered in BUK - PHY 101. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

**Minimum Academic Standards**

Physics laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 107: Probability I (2 units, LH 45, PH 0)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in handling and analysing statistical data as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course covers the use of elementary probability to analyse data obtained from different processes, operations and experiments. It is designed to introduce and expose students to concepts and principles of probability, distribution functions as well as the various probability tools required in the computation and analysis of data. This course develops the capacity of students in the area of geological data analysis.

**Objectives**

The objectives of the course are to:

1. explain to the students how to use statistical principle in geological data analysis;
2. highlight to the students a wide-ranging and balanced foundation in probability, distribution functions as well as the various probability tools required in the computation and analysis of data;
3. explain to the students how they can apply their knowledge and skills in Probability to resolving theoretical and practical problems in Geoscience;
4. highlight to the students, through an education in Probability, a range of skills in permutation and combination for laboratory data analysis; and
5. explain to the students how they can use their knowledge and skills- base in statistic for further studies in multi-disciplinary areas involving geological data analysis

**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.

**Minimum Academic Standards**

Statistical softwares with NUC-MAS requirement facilities

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK-GEY 108: Introduction to Field Geology (2units, LH30, PH 20)**

**Senate- approved relevance**

This course introduces students to the practical identification of igneous, metamorphic and sedimentary rocks as well as identification of minor geological structures.

**Overview**

This course is designed to provide the students with practical skills for identifications of rocks and minor structures in the field.

It also provides the students with basic knowledge geological mapping techniques and map production.

**Objectives**

This field geological course is specifically designed to:

1. explain safety measures in the field
2. discuss practical identification of rocks and minerals
3. describe minor structures in the fields
4. highlight basic geological field tools (e.g compass clinometer and GPS)
5. explain basic geological mapping techniques

**Learning Outcomes**

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

1. identify the three major rock types in the field
2. describe minor structures in the field
3. describe and use basic geological field tools
4. understand basic geological mapping techniques

**Course Contents**

Safety measures during geological field studies; identification of igneous, metamorphic and sedimentary rocks and their modes occurrences in the field. Basic geological field tools and their uses.

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**Minimum Academic Standards**

Basic geological field tools with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK - GEY 213: Analytical Chemistry I (2 units, LH 30, PH 20)**

**Senate- approved relevance**

Training of high-quality graduates that are well skilled and knowledgeable in handling and analysing chemical data as it relates to Geology in line with BUK’s mission to address African developmental challenges.

**Overview**

This course covers the areas of analytical chemistry that include chemical methods of analysis such as volumetric and gravimetric data analyses. The chemistry programme is designed to enable graduates acquire broad based knowledge on statistical treatment, sample collection and processing.

The course is designed to give students a broad understanding of analytical chemical techniques to prepare them for mineralogy, crystallography and geochemistry.

**Objectives**

This chemistry course is specifically designed to:

1. teach student fundamentals of chemistry and its applications;
2. highlight to the students a broad and balanced base of chemical analytical skills;
3. expatiate on a wide range of chemical analytical skills that are required for geological studies and research;
4. explain to the students the application of chemistry in the geochemical exploration of rocks and minerals;
5. highlight to the students the application of analytical techniques of Chemistry to mineralogy, crystallography and geochemistry, and

**Learning Outcomes**

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

1. explain analytical processes which include description of chemist as a problem solver;
2. describe and differentiate forms of error;
3. explain its implication on laboratory analysis;
4. state different statistical tool use in treatment of data;
5. solve practical problems using the statistical tools;
6. define sampling and give reasons for sampling in field work;
7. state and describe different sampling techniques;
8. state different forms of sample collection and processing;
9. describe volumetric method of analysis and solve some practical problems; and
10. describe gravimetric method of analysis and solve some practical problems.

**Course Contents**

Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis. Presentation and physicochemical methods. Optical methods of analysis; separation methods.

**Minimum Academic Standards**

Software’s with NUC-MAS requirement facilities

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK-GEY204: Optical Mineralogy (2 units, LH 30, PH 20)**

**Senate- approved relevance**

This course introduces students to the study of rocks and minerals using transmitted and reflected microscopes to cover rock relationships in the exploration and exploitation of abundant solid mineral resources of the North-western Nigeria in line with BUK’s mission to address African developmental challenges.

**Overview**

Optical Mineralogy is a pivotal level two course for all core Geology students as it deals with the identification and characterization of rock samples. It covers the routine use of a polarized light microscope to study minerals and rocks under both transmitted and reflected light. Mineral and rock relationships will be studied in detail. Students will also be trained to use rock and mineral microstructures and textures to interpret geological relationships.

The knowledge to be acquired include understanding the concepts of light interaction with minerals, relating crystalline internal order and symmetry to external crystallographic form, description of the basic optical properties of minerals, recognition of optical properties of the common rock-forming minerals by means of a standard polarizing microscope, and the relationship between mineral properties and their paragenesis and provenance. Therefore, students will have the skill to operate a polarizing microscope in the study of minerals and rocks in thin sections, demonstrate familiarity with common minerals including predicting mineral properties using knowledge of crystal structures, interpret mineral and rock textures, and demonstrate the ability to communicate research from practical observation.

**Objectives**

The objectives of the optical mineralogy course are to:

1. explain to the students the techniques of rock samples identification and characterization;
2. highlight to the students how they can routinely use a polarized light microscope to study minerals and rocks under both transmitted and reflected light;
3. expatiate on a range of transferable skills relating to the description of the basic optical properties of minerals, and recognition of optical properties of common rock-forming minerals;
4. explain to the students how they can use their basic knowledge and skills in optical mineralogy for

further studies in specialized areas of mineralogy and crystallography; and

1. highlight to the students an application of optical mineralogy to elucidate the relationship between mineral properties and their paragenesis and provenance.

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Identify and describe parts of petrographic microscopes
2. Practically produce thin section
3. Identify and describe minerals in orthoscopic and conoscopic vision.
4. Describe the crystal form, size and alteration in minerals

**Course Contents**

The Polarizing microscope: parts and functions. Routine techniques: magnification, centering, crossing the nicols, vibration direction of the polarizer. Method of preparation of thin section for microscopic examination. The path of light for orthoscopic vision in the polarizing microscope. Optical properties in plane polarized light. Optical properties in crossed polarized light. Conoscopic vision; optical effects in convergent light. Introduction to reflected-light microscopy.

**Minimum Academic Standards**

Petrography laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK-GEY216: Introduction to Geology and Mineral Resources of North-western Nigeria (2 units, LH 30, PH 20)**

**Senate- approved relevance**

This course introduces students to the study of basic geology and processes that control mineral occurrences in the exploration and exploitation of abundant solid mineral resources of the North-western Nigeria in line with BUK’s mission to address African developmental challenges.

**Overview**

This course covers the processes that control the formation of ore deposits and mineral resources. Mineral resource-forming processes are examined in the framework of the tectonic, petrogenetic, and geochemical evolution of the Earth's crust on local, regional, and global geological scales. Thus, the course draws upon igneous and metamorphic processes, geochemistry, and structural geology.

The course also introduces geochemical techniques that can be applied to the detection and mapping of mineral resources and quantifying the environmental impact of mining. Practical work emphasizes the mesoscopic recognition of ore minerals and textures in both hand samples and drill core and the methods of data collection presentation and analysis of geochemical data in mapping ore deposits.

**Objectives**

The objectives of this course are to:

1. highlight to the students a wide-ranging and balanced foundation on the formation of ore deposits and mineral resources;
2. explain to the students in mode of formations of wide range of mineral resources;
3. expatiate on a range of geological skills required for the description of basic optical properties of minerals, and recognition of optical properties of common rock-forming minerals;
4. teach students geochemical techniques for the detection and mapping of mineral resources and quantification of the environmental impact of mining;
5. highlight to the students the ability to recognize ore minerals and textures in rock samples from North-western Nigeria, and.

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Recognize the field characteristics of alkaline and calc-alkaline rocks in north-western Nigeria.
2. Locate and describe major crystalline rock types and structures in north-western Nigeria
3. Recognize the location of mineralized zones, mines and quarries in north-western Nigeria.
4. Describes the geology of Cretaceous and Tertiary sequences in north-western

**Course Contents**

Broad outline of the bedrock of North-western geology of Nigeria. Distribution of crystalline basement and sedimentary basins and associated major minerals occurrences and reserves.

**Minimum Academic Standards**

Petrology laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK- GEY 215: Environmental Geology and Mineral Resources of North-western Nigeria (3 units, LH 45, PH 20)**

**Senate- approved relevance**

This course trains students to efficiently and sustainably explore Nigeria’s mineral resources, taking into consideration potential environmental pollution, geological hazards and mitigation measures in line with BUK’s mission to address African developmental challenges in tandem with SDGs’ goal number 15 of environmental protection and biodiversity.

**Overview**

The course will study the interaction between the geosphere, hydrosphere, atmosphere, biosphere, and human activities. It also covers the interaction of humans with all aspects of the environment – physical, atmospheric, and biological. The course entails study of the environmental impact of mineral exploration activities, including areas of environmental management and regulations, pollution and contamination remediation.

The course relates to the implication of sustainable mining in North-western Nigeria and mitigation measures to prevent adverse consequences on the environment. It also provides an overview of the sustainability of minerals as a critical resource for the region. Pollution and its sources and control will also be taught, in addition to the prediction and control of geologic hazards such as landslides, flooding, earthquake, desertification.

**Objectives**

The objectives of this course are to:

1. explain to the students how to identify and describe geologic hazards;
2. expatiate on the major mineral resources in North-western Nigeria
3. explain to the students how to classify, quantify and report the major mineral resources in North-western Nigeria
4. highlight to the students the of surface and underground water hydrology of North-western Nigeria
5. describe to the students how to develop mitigation measures for potential geological hazards;

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Identify and describe geological hazards and suggests mitigation measures
2. Identify and describe the major mineral resources in North-western Nigeria
3. Identify environmental pollution and suggest mitigation measures
4. Understand how environmental geological processes impact humans and society
5. Understand how anthropogenic activities modify natural environmental processes

**Course Contents**

Elementary geology, distribution and utilization of metallic and non-metallic mineral resources, and energy resources. Fossil fuels; surface and underground water hydrology. Pollution and its sources, hazards, and control. Prediction and control of geologic hazards. Significant and potential mineral resources of Nigeria: Energy (hydrocarbons, coal, uranium); Metallic (tin, tantalum, niobium, gold, lead-zinc, chromium; Non-metallic (limestone, dolomite, clays, sand-aggregates, feldspars, laterites, barites, evaporates, gemstones).

**Minimum Academic Standards**

Petrology laboratory with NUC-MAS requirement facilities

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK- GEY 214: GIS Application in Geosciences (2 units, LH 30, PH 20)**

**Senate- approved relevance**

This course trains students on the application of GIS softwares in the delineation of earth resources inline with BUK’s mission to address African developmental challenges in tandem with Federal Governments’ initiatives on the diversification of Nigeria’s economy.

**Overview**

Geographic information system (GIS) is an effective tool in geological mapping as the technology provides advanced capabilities in spatial analysis and visualization of surface and subsurface geological and geophysical data.

These analysis and visualization capabilities help with efficient and effective evaluations of prospects in potential zones and alteration signatures. Mapping is a central function of the Geographic Information System, which provides a visual interpretation of data. Students will digitize maps of any area with precise and desired scales to aid accurate measurements. GIS stores data in a database and then represent it visually in a mapped format.

**Objectives**

The objectives of this course are to:

1. describe to the students the storage, visualization, analysis and interpretation of geographic data
2. explain to the students how to the use GIS to develop geological maps
3. explain to the students the fundamental of digital cartography and geocoding
4. highlight to the students on the application of GIS for detection of potential zones of mineralization
5. teach students to be proficient in the use of relevant GIS software packages

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Understand the fundamental concept of GIS techniques
2. Use GIS to solve geoscience-related problems
3. Understand the application of GIS in delineation and exploration of strategic earth resources
4. Use GIS to produce geological maps and cross-sections

**Course contents**

A broad introduction to geodatabase, component of GIS and the use of GIS within the geosciences; exposure to both pertinent computer and analytical skills common in GIS; digital cartography and geocoding; application of GIS in solving geosciences-related problems including exploration of strategic earth resources.

**Minimum Academic Standards**

GIS laboratory with NUC-MAS requirement facilities

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK- GEY303: Igneous and Metamorphic Petrology (3 units, LH 45, PH 20)**

**Senate- approved relevance**

This course introduces students to the study of basic petrogenetic processes associated with crystalline rocks that host major metallic and non-metallic mineral resources of North-western Nigeria in line with BUK’s mission to address African developmental challenges.

**Overview**

The course describes igneous phase diagrams and mineral phase relationships. This theoretical knowledge is put in use to explain the melting and crystallization of magmatic liquids and portrays these processes in various magmatic environments related to plate tectonic on Earth.

Subsequently, the course will introduce metamorphic petrology, metamorphic textures, and nomenclature, familiarize with the interpretation of metamorphic phase diagrams, and discuss the metamorphism of different rock types and in different geodynamic settings. Fundamental principles of geothermobarometry, reactive fluid flow, and hydrothermal mineral deposits will be discussed in the final part of the course. The theoretical lectures will be accompanied by practical exercises including petrological observations in thin sections of selected samples, CIPW norms, and simple igneous and metamorphic phase diagrams.

**Objectives**

The objectives of this course are to:

1. highlight to the students the geological processes in various magmatic environments related to plate tectonics;
2. explain to the students the petrology, textures, and nomenclature of igneous and metamorphic rocks;
3. expatiate on a range of geological skills required for the interpretation of metamorphic processes and metamorphism in different geodynamic settings;
4. teach students how they can use of petrological techniques to identify metamorphic facies of crystalline rocks;
5. describe to the students how to recognize ore minerals and textures in rock samples,

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Describe characteristics of igneous and metamorphic structures
2. Classify igneous and metamorphic rocks
3. Use phase diagram/phase equilibria to constrain the origin and evolutionary processes of igneous and metamorphic rocks
4. Identify metamorphic facies of crystalline rocks
5. Describe textures of igneous and metamorphic rocks.

**Course Contents**

Magma; Types, composition, physical and chemical properties. Extrusive and intrusive igneous processes and products. Magma evolution types and trends. Volcanic and plutonic igneous structures. Classification of igneous rocks (IUGS System). Association of igneous rocks in space and time. Basalts; mineralogy, petrology and origin with Nigerian examples. Classification of alkali olivine basalts and tholeiites. Layered basic intrusions and associated rock. Ultramafic rock associations. Granites; mineralogy, petrology and origin. Phase equilibria and binary phase diagrams. Older and Younger Granites of Nigeria. Petrography of the major rock groups; granites and associated rocks, gabbro, peridotites, pyroxenites, basalts and undersaturated rocks.

Factors of metamorphism, Geological classification of metamorphism. Most important minerals of metamorphic rocks. General nomenclature of metamorphic rocks. Metamorphic textures. Important metamorphic reactions. Grubemann’s metamorphic depth zones. Mineral zones of contact aureoles in calcareous, basic and pelitic rocks. Mineral zones and isogrades in regional metamorphism. Concepts of basic types of metamorphism and metamorphic facies. Summary of progressive mineral changes in metapelites, metabasites and metamorphic calc-silicate rocks. Igneous rock associations related to regional metamorphism with examples from Nigerian Basement Complex.

**Minimum Academic Standards**

Petrology laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK- GEY 317: Georesources Exploration and Characterization (3 units, LH 45, PH 20)**

**Senate- approved relevance**

This course trains students to utilize geological and geochemical techniques in the exploration of Nigeria’s conventional and unconventional georesources in line with BUK’s mission to address African developmental challenges in tandem with Federal Governments’ initiatives on the diversification of Nigeria’s economy.

**Overview**

Knowledge in research and identification of geological resources through integrated methods of geological exploration and skills for planning and execution of exploration campaigns. In this sense, the students should: identify the phases of exploration in context; list the following tasks to develop in each exploration phase; identify select, and execute exploration techniques to be used, estimate and justify the economic potential of the targets; determine the prospecting techniques to be used in subsequent phases. Also, apply the knowledge of mineral deposits and geochemistry to plan and propose the use of techniques in prospecting campaigns to specific fields.

The students should be able to describe the natural form and occurrence of resources in Earth’s crust and explain the processes of formation of different ore deposit types. They should also be able to describe geological and geochemical methods of exploration and discuss the importance of resources for society

**Objectives**

The objectives of this course are to:

1. explain to the students how to carry out interpretation of geochemical data and maps for mineral exploration
2. describe to the students the geological and geochemical methods requisite for exploration and exploitation of georesources
3. highlight to the students the geochemical methods in mineral exploration
4. expatiate on the primary and secondary geochemical halos and their application in mineral exploration
5. highlight to the students the fundamental processes that underpin the formation of geothermal resource

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Describe the natural form and occurrences of resources in the Earth crust
2. Evaluate geological and geochemical methods of exploration of earth resources
3. Understand how to interpret geochemical data and maps
4. Identify and describe primary and secondary geochemical environment and their related dispersion halos
5. Understand the basic concept of geothermal resource

**Course Contents**

Occurrences, distribution and characterization of earth resources; geochemical exploration methods; controls and element distribution in relation to ore genesis; primary and secondary geochemical environment; geochemical dispersion halos and their application in mineral deposits exploration; application of stable and radiogenic isotopes; interpretation of geochemical data and maps. Introduction to geothermal resource.

**Minimum Academic Standards**

Geochemistry laboratory with NUC-MAS requirement facilities

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK- GEY401: Advanced Igneous petrology (2 units, LH 30, PH 20)**

**Senate- approved relevance**

This course enables students to develop evidence-based reasoning from mineralogy and chemistry of igneous rocks to determine their evolution in line with BUK’s mission to address African developmental challenges with regards to the exploration and exploitation of Nigeria’s mineral resources.

**Overview**

This course will examine a variety of petrologic and petrographic tools useful for unravelling the petrogenesis of igneous rock suites. The course will cover geochemical modelling, but will concentrate on what can be learned from phase equilibria and the application of modern petrographic techniques. Ideally, these results would be combined with more standard geochemical modelling techniques to place quantitative constraints on petrologic processes.

It covers the history of and recent developments in the study of igneous rocks. Students review the chemistry and structure of igneous rock-forming minerals and proceed to study how these minerals occur and interact in igneous rocks. The course focuses on igneous processes and how we have learned about them through studying a number of significant sites worldwide

**Objectives**

The objectives of this course are to:

1. highlight to the students the geological processes in various magmatic environments related to plate tectonics;
2. expatiate on the variety of petrologic and petrographic tools useful for unravelling the petrogenesis of igneous rock suites;
3. discuss the study and application of phase equilibria and modern petrographic techniques to constrain magma types and evolutionary trends;
4. highlight to the students’ students on the use of geochemistry and radiogenic isotopes to determine the petrogenesis and evolutionary processes of igneous rocks;
5. teach the students to be experts in the use of experimental petrology for mineral exploration

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Identify calc-alkaline and alkaline rocks associations as well as volcanic and plutonic rock series
2. Use elemental geochemistry and radiogenic isotopes to constrain the origin and evolutionary processes of igneous rocks
3. Use Binary and Ternary phase diagrams to constrain magma types and evolutionary trends.
4. Understand the basic concept of experimental petrology.

**Course Contents**

Introduction to the concepts of experimental petrology and the use of phase rule, including simple problems in phase diagrams. Simple binary and ternary system of petrological significance. Petrographic provinces. Chemical variation in associated igneous rocks. Introduction to the construction and use of chemical variation diagrams. Minor elements and isotopes in igneous rocks. Mineralogical and chemical compositions and variations, chemical affinities, modes of occurrence, origin, crustal environment and petrogenesis of calc-alkaline rocks association; plutonic and volcanic rocks series, andesites and anorthosite complexes Alkali rock types (including carbonatites); mineralogy, magmatic affinities. Structure of Carbonatite complexes, petrogenesis. Pyroclastic rocks and rhyolites, pyroclastic fall and ashflow deposits.

**Minimum Academic Standards**

Petrology laboratory with NUC-MAS requirement facilities.

**Bayero University, Kano (BUK)**

**Earth and Environmental Science**

**Department of Geology**

**B.Sc Geology**

**BUK- GEY403: Advanced Metamorphic petrology (2 units, LH 30, PH 20)**

**Senate- approved relevance**

This course enables students to develop evidence-based reasoning from mineralogy and chemistry of metamorphic rocks to determine their evolution in line with BUK’s mission to address African developmental challenges with regards to the exploration and exploitation of Nigeria’s mineral resources.

**Overview**

Metamorphic petrology covers the chemical and physical work done in natural systems in response to changing physical conditions. Petrogenetic processes such as recrystallization, continuous and discontinuous reactions, mixed volatile reactions, and deformation are addressed.

The principles of metamorphic petrology are then applied to a number of orogenic events through geologic time, and modern advances in research in metamorphic petrology are explored.

**Objectives**

The objectives of this course are to:

1. explain to the students the detailed metamorphic processes;
2. highlight to the students on the application of petrologic and petrographic tools to unravel the textural and compositional changes in mineral assemblages due to metamorphism;
3. teach the students to be experts in the use of experimental petrology for mineral exploration
4. discuss the study and application of phase equilibria and modern petrographic techniques in metamorphic petrology
5. explain to the students the fundamental techniques that are applicable to the exploration and exploitation of mineral ore deposits that occur in metamorphic facies of crystalline rocks

**Learning outcome:**

**At the completion of the course the students should be able to:**

1. Identify paired metamorphic belts
2. Describe the effect of pressure, temperature and fluids action during metamorphism
3. Use phase rule and paragenetic diagrams to understand changes in mineral assemblages during metamorphism
4. Describes chemical reactions and compositional changes during metamorphism.

**Course Contents**

Metamorphic reactions. Behaviour of fluids in metamorphism. Equilibrium curves. Effect of P–T relations of metamorphic reactions on mineral assemblages. Element distribution in coexisting minerals. Compositional changes in solid-solution minerals during metamorphism. Significance of isogrades. Phase rule and diagramatic representation of mineral paragenesis. Paired metamorphic belts. Distribution of metamorphic facies.

**Minimum Academic Standards**

Petrology laboratory with NUC-MAS requirement facilities.