Department of Metallurgical & Material Engineering
Ahmadu Bello University Zaria
The Course Description Mining Engrineering

100 LEVEL

MATH 101: SETS AND NUMBER SYSTEMS **(2 Credit Units)**
Elements of set, universal set, empty set, etc Cartesian product; Finite and infinite sets; Venn diagram; Cardinal number, power set, Disjoint set, etc. Relation, mapping and functions; Binary operation, Structure of number system.

MATH 103: TRIGONOMETRY AND COORDINATE GEOMETRY (**2 Credit Units**)
The trigonometry functions, Special angles, inverse trig functions, identities. Additions formulae for trig functions, Trigonometric functions of multiple and half angles, the Factor formulae. The sine rule, heights and distances. Systems of coordinates; Cartesian coordinates. Lengths parallel to the axis, Gradients, and Division of a line in a given ratio. Equation of a straight line: Gradient and one point form, General equation, the Point of intersection, Line through the mid points of two lines, parallelism, etc. The Circle: Equation, etc.

MATH 105: DIFFERENTIAL AND INTEGRAL CALCULUS **(2 Credit Units)**
Functions: Definition, Even and odd functions, Period functions, transcendental functions, Polynomial functions. Limits and continuity of functions. Graph of a function. Differentiation; Derivative, Differentiable functions. Algebraic properties of derivatives; Sum, Difference, Product Quotient and chain rules. Higher order differentiation. Integration; Definite integrals, Techniques of integration. Partial fractions.

COSC 101: PROGRAMMING IN BASIC **(2 Credit Unit)**
Basic computer concepts; problems solving on the computer; Characters, Constants and Variables. Arithmetic expressions; BASIC Statements; BASIC Function; The PRINT statement; Entering data; Transfer of control statements; Repeating or looping; Subscripted variables of the DIM statement; Subprograms; Matrix commands.

PHYS 111: MECHANICS (**2 Credit Units**)
Units and Dimensions. Vector and Scalar quantities. Linear Motion, concept of force. Work, energy and power, Circular motion, Simple harmonic motion. Motion of a rigid body. Static, Gravitation.

PHYS 131: HEAT AND PROPERTIES OF MATTER (**2 Credit Units**)
Structure of solids, liquids and gases. Kinetic theory of ideal gases Elasticity, Surface tension. Fluids in motion, Solid friction and viscosity, Heat and temperature, Calorimetric. Thermal extension. Transfer of heat.

PHYS 161/162: GENERAL PHYSICS PRACTICAL I/II **(1 Credit Unit each)**
The introductory courses emphasizes quantitative measurements, treatment of measurement errors and graphical analysis. A variety experimental techniques will be employed. Simple experiment in mechanics, properties of matter, heat, light, and electricity are emphasized, which are relevant to the course PHYS 131, 122 and 124.

CHEM 121: INTRODUCTION TO INORGANIC CHEMISTRY (**2 Credit Units**)
Periodic table (gradation of physical and chemical properties within the table, the first transition elements series, comparison of chemistry of the elements of periods II and III); transition metal complexes (nomenclatures, isomerism and hybridization involving orbital).

CHEM 191: INTRODUCTORY PRACTICAL CHEMISTRY I (**1 Credit Unit**)
Basic apparatus; terminologies; safety regulations; basic working skills in the chemical laboratory; acid-base titration; redo titration; weighing and gravimetric analysis.

ENGG 101: ENGINEERING PROFESSION AND INSTITUTIONS (**1 Credit Unit**)
Development of Professional engineering: History of technology and its effect on society. The engineering institutions, their objective all functions. Data measurement, representation and interpretation, report writing and oral representation of information introduction to Economic; Elementary economic concepts; evolution of economic activity; characteristics of modern economic systems.

GENS 101: NATIONALISM (**1 Credit Unit**)
The concept of a national Nationalism: Concept, Significance and History; Nigeria: Cultural diversity, Unity, Consciousness, Identity, Influence of foreign culture; Patriotism; Concept, Significance, examples, Basic and characteristics of nationalism and patriotic spirit in Nigeria; Approaches to nationalism and patriotism.

GENS 103: ENGLISH AND COMMUNICATION SKILLS (**2 Credit Units**)
Listening-comprehension; Listening for specific information, Words and expressions, Main idea. Note taking from lectures; Listening for critical analysis; Reading; Skimming and scanning; Reading for speed; Intensive reading; Note taking from texts; Summarization and Synthesis of Science and Technology, English for arts and social sciences, English for Administrative and Business Studies; English for Law, English for Medical and Paramedical Science; The peculiarities of the course are those of specific registers and pattern of structural discourse.

CHEM 112: INTRODUCTORY PHYSICAL CHEMISTRY (**2 Credit Units**)
States of matter; kinetic theory, colligative properties; structure of solids; crystal lattice structures; thermochemistry; chemical kinetics of first and second order reactions; chemical equilibrium; Buffer solution; hydrolysis constants and solubility products; and electrochemistry.

MATH 102: ALGEBRA (**2 Credit Units**)
Principles of Mathematics induction: Application to sequences and series. Linear, Quadratic and other Polynomial function; the meaning of /X/. The modulus of real number X Elementary properties of quadratic functions; roots of quadratic equations. Application to symmetric functions, Polynomial functions of 3rd and 4th degrees provided they can be reduced to a quadratic or factorized by the reminder theorem. Theory of indices and Logarithms surds: Solution of simple exponential and Logarithmic equations, change of base; Partial Fractions: Application to summation of series and integration; Sequences and series: Limits of sequences (Rigorous treatment not required). Convergence of series: Illustration by simple examples of convergence of geometric series and series obtained by the partial fractions and the binomial series; Permutations and Combination: Simple examples. The Binomial Theorem and its proof for a positive integral

index. Use of the binomial theorem for any rational index; interval of convergence. Applications to approximations and errors. Series expansions for e^k for all x and $\ln(1+x)$ for $-1<x<1$.

MATH 104: CONIC SECTIONS AND APPLICATIONS OF CALCULUS **(2 Credit Units)**
Parabola. Ellipse. Hyperbola. Rectangular hyperbola: Focus-directrix properties, Cartesian and parametric equations, Applications. Determination of locus of a point. Equations of tangents and normal to the conic section, the derivative as rate of change: Velocity, Acceleration and other rates, Curve sketching: Maxima and errors, Newton's approximation. Applications of integration to area and volume determination. Introduction of differential equations: First order differential equations; existence and uniqueness of the solution.

MATH 106:   VECTORS **(2 Credit Units)**
Motion of a vector. Position vector, Modulus of a vector, etc Algebra of vectors; Addition, Parallelogram law, Triangle law, etc Scalar product: Components of a vector as its scalar product with a unit vector in a given direction. Applications to finding the angles between two lines and other geometrical applications.

STAT 102: INTRODUCTION TO STATISTICS   (**2 Credit Units**)
Stem and leaf charts; frequency distribution tables; Graphical displays, Measures of central tendency and dispersion. Frequency distribution. Discrete sample space, events; probability. Random variables. Binomial, Poisson and Normal distributions. Bivariate data. Correlation.

PHYS 122: ELECTRICITY, MAGNETISM AND MODERN PHHYSICS
(**2 Credit Units**)
Electrostatics; Capacitance; Current Electricity; Magnetic force; Magnetic effects of currents; Electromagnetic induction; Alternating currents. Modern Physics; electronics.

PHYS 124: GEOMETRIC AND WAVE OPTICS (**1 Credit Units**)
Reflection and refraction; the prism: Lenses and their construction; Spherical mirror; Dispersion and the spectrometer, Optical instruments. Wave nature of light.

CHEM 132: INTRODUCTORY ORGANIC CHEMSITRY (**2 Credit Unit**)
Scope of organic chemistry; types of organic compounds and determination of molecular formulae, alkenes, alkanes, alkynes and simple aromatic compounds; types of organic reactions; phenols; carbonyl compounds; carboxylic acids; and carbohydrates.

CHEM 192: INTRODUCTORY PRACTICAL CHEMSITRY II (**1 Credit Units**)
Qualitative analysis of inorganic anions and cation; Organic qualitative analysis.

GEOL 102:   INTRODUCTION TO MINERALOGY AND PETROLOGY (**1 Credit Units**)
Definition of minerals and rocks. Introduction to crystals and crystal systems. Classification of minerals based on composition: Native Elements, Sulphides, Oxides, Carbonates, Sulphates, Phosphates and Silicates etc. The use of physical properties in minerals identification. Classification of rocks based on origin. Modes of occurrence, composition and textures of the major igneous, metamorphic and sedimentary rock types.

MIME 102: HISTORY OF MINING IN NIGERIA **(1 Credit Unit)**
Definition of minerals; Types of minerals mined [cassiterite (tin ore), columbite, coal], Sources of

minerals mined, Tin Ore: Traditional mining, ore trading, traditional tin smelting, exploration of the plateau for tin, Development of commercial tin mining; Commercial Mining, Processing and Smelting of tin; Uses of tin - Traditional (Benin bronze, musical instruments, Cooking wares) and industrial (tin plate, tin coating, tin alloys). Coal: Locations found, Mining and processing of coal, Uses of coal.

GEOL 106: INTRODUCTION TO PALAEONTOLOGY AND STRATIGRAPHY (**1 Credit Units**)
The meaning of fossils and fossilization. General taxonomical classification of fossil groups. Relative and absolute age determinations; stratigraphy and stratigraphic column. Origin and brief history of life on earth and earliest records of life. Protozoans and Metazoans: their characteristics and taxonomy. Index fossils and fossils records; their application to stratigraphy, paleoecology and paleogeography.

200 LEVEL:

MATH 241: CALCULUS I (**3 Credit Units**)
Sequences and Functions: Infinite sequences and their limits, a short recollection of elementary functions and their properties, limits and continuity of functions of a single independent variable. Differential Calculus: Definition of the derivative. Differentiability of a function of one independent variable; geometrical and physical interpretation of the derivative, techniques of differentiation, Rolle's theorem and the mean-value theorem, Taylor and Maclaurin's series expansion, application of differentiation; maxima and minima of function of single independent variable, curve sketching in Cartesian rectangular coordinates, L'Hospital rule for evaluation of limits of functions in the indeterminate forms, tangents and normals, curvature and evolutes of plane curves, Leibniz's formula, for finding the nth differential coefficient of a product of two functions.
Integral calculus: Indefinite integral, techniques of integration – change of variable, integration by parts and reduction formulae, integration of rational functions (standard integral and methods of partial fractions), the definite integral interpretation and properties; application of integral, average value of a function, finding lengths of area, plane areas, volumes of solids revolution area of surface of revolution, pressure, etc.

MATH 243: METHODS OF LINEAR ALGEBRA I (**2 Credit Units**)
Complex numbers: Addition, multiplication, division, argand diagram, polar representation, DeMoivre's theorem, Vector Algebra: Definition of Vector and Physical examples, addition, multiplication by scalar, scalar and vector products, triple products, components and applications in geometry, Vector Analysis: Cartesian and polar coordinates in two and three dimensions. Vector functions of a real variable, continuity and differentiation, application to curves and surfaces in 3 space equation of straight lines, plane and sphere, tangent and normals to a curve, tangent plant and normal to a surface.

EEEN 201: ELECTRICAL CIRCUITS AND FIELD THEORY (**2 Credit Unit**)
Field Theory: *Electric*: Electric charges, Coulomb's Law, Gauss" Law, Electric field, Electric dipoles, potentials, capacitance, work energy. *Magnetic:* Magnetic forces between current elements, Biot-Savart Law, Ampere's Law, Lenz's Law, Lorentz Law, Motor principle, Generator principle, Work Energy.

EEEN 203: ELECTRICAL MACHINE, POWER AND INSTALLATION (**2 Credit Units**)
Transformers and Rotating Machines: Basic Principles: Induction (Faradays Law), interaction (Biot-Savart Law), and alignment, Generalized Basic Units, Magnetic, electrical, mechanical and thermal. Generalized torque equation of electric machines and simple calculations, transformer, Constructional features, types, connections (including 30phase type and application of various types, (DC Machines: Constructional features, types (separately excited, shunt, series and compound), and application. *Introduction Machines:* Constructional features, types (single phase and 3-phase), types of rotor (squirrel cage and wound or slip-ring) and application. *Synchronous Machines*: constructional features, types (salient or non-salient poles types), and application. Brief Introduction and Application of Special Machines: A.C. commutator machines, general purpose machines, repulsion machine, linear motors, etc.
Electric Power Generation, Transmission and Distribution: Types of Power stations, Power generation and transmission problems (flow diagram representation from generator to consumer terminals). The synchronous generation and its importance in power generation (from small types) in motor cars to huge types in power stations.
Transmission of electric power: The H.T overhead lines and underground cables (show typical underground cables). The distribution transformers in power distribution and their use in the design of estates a.c. and d.c. supplies. The use of a.c. in preference to d.c. stressing the importance of the transformer. Single and three phase supplies; (delta and star connections); typical 3-phase, 4-wire distribution systems. Two wire services and typical consumer circuits. The meaning of impedance (X), volts (V), power ohms and power factor (PF) in a.c. supply systems.
Wiring System: Supply control and distribution in building including, intakes, diversity, wiring circuits for lightning using loop methods, number of points on one circuit, wiring socket outlets. Conductors and cables including: main parts of cables, types of insulators and the choice of cable sizes in various types of installations. Wiring systems including: Conduct systems, rubber and PVC soothed systems; components and accessories used in wiring systems, ceiling roses, lamp holders, switches, etc.
Safety Precaution Including, the need for safety, the use of circuit breakers, and fuses, and the importance of earthling. Illumination: Principle of illumination, definition of terms and the inverse square law, Glare and its effects. Types of lamps and lamp fittings; Principles of lighting design and illumination requirement for various types of usual tasks.

CVEN 201: FUNDAMENTALS OF STRUCTURAL ANALYSIS (**2 Credit Units**)
Concept of structural analysis, Stability and determinacy of frameworks, Analysis of statistically determinate structures, Bending moment and shear force diagrams for determinate beams. Beam deflection. Framework deflections and strain energy in frames, Suspension cables. Determinate arches, stability of gravity sections.

MEEN 201: ENGINEERING GRAPHICS   (**2 Credit Units**)
The principles of engineering drawing, engineering lettering, figures and types of line (BS 308 – 1972, Part 1, 2, 3), dimensioning, useful geometrical constructions, principles of tangency, loci-conk sections (ellipse, hyperbola, parabola); cycloids, epicycloids involutes, helices, orthographic project (1st and 3rd angle orthographic projection).

MMEN 201: FUNDAMENTALS OF MATERIALS SCIENCE (**2 Credit Units**)
Physical properties of materials: Structure of atoms, bonding forces, structure of matter, including mention of wood, cement and plastic. Electrical properties of materials: electrical properties,

conductors, electronic properties, semi and super-conductors, magnetic properties, dielectric properties. Mechanical properties: Elastic plastic deformation of materials, Temperature effects on mechanical properties, Fatigue, Creep, Hardness, Mechanical working. Thermal properties: Thermal capacity, thermal expansion, thermal conductivity, thermo-couple phenomenon, temperature consideration in the choice of materials. Chemical properties of materials: corrosion phenomenon and its prevention. Metallurgy: structure of crystalline materials, solidification, mechanical working, liquid and solid solution, interution to the concepts of phase and solid solutions, introduction to the concept of phase equilibrium, micro and macro-structure of materials. Non-metallic materials: Cement, concrete, wood, Ceramics (Glass, ceramic ware), Plastic (Wood, Rubber, etc) and resin.

WREN 201: FLUID MECHANICS I (**2 Credit Units**)
Properties of Fluid: Pressure, viscosity, surface tension, compressibility etc. Hydrostatics: Variation of pressure with position in a fluid, equilibrium of a fluid of constant density, measurement of pressure, barometer, manometer, the Bourdon gauge, thrust on plane and curved surfaces, buoyancy, stability of floating and submerged bodies.
Principles of Fluid Motion: Continuity, Bernoulli's equation, energy transformation in a constant density fluid, energy correction factor, streamlines, pressure variation perpendicular to streamlines, flow through a sharp edged orifice, pilot tube, venture meter, nozzle and orifice meter, notches and sharp crested weirs.
Momentum Equation: Momentum equation for steady flow, momentum correction factor, application of the momentum equation, force caused by a jet striking a surface, force caused by flow round pipe bend, force at a surface at a nozzle and reaction of a jet under short wheel as an example of a simple hydraulic machine.

GEOL 203: CRYSTALLOGRAPHY (**2 Credit Units**)
Definition of crystal; crystallization. Internal structure of crystals. Relationship between internal order and morphology. Crystallographic axes, crystal systems, geometric operations, symmetry elements, crystal forms, crystal classes. Interfacial angles, parameters, axial ratios and Miller indices. Bravais Law, Steno's Law and Law of Rational Indices. Zones and Zone axes. Twinning; origin, Laws and importance. Spherical and stereographic projection. Constituents of crystals; isomorphism, polymorphism and pseudomorphic. Graphic representation of composition Variations. Physical properties of minerals and the relationships to composition and internal structure. Physical properties of crystals dependent on heat, electricity, magnetism and radioactivity. Practical identification of crystallographic axes, symmetry elements, forms, zones and zone axes, of common basic crystal systems/classes. Measurement of interfacial angles. Determination of axial ratio and Miller indices. Stereographic projection plotting.

GEOL 205: FIELD GEOLOGY I (**1 Credit Units**)
Field study of weathering, Soil Formation, Erosion and Sedimentation Processes. Examination in the field of igneous and metamorphic rocks, sediment, associated structural and other features including land forms. Preparation of field notes and reports. Use of topographic maps in the field. Geological mapping; techniques at large and small scale. Preparation of simple field geology map (e.g. BZ Water Tower).

CHEN 202: INTRODUCTION TO ENGINEERING MANAGEMENT (**1 Credit Units**)
Introduction (definition, uses and types of organization, need for management, the manager and

his functions): planning, decision making, organizing, directing and leadership (motivation, communication and leadership), control.

MEEN 202: ENGINEERING DRAWING (**2 Credit Units**)
Isometric projection; free hand sketching, sections and sectional views, auxiliary projections, interpretation of surfaces, development of surfaces, screw threaded and threaded screwed fastenings, conventional representation on the threaded elements on drawing.

MEEN 204: STRENGHT OF MATERIALS (**2 Credit Units**)
Direct stress and strain: tension, compression. Hook's law elastic constants, strain energy, impact load, thermal stress. Geometrical properties of areas: centroid, first and second moments of area, parallel axis theorem, product moment of area, cross sections having and not having axes of symmetry. Simple theory of bending: Classification, bending moment and shear force diagrams, relations between bending moments, shear force and load, bending stress section modulus, strength requirements, combined bending and tension/compression, eccentric loading, unsymmetrical bending, compound bars deflection of beams. Simple shear force: Shear stress, shear strain, Hooke's law technical shear. Torsion of circular cross-sections: Torque diagram angle of twist, shear stress due to torsion, transmission to power by shafts, helical springs. Special problems statistically indeterminate problems, thin cylinders and spheres under pressure.

MEEN 206: FUNDAMENTAL OF DYAMICS (**2 Credit Units**)
Kinematics of particles: rectilinear motion, plane curvilinear motion, appropriate choice of reference frame in solving problems, Relative motion, translating axes. Kinetics of particles: Newton's second Law of motion, Work and Kinetic energy method for deriving equations of motion, Impulse and momentum. Kinetics of systems of particles: Defining equations, Steady mass flows, Variable mass problems, Plane Kinematics of rigid bodies; Absolute motion, Relative Velocity, Instantaneous centre of zero velocity, Relative acceleration. Plane kinetic of rigid bodies: General equation of motion, Translation, Fixed-axis rotation. General planed motion, Work energy relations, Impulse and momentum equations for rigid bodies.

MEEN 208: BASIC THERMODYAMICS (**2 Credit Units**)
Dimensions and Units: (S.I. Units to be introduced): Fundamental concepts: Energy i.e. Potential, Kinetic, internal; property, state, process and cycle system and surroundings; pressure; temperature, Zeroth law, arbitrary nature of temperature, scales; equilibrium reversibility, heat and work. First Law of Thermodynamics: As applied to closed and flow systems, and in the cyclic and no-cyclic (process) forms, as well as in the differential form; Application to particular processes of constant volume; constant pressure, Isothermal, adiabatic, polytrophic and throttling; the flow energy equation and its application to turbines, compressors, nozzles, boilers, condensers, heat exchangers (treated as black boxes only). Second Law of Thermodynamics: Definition of heat engines, Cannot cycles, thermodynamic temperature scale, entropy (as a property). Properties of Pure Substances: Condensable fluids: T-P diagram, P-V diagrams, the two phase mixture, T-S diagram, H-S diagram, the use of property tables and diagrams. Perfect Gases: Properties of perfect gas; entropy changes in perfect gases.

MATH 242: CALCULUS II (**2 Credit Units**)
Infinite number series and their properties, test of convergence complex number series, Improper integral, Improper integral of types I, II and III. Evaluation of improper integral, convergence of

improper integral, Convergence in the Cauchy Principle value, test of convergence. Partial differentiation: partial derivatives of functions of two or three variables, total differentials and applications. Ordinary differential equations: First order differential equations with variables separable, exact equation and integrating factors; linear first order equations and those reducible to linear form, The Bernoulli equation, applications (geometrical and physical situations).

MATH 244: METHODS OF LINEAR ALGEBRA II (**3 Credit Units**)
Determinants and matrices definition and properties of the determinants, its evaluation, matrices addition, multiplication by scalar, adjugate, inverse of non-singular matrix, rank and its evaluation. Simultaneous linear equations, consistency, linear dependence, solution (including Cramer's rule) eigen values and eigen vectors, special matrices, symmetric, skew symmetric orthogonal, etc.

MIME 222: INDUSTRIAL APPLICATION OF MINERALS (**1 Credit Units**)
Role of mineral industries in national development with emphasis on developing countries, especially Nigeria; Characteristics of successful mining operations; Overview of mineral resource development; Mineral resource and production in Nigeria; Overview of significant Nigerian mineral deposits; and Control of Polution in mining and mineral processing operations.

GEOL 202: ELEMENTARY STRUCTURAL GEOLOGY (**2 Credit Units**)
The attitude of beds. Introduction to rock deformation, Horizontal, folded and faulted strata and Joints. The effect of topography on outcrop patterns. Unconformities and igneous intrusions. Foliations and lineations. Graphical and trigonometric determinations of attitudes of planes and lines. Interpretation of geological maps and sections; structures and history. Thickness and depth determinations. Outcrop and map areas.

GEOL 212: ELEMENTARY SURVEYING FOR GEOLOGISTS (**2Credit Units**)
Maps for geology; scale selection; Preparation of larger scale maps for geological mapping. Measurement of distances (horizontal and vertical); paces, tape, stepping, barometer, baseline, tacheometry, leveling, radar/light/radio/infra-red waves and calculation. Measurement of angles (horizontal and vertical) compass, clinometer, planetable/alidable, and theodolite. Methdologies, triangulation, resectioning, off-setting and gridding. Photogrammetry.

300 LEVEL:

MIME 311: MINING ENGINEERING I (**2 Credit Units**)
Rocks and minerals: origin, distribution, diagnostic features and classification. Energy, minerals and water resources. Importance of minerals to national development. Development of mining technology – Surface Mining, Underground Mining and excavations etc. Mine Surveying, and the Geographic Information Systems (GIS). Stages in the life of a mine. Unit operations in mining. Mining and its consequences. Processing and uses of minerals. Introduction to geophysical prospecting methods. Government rules and regulations in the Oil and Mineral Industry.

MIME 321: MINERAL PROCESSING I (**2 Credit Units**)
Structures and textures of Mineral and their significance in Mineral genesis and treatment. Ore analysis: Qualitative and quantitative assaying and mineralogical analysis. Basic Communition theory, Communition and liberation. Particle sizing: sizing by screening, sizing by classification. Particle size analysis. Mineral concentration techniques - heavy medium separation, magnetic,

gravity, flotation and other separation techniques including the physical and mechanical processes of agglomeration. Hydrometallurgical and Biological recovery processes. Preparation of Metallurgical mass balance: recovery and metallurgical losses. Introduction to essential laboratory experiments in minerals engineering.

MIME 313: ENGINEERING AND MINE SURVEYING (**3 Credit Units**)

Maps and plans. Reference datum, bench marks and other global references. The global positioning systems (GPS) – satellites, terrestrial total station, handheld GPS receivers, and other electronic and digital tools. Theodolite – types of theodolite, construction, adjustment and precautions. Unique difference between mining theodolite and land surveying theodolite. Measurement of areas and volumes, use of planimeter. Control measurements. Calculation of co-ordinates. Theory of errors in surveying. Chain, compasses and theodolite surveys. Triangulation. Gridding and Traversing. Level transit and measurement. Application of leveling to topographical mapping. Surveying in open cast mines. Mine survey control in supports and stability of slopes in quarry/open pit mines. Surveying in underground mine systems – control on industrial layout of underground deposits. Geometrical projections of mine rocks and other mine features. Geometrical classification of industrial and non-industrial mineral deposit. Parameters of mineral reserve estimation and methods of quantifying mineral reserve. Concept of displacement in underground mining zone. Process of displacement of mine rooks/earth surface. Factors affecting rock displacement in mineral deposit. Mine survey control on displaced mine rock/earth surface. Application of Photogrammetry and remote sensing in mining. Geographic Information System (GIS) and its application in the mineral industry. Computer application in surveying, mine planning and Field work.

MIME 315: STRENGTH OF MINE MATERIALS   (**2 Credit Units**)

Advanced topics in bending moments and shear force in beams. Theory of bending of beams. Deflections of beams. Unsymmetrical bending and shear centre. Application. Strain energy. Biaxial and triaxial state of stress. Transformation of stresses. Mohrs circle. Failure theories. Springs. Creep, fatigue, fracture and stress concentration. Materials for mine support and analysis of stresses in underground mine support systems. Failure theories and their application in mine materials for accident prevention and process optimization.

MIME 317: MINE GEOMETRY (**2 Credit Units**)

Geometry of deformation of mineral rocks. Effects of temperature pressure on deformation of mineral rocks. Spatial representation of form and structure of mineral deposit. Stress-strain relationship in faults; classification of faults; origin and classification of folds. Graphical/statistical analysis of mineral properties in a given deposit. Tectonic destruction; concept and its classification. Effects on spatial representation of structure, properties and condition of bedding of mineral deposit. Classification of mine geometry as a tool for mine planning.

MIME 391: LABORATORY COURSE WORK I (**1 Credit Unit**)

Practical exposure covering mine survey, geotechnical investigation, mining methods and mineral processing. The students are required to prepare a technical report of the entire field work and present a seminar on the field programme.

GEOL 315: GEOPHYSICS I (**2Credit Units**)

Physical properties of rocks. Concepts of Electrical potential, current density and conductivity of rocks, potential distributions in a homogenous earth and apparent resistivity. Principles, equipment, data acquisition, processing, interpretation and application of electrical (SP, resistivity, IP and EMO, gravity, magnetic, seismic (refraction and reflection) and nuclear methods of geophysical surveying.

MATH 341: DIFFERENTIAL EQUATIONS AND TRANSFORMS **(2 Credit Units)**
Exact Equations, Linear Equations of first and second order with variable coefficient, geometrical interpretation, isoclines, statement of existence theorem, series solution of differential equation with nonsingular points; definition of Bessel equation and Bessel function of the first kinds, definition of Legendre polynomials. Fourier integral and transforms, Laplace transform and its applications to the solution of differential equations.

QTYS 309: DEVELOPMENT ECONOMICS **(1 Credit Unit)**
Introduction to economics: Elementry concepts, evolution of economic activity, characteristics of modern economic concepts. Basic Economics: Economics of taxation and public expenditure, business organization, industrial concentration and government control. Location of West African industry and trade: Background of West African economy, economic planning, development problems. The banking system: Money and Capital Markets, inflation, cost-benefit analysis.

MIME 312: DRILLING AND BLASTING **(2 Credit Units)**
Rock characteristics affecting drilling - engineering properties of rock material rock drillability and blastability. Classification of drilling and penetration methods. Theories of rock penetration. Rotary, percussive, rotary-percussive and thermal drilling. Drill bits and their applications. Diamond drilling and Core recovery. Basic parameters affecting bench drilling (bench height, burden, spacing and drilling pattern). Choice of drilling equipment. Drilling components manufacturing process (drilling rods, bids, coupling, pistons etc.). Handling and maintenance of drilling equipment. Definition of explosives. Brief history of explosives. Terminology and definition – velocity of detonation, density, detonation pressure, sensitivity, strength, and water resistance, fume characteristics. Properties and classification of explosives – dynamites, ammonium nitrate and fuel oil (ANFO) Cracking agents. Explosive accessories. Magazine construction. Blasting methods and practices in surface and underground workings. Blasting patterns; special blasting techniques – smooth, presplitting, secondary blasting procedure. Disturbances created by blasting. Applications in dimension, aggregates, water well, water works, hydropower, road works, railways, pipelines, built-up areas etc under water blasting, underground blasting (tunneling, shafts, Chambers).

MIME 314: ROCK MECHANICS **(2 Credit Units)**
Introduction to Rock Mechanics – Definition of terms and importance of rock mechanics; field applications in Mining, Civil and Petroleum Engineering. Classification and Index properties of rocks – Geological classification of rocks (crystalline rocks, organic rocks); Porosity Density; Permeability; Strength: Slaking and Durability: Sonic velocity as an index to degree of fissuring; Classification of rock masses for engineering purposes. Rock strength and Failure Criteria Modes of failure of rocks Common Laboratory strength tests (Uniaxial, Triaxial, Brazilian, Flexural tests); Stress-Strain behaviour in compression; Effect of confining pressure; the meaning of rock strength;

Application of the complete Stress-Strain curve. The Mohr Coulomb failure criterion; The effect of water; The influence of the principal Stress ration on failure; Empirical criteria of failure; Coulom-Navier criterion of failure of rocks; Griffith brittle failure Criterion. Elastic properties. Applications of rock mechanics in engineering or underground openings. Rock slope stability. Support systems design and selection – caving and subsidence. Observation of mass deformations – extensometers and strain transducers. Case studies.

MIME 322: MINERAL ANALYSIS **(2 Credit Units)**
Introduction of tests and analyses carried out for the purpose of designing Mineral beneficiation flow sheets; Laboratory Practicals on Sampling; Chemical and Assay analysis using Atomic Absorption Spectrometry (AAS), X-ray Fluorescence (XRF), Fire Assay and SEM-EDS; Mineralogical analysis using X-ray Diffraction Analyser (XRD); Size and assay analysis using sieves and AAS/XRF, Liberation studies, Work index determination and Separation Tests.

MIME 324: MINERAL PROCESSING II **(2 Credit Units)**
Dewatering, flocculation and dispersion. Thermal and agglomeration techniques: thermal drying, calcinations, sintering, palletizing, briquetting, theory and practice of thickening, filtration and drying. Process and ore sampling techniques. Analysis of comminution theory. Criteria for selection of crushing, grinding and screening equipment for mineral concentration processes. Selection of concentration techniques for downstream processes. Selection of mineral concentration equipment. Design, testing and evaluation of mineral beneficiation flow sheets for copper, tin, lead, zinc, iron, gold and other ores. Materials handling methods – Holding and transport of bulk solid, storage, holding and transport of fluids in mineral processing plants. Feeding and materials reclaiming systems. Smelting plants etc. On-line analysis, process control and automation. Tailings disposal.

MIME 326: ARTISANAL AND SMALL SCALE MINING AND MINERAL PROCESSING **(2 Credit Units)**
Definition of Artisanal and Small Scale Mining (ASM)., Differences between Medium and Large Scale Mining and Artisanal and Small scale Mining.Examples of mode of operation of ASM e.g. gold, tantalite, granite, sand and gravel, Tin, Columbite and other precious minerals. Financing of ASM operations. Occupational Health and safety hazards Associated with small scale informal mining operations. Problems and prospects of ASM operations. Involvement of women and children in ASM. Government regulation of ASM operations in Nigeria, Ghana and South Africa.

GEOL 414: GEOLOGY AND MINERAL RESOURCES OF NIGERIA **(2 Credit Units)**
General description of the geology of Nigeria. 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).

GEOL 702: MINERAL EXPLORATION TECHNIQUES **(2 Credit Units)**
Geology applied to mineral exploration. Zoning, wall-rock alteration paragenesis, etc. Principles of fluid inclusion and stable isotope studies. Ore evaluation and economic parameters of mineral deposits. Resources and reserves. Reserve estimation by pitting, trenching and drilling. Grade and tonnage. Drill-hole section and plan interpretation methods of core logging. Historical aspects of the mining industry, with emphasis on Nigerian example where possible. Mineral policy and

environmental conservation.

MIME 316: MINE CAMP (DRILLING AND BLASTING PRACTICALS) **(3 Credit Units)**
One Week Blasting and Drilling Practicals entailing Drilling Pattern Design, Charge Calculations, Blast hole Drilling, Explosive Charging, Blasting and Mucking Operations.

MIME 318: MINERAL PROCESSING PILOT PLANT OPERATIONS **(3 Credit Units)**
One Week Mineral Processing Pilot Plant Operations involving practical operations in a typical Mineral Processing Plant (Sampling, Testing, Crushing, Grinding, Screening/Classification, Mineral Concentration, Solid Liquid Separation and Packaging).

400 LEVEL:

MIME 411: SURFACE MINING **(2 Credit Units)**
Analysis of elements of surface mine operation. Design of surface mining systems with emphasis on minimization of adverse environmental impact and maximization of efficient use of mineral resources. Factors affecting stability and deformation of slopes in quarry or open pit mines. Methods of calculation of angle of slope in quarry or open pit mines. Surface excavation. The uses, handling and maintenance of surface equipment and plants. Ore reserve estimates, grade control (blending and dilution), short and long range planning, unit operations, equipment selection, cost estimation, slope stability and Placer mining operation. Aggregates quarrying and dimension stones production. Ore handling equipment. Case studies of typical surface mines: coal, metallic and non-metallic mines. Scheduled Field trips to operating mines.

MIME 413: OIL/GAS WELL DRILLING TECHNOLOGY **(2 Credit Units)**
Techniques for oil/gas well drilling. Drilling rigs: equipment, hoisting, drill string, casing, drill bits and drill string design. Circulating system-drilling fluids, drilling hydraulics. Functions of drilling mud, types and fundamental properties of drilling mud. Drilling, casing and completion programmes. Drilling performance. Offshore drilling rigs. Drilling line design consideration, mud engineering. Rig hydraulics, Casing design, Functions and types of casing, Strength consideration and loading. Cementing-functions, classes and types cement, properties of cement slurry, mechanics of cementing. Hole problems. Formation characteristics and associated drilling problems. Directional drilling and multi-zone completion. Well head equipment. Planning and materials selection for drilling programmes. Lithological sequence in the Niger Delta and drilling for oil and gas. Fishing work-over and well conversion. Site visit.

MIME 415: MINE VENTILATION **(2 Credit Units)**
Fundamentals of mine ventilation. Techniques for the control of dust, temperature, humidity, gas. Physiological effects and dangers of poor mine ventilation. Basic principles of mine ventilation design. Design of flow of air through ducts and mine opening. Ventilation Equipment (axial flow fans, centrifugal fans, refrigerators, air-conditioners etc.). Equipment selection, criteria, maintenance, instrumentation and air measurements. Evaluation of efficiency of ventilation systems. Testing of refrigeration and air-conditioning equipment, leak detection methods: charging and other service procedures for refrigeration and air-conditioning systems, Trouble shooting. Construction of air ducts**.**

MIME 421: PRECIOUS STONE TECHNOLOGY **(1 Credit Unit)**
Description of gemstones, Properties of gemstones, Mode of occurrence, Gemstone types and locations in Nigeria, Gemstone identification methods, Gemstone mining, Gemstone processing, Gemstone trade and legal requirements.

MIME 423: MINERAL ECONOMICS **(2 Credit Units)**
Variation in ore grade, non-renewable asset, increases in funding with increase in depth, wealth conservation. Global production and consumption patterns of major mineral commodities. Structures of established mineral market, supply and demand; mineral pricing. Projecting and forecasting methods; marketing research. Mine-legislations and the mineral industry: Public and the mineral act, mineral disposal systems, mineral taxation policy, conservation and the preservation of the environment, etc. International bodies related to mineral industries like OPRC, ITC: their relevance to national development. International politics and the minerals industries especially its impact on the developing nations.

MMEN 411: NON-FERROUS EXTRACTIVE METALLURGY **(2 Credit Units)**
General classification of metals. Periodic Table. Industrial classification into Heavy, Light, minor, Noble, Refractory, Rare-earth, Disseminated and Radio – active metals. Principles of Extraction of Non-Ferrous Metals by Pyrometallurgy (Ellingham diagram for oxides, applications and uses in metal extraction and other areas. General principles of smelting/reduction of oxides, slag formation, refining of the molten metals. Simple charge calculations (material and mass balances) in smelting); Hydrometallurgy (Types and methods of Leaching, Treatments given to leached liquor prior to recovery of valuable metals: solid-liquid separation, concentration and purification of leached liquor by solvent extraction, Ion Exchange, Carbon Absorption. Recovery of Valuable metal from leached liquor by Chemical precipitation, Cementation, electrowinning etc.,); Electrometallurgy (General principle of Electrolysis, Aqueous and fused salt Electrolysis electrowinning and electrorefining processes and applications in extraction and refining of metals, limitations and factors influencing the choice of a refining process). Application (Study of typical extraction and refining flow sheets of the following non-ferrous metals. Tin, Copper, Aluminium, Lead and zinc, Tin, Gold); Refining Plants (A study of the design and operations of extraction equipments and plants. Problems encountered in various plants, e.g. environmental pollution etc.).

MMEN 413: CORROSION ENGINEERING (**2 Credit Units**)
Introduction (Definition of Corrosion and Corrosion Engineering corrosion damage and cost of corrosion, corrosion and society, monetary considerations and social implications, rust formation, environments economic and environmental issues in corrosion); Engineering Principles of Corrosion (Factors affecting corrosion rates, oxygen and oxidizers, velocity, temperature corrosive concentration, Galvanic coupling, Metallurgical properties, Ringworm. Corrosion-rate expressions, practical aqueous corrosion/Electrochemical aspects of corrosion); Thermodynamic aspects of corrosion reactions (Adsorption heat, Faraday's law and Nernst equation. The basic wet corrosion cell. Standard electrode potential, Galvanic and electrochemical series, Reference electrode(s); SCE Cell potential; the Daniel cell); The Kinetics of corrosion reactions (Activation energy, Arrhenius equation. Polarisation; activation and concentration types, Diffusion processes and the double layer. Mixed potential theory; Evans diagram, E/logi plots and E/pH (Pourbaix) diagrams). Corrosion properties of some materials, forms of corrosion, high temperature corrosion, corrosion testing and monitoring corrosion prevention and control.

MMEN 425:   TECHNICAL REPORT WRITING **(1 Credit Units)**
An introduction to the planning and writing technical and scientific reports. Introduction to different study skills. Information search and retrieval techniques. Organizing information for technical and scientific reports. Audience types, psychology, speech qualities and verbal presentation of technical/scientific report. Feasibility study techniques. Referencing and reference citation and listing methods. Team working. Acquisition and technical presentation of mineral resource assessment data. Selected and simulated case studies.

MIME 491: LABORATORY COURSE WORK III **(1 Credit Unit)**
Practical on corrosion, smelting, electrometallurgy and mine ventilation.

STAT 443: EXPERIMENTAL DESIGN AND CONTROL **(2 Credit Units)**
Analysis of variance, randomized blocks, Latin squares, simple factorial designs, statistical quality control, control charts for means, standard deviation, image, number of proportion of defective and defects. Acceptance sampling (sampling inspection plans examples of single, double, multiple and sequential sampling, plants) the operating characteristics (OC) curve, producer's and consumers, risks, average sample number (ASN) and average outgoing quality level (AOQL), Linear programming.

GEOL 405: HYDROGEOLOGY **(3 Credit Units)**
The hydrological cycle. Occurrence and movement of groundwater. Aquifers: classification and hydraulic properties; introduction to laboratory and field determination of aquifer hydraulic properties; introduction to pump test analysis. Well location and esign. Hydrogeological maps; Water quality; Physical, chemical and biological. Stiff and Piper diagrams. Pollution. Introduction to groundwater prospecting. Regional hydrogeology of Nigeria. Concepts of Water Resources and Water Resources Management.

GEOL 417: PETROLEUM GEOLOGY **(2 Credit Units)**
Origin, migration and accumulations of hydrocarbons; characterization of source and reservoir rocks. Surface and subsurface occurrences of hydrocarbons. Physical and chemical nature of reservoir fluids; preservation, distribution, maturation and destruction of organic matter (Petroleum cycle and palaeoenvironment of source rocks); organic matter types. Hdrocarbon trap types and abnormal formation pressures. Evaluation and prospects of petroleum potential of a virgin sedimentary basin; reserve estimation and construction of subsurface maps and sections. Petroliferous horizons with case histories from Nigerian.

MIME 497: STUDENT INDUSTRIAL WORK EXPERIENCE SCHEME **(6 Credit Units)**
The programme is embarked upon in the second semester of 400 level and long vacation. A comprehensive internship programme in which students spend a period of six months in approved Mining Engineering establishments (private and public) and industries. The exposure also provides opportunity for students to sharpen their technical writing skills through field reports, keeping log-books and prepare technical documents under close supervision of professionals and lecturers. The students are to be assessed by Industry-based Supervisor, ABU Supervisor and through Student's Report and Seminar Presentation.

500 LEVEL:

MIME 511: UNDERGROUND MINING **(2 Credit Units)**
Selection, design and development of most suitable underground mining methods based on the physical and geological properties of mineral deposits. Unsupported and supported underground mining methods. Tunneling Engineering; construction and maintenance. Underground Mining systems. Mining of averagely thick and thick deposits. Equipment, conveyors, cable ropeways and rope haulage, tract and trackless mining systems, hydraulic transport and pipeline systems. Calculations of ore reserve estimates, development planning and preparations for development and extraction, construction of development openings. Conservation and environmental systems Case studies of typical underground mines: coal, metallic and non-metallic scheduled. Field trip(s) to operating mines and Tunnels.

MIME 513: MINE AND MINERAL PROCESSING EQUIPMENT AND MACHINERY **(3 Credit Units)**
Essential features of a machine: gears, shaft, bearings, couplings etc. Construction and application of wire rope used in mine machinery. Hoisting equipment care of ropes. Types of pumps and their application. Pumps characteristics compressors-reciprocating, piston and rotary types, characteristics and choice of compressors. Surface mine Machinery. Power shovel, front-end-loaders, dragline, hydraulic excavators, bucket wheel excavators, bucket chain excavators, rippers, scrapers and bulldozers. Dump trucks. Underground mine machinery: Loaders – gathering arm loaders, bucket type loaders, front-end-loaders, and load-and slushier. Coal cutter, Power arch, Nut and Bolt support. Transport and Haulage: Railways (locomotives, wagons, tracts); train ways, trolley; conveyor belts, rope haulage-direct and endless rope, rope way. Mineral processing plant equipment: Crushers (Jaw, Gyratory & Cone), Grinding mills (Rod Mill, Ball mill, High Pressure Roll Mills), Screens, Classifiers, Concentration equipment (Tables, Jigs, Spirals, Flotation Cells, Magnetic and Electrostatic Separators, Enhanced gravity concentrators), Slurry Pumps, Fans, Filters and Dryers. Dredges hydraulic monitors and gravel pumps, sluice boxes. Maintenance of mine and mineral processing plant machinery; routine, emergency, periodic overhaul, planned maintenance. Reliability and availability of equipment. Workshop and maintenance tools. Lubricants.

MIME 515: MINE MANAGEMENT AND LAW **(2 Credit Units)**
Definition of Management: Kinds of manager criticize, role and skills of manager, acquiring the skills of manger. Basic concept of management. Management structure. General principles functions and responsibilities of management under planning, organization directing, controlling and coordinating. Different forms of business organizations. Wage systems. Industrial relations. Introduction to innovative thinking, project development, planning and execution. Project appraisal and feasibility studies. Types of business and ownership structure of business enterprises. Product/business registration and patient right. Project financing and product marketing strategies. Sources of fund for project financing. Financial feasibility, project valuation and risk assessment. Budgeting and financial statements analysis. Material procurement methods. Contracts initiation, execution and management. Nigerian Minerals and Mining Act, 2007 and its Regulation, 2011. Planning and Decision Making Destruction of planning, types of plans, steps in planning, objective versus goals, kind of goals, making goal, setting effective organizational goals and planning strategic management. Organizing: Human Resources, Planning and recruitment of personnel; compensation and benefits, training and development. Human Factors. Motivations and leadership. Herzberg: Two – factor model: Abraham Maslow: Two – factor model leadership. Controlling: Destructives and propose of control, types of control, factors of control, management

by objectives (MBO), management by exception (MBE), management by delegation (MBD).

MIME 517: MINE DESIGN **(2 Credit Units)**
Design of surface mine excavation methods. Determination of bench parameters. Calculation of the width of working platform of the bench. Determination of the optimum depth of a surface mine. Selection of mine equipment and machinery. This include draglines, loaders, power shovels, drilling rigs, jack hammer, compressor, conveyor, belt etc. Feasibility study of a proposed quarry. Design of a surface mine using an existing data. Software applications to surface mine design in planning and organization using various software packages in the laboratory. Slope design in surface mines to ensure safe operation. Practical exercise. Design and construction of shafts, winze and raise. Phases of shaft construction. Different methods of shaft sinking such as bench method and Jora lift method. Detailed shaft site investigation in order to optimised construction cost and time to ensure safety. Detail discussion on hoisting machines, tunnel, drifts and adit design and constructions. Various methods of tunneling in underground mines using tunneling machines and explosives. Drilling and blasting parameters in shaft sinking and tunneling. Design of powered supports arch and nut and bolt supports. Design of ventilation systems in underground mines. Selection of the best methods of mining during the design of underground mines. Application of software packages to underground mine design.

MEEN 503: PRODUCTION MANAGEMENT I **(1 Credit Unit)**
Investment Analysis: *Relevant costs* – Break even analysis; compound interest factors; locomonic alternatives; Production: Planning; Sales forecasting technique; Determination of factor-production requirement. *Factory Design:* Siting of factory; space requirements; development of departmental arrangements; plant layout; materials handling. *Production Control* : Production control in intermittent manufacture and continues manufacture, linear programming; critical path scheduling; factory organization; types of organization; Personnel functions; sales organization; purchasing; welfare and financial control.

MIME 519: PETROLEUM RESERVOIR ENGINEERING **(3 Credit Units)**
Introduction to hydrocarbon reservoir. Origin, migration and accumulation of oil and gas. Composition of petroleum, state of petroleum. Types of traps. The Niger delta. Petroleum reservoirs: Gas-reservoirs, Gas-condensate reservoirs, unsaturated reservoirs, and oil reservoirs under various drive mechanisms. Material balance applied to oil reservoirs. Fluid flow in reservoirs. Mechanism of fluid flow in porous media, Drilling, Completion and Work over, Production and Christmas-tree, pressure, build-up survey, Amarada, well flowing, choke and arrival manifolds, Heaters, separators, Well flow measurement and monitoring. Monitoring and measuring devices. Reservoir and well modeling and simulation.

MMEN 511: IRON AND STEEL MAKING PROCESSES **(3 Credit Units)**
Iron ores - Classification, distribution (world and Nigeria), Evaluation and methods of beneficiation of iron ores. Thermal Pre-treatments of Iron ore Concentrates - Calcinations, Sintering, pelletizing. Physical Chemistry of the Blast furnace - Decomposition of materials, Reduction of iron oxides, Direct and indirect reduction of iron in the Blast furnace (equilibrium diagram of Fe-O-C and Fe-O-H should be looked at); Rates of reduction by hydrogen and carbon-monoxide; The effect of temperature, velocity and pressure of gases on reduction. Physical and chemical properties of ores and how it affect rate of reduction advantage and disadvantages. Manganese, Silicon, phosphorus sulphur reduction and Desulphurization in the Blast furnace. Pig

Iron and slag formation. Properties of slag. Methods of Blast furnace intensification. Blast furnace equipment - Ladles, Torpedoes, Anzitiary equipments e.g. for cleaning and utilizations of Blast furnace gases etc. Alternative methods of iron making - Pellet production (Green ball formation its composition, binder and machine etc.), sintering (flored and unflored), direct iron reduction and coke production. High Manganese; pig iron production its uses. Blast furnace Design and operation - General design principle; Blast furnace profile; refractories instrument, Blast furnace assay calculation and thermal balance. Chemistry of Steel Making - Thermodynamics of oxidation reactions e.g. Carbon, sulphur, phosphorus, manganese Oxidation. De-oxidation of steels by Mn, Si, Ti, Al, Si-Ca, Si-Mu etc. Precipitation de-oxidation. Diffusion de-oxidation. De-oxidation using vacuum and synthetic slags. Gases and non-metallic inclusions in steels. Steel making slags, classification of steels. Steel making processes: Open-Hearth Process - Principles of the open-Hearth Process. Bessemer Processes - Construction of the converters. Acid and Basic processes (Advantages and Disadvantages). Modifications of the processes. Oxygen Process - Developments of LD Converters. Construction of LD converter (Linings & Raw materials). Oxidation of impurities in the LD process. Steel making practice. Modifications – KALDO, ROTOR, LD-AC Processes. Electric Arc Furnace Process (EAF): Steelmaking in Induction furnaces. Production of steel from sponge Iron. Special Treatments - Iron gas (especially Argon) injection. Injection of powdered materials. Vacuum Treatment of Steels (RH, DH, ladle etc.). Treatment of steel with synthetic slags. Casting Technology - Crystallization of steel. Ingot structure. Types of Ingots and their casting. Ingot Defects and their control. Continuous casting of steel – Types, practices Merits and Demerits. Special Steel Production - Stainless steel production using AOD, VOD methods. High-Speed steel production. Alloy-steel production. Ball-Beating steel production and Ferro-alloy productions. Secondary Steelmaking Practice - Electro-slag re-melting (ESR). Vacuum EAF and vacuum Induction furnace. Plasma.

MIME 522: MINERAL PROCESS PLANT DESIGN (**3 Credit Units**)
Introduction - Differences between Process Design and Process Plant Design, Process unit operations and Flow sheets, Types of Flow sheets, Procedures and steps followed in the design of flow sheet for the beneficiation of newly discovered mineral ores. And design of metal extraction flow sheets. Tests and analyses carried out for the purpose of designing Mineral beneficiation flow sheets - Chemical and assay analysis, Mineralogical analysis, Size and assay analysis, Liberation studies, Work index determination and Separation tests. Chemical / assay analysis for metallurgical process circuit development - Sampling for the purpose of assaying, the use of Gy's formula for minimum mass of sample to be taken**.** Mineralogical analysis for metallurgical flow-sheet development - Mineralogical analysis in process tests Sample preparation for mineralogical analysis, Determination of grain size of the individual minerals (valuable and gangue), Determination of degree of association between the valuable mineral and the gangue, Determination of the mineralogical composition of the ore using Mineral Liberation Analyzer (MLA) and X-ray Diffraction (XRD). Size / Assay Analysis - Particle size analysis, Assay analysis of each size fraction, Analysis of the results. Liberation Studies and Grindability test - Significance of grindability test and how it is carried out, Determination of the liberation size of the valuable and non-valuable minerals, Determination of optimum mesh of grind of valuable minerals. Work index determination - Importance of work index as a comminution parameter, The use of work index in determining power requirement and in the selection of comminution equipment; and Methods of determining work index (Standard Bond's Method, Berry & Bruce Method, etc.). Separation Tests for Ores - Objectives of ore testing for newly discovered and existing ores, Stages of ore testing (Batch Test, Cycle or Locked Test, Pilot Plant Test and Mill Test). Pilot plant tests -

Aims and objectives of pilot plant tests, sample requirements, methodology for data collection and evaluation, quality of the data, scale up, practical requirements and limitations. Process equipment selection and costing - Size, type, quantity, power requirement, service condition. Outline of process plant layout criteria - Equipment and machines layout in the plant safety of personnel, material movement and the need for maintenance. Case Study I **-** Analysis of existing flow sheets and their design philosophies: Iron ore concentration flow-sheet. Barite processing flow sheet, Cassiterite-tantalite-columbite processing flow sheet, Gold extraction flow sheet, Copper extraction flow-sheet, Tin extraction flow-sheet, and lead-zinc extraction flow-sheet. Case Study II: Students are expected to be given case studies on the design of new flow-sheets for the beneficiation and extraction of metal values from newly discovered ores.

MIME 512: MATERIALS HANDLING **(2 Credit Units)**
Definition, Haulage System (Rail or track mounted – rope haulage, Locomotive haulage – Electric, Battery, Combination, diesel, compressed air, Trackless or Tyre haulage – automobiles, LHD, shuttle car, underground trucks, Conveyor systems, Hoisting or winding systems, Aerial Ropeways, Track and Mine Car, Hydraulic transport

MIME 514: MINE VALUATION **(2 Credit Units)**
Mine valuation concept. Methods of sampling. Ore reserve calculations and statistical analysis applied to the valuation of ore deposits. Methods of financial appraisal and valuation criteria for project selection. Leases, royalties and taxation: Interest rates, calculation of depreciation, depletion and increasing costs. Estimating future costs and profits. Feasibility studies in Mining and mineral projects. Evaluation of Turn-Around-maintenance of mineral facilities.

MIME 516: HEALTH AND SAFETY IN MINING AND MINERAL PROCESSING OPERATIONS **(2 Credit Units)**
Importance of Mine Health and Safety to mining industries. Safety in surface and underground mines operations. Safety in mineral processing plants. Safety regulation in the handling of blasting accessories such as explosives, detonators, blasting caps and safety fuse. Construction and maintenance of explosive and detonator magazine for safe operation. Identification of the courses of mine fire, dust and gas explosion in mines. General safety rules and regulations in the mining industries in Nigeria. Mine health and safety regulations. Industrial visit to quarries and other mining industries for Health and Safety assessment.

MIME 524: ENVIRONMENTAL IMPACT ASSESSMENT RELATED TO MINING AND MINERAL PROCESSING OPERATIONS **(2 Credit Units)**
Environmental pollution: definitions, causes and interrelationships. Gaseous and particulate pollutants and their sources. Mine atmosphere: detection of mine gases, physiological effects, inflammation and detonation, gas layering and diffusion. Dust hazards. Pollution monitoring and control, methods of controlling gaseous and particulate pollutants. Mine effluents, effects on air, surface and ground water, and land. Spontaneous combustion, acidity, etc. Tailings Dam Management and Control. Methods of effluent treatment. Impact of mining on mine environs effects on agriculture, surrounding habitats, etc. Methods of reclamation. Mine drainage: water recovery and re-cycling.

MIME 526: MINERAL TITLE ACQUISITION AND ADMINISTRATION **(2 Credit Units)**
Types and Geometry of Mineral Titles; Qualification of Mineral Title Applicants; Procedures for

acquiring Mineral Titles; Requirements (supporting Documents) accompanying mineral title applications; Mineral Title Fees; Contents of Mandatory Periodical Reports submitted to Regulatory Ministries, Departments and Agencies; Mineral Title Modifications/Renewal/Relinquishment/ Assignment/Revocation, etc.; Case Studies.

MIME 528: SOFTWARE APPLICATIONS IN MINING AND MINERAL PROCESSING **(2 Credit Units)**
Review of applicable computer programmes and programming languages in mining and minerals engineering operations including such software as Split-Desktop for rock fragmentation analysis, SuperMinex5 (with DrillKing, SurpacV5 and Logmate) for surface and underground mining operations, GIS software such as ArcView, MapInfo, Illwis Academic, the sufer series, etc for map making and BRUNO (Meso. Minerals Process Simulator), JKSmiMet, JKSimfloat and USIMPAC series for simulating mineral processing operations; Projects in software development in relevant areas of the mining operations. Computer simulation of mining and processing operations using case studies with any existing or developed software

MEEN 502: PRODUCTION MANAGEMENT II **(1 Credit Unit)**
Work study: *Lotion Study:* Method study objectives; Basic procedure; process charts; activity chart, motion study. *Time study:* Stop watch time study; standard data method and waiting line analysis. *Inventory Control:* Relevant factory; economic lot sizes; inventory control under risk; inventory levels and production schedule; inventory decision rules and simulation. Statistical quality control; Control shirts for variable; defectives and defects; acceptance sampling; design of acceptance sampling; design of acceptance sampling plans. *Job Evaluation*: Job specification – quantitative and non-quantitative systems of job evaluation. Wage incentives: Incentive plans; day rate plan; full participation plan; less than full participation; step plan.

MIME 599: FINAL YEAR STUDENT'S PROJECT   (6 Units)
The student prepares a project report in the final year of study on a selected and approved research project in any aspect of the discipline. The student is expected to plan and carry out an investigation on a project under the supervision of a member of staff. The project shall be assessed by the project supervisor and the External Examiner.

3.3.   The Course Credit System
The course units in the Department are organized on the course credit system per semester. A semester lasts for approximately 18 weeks, including the periods of registration and examinations provided that not less than 15 weeks are devoted to actual teaching. One credit unit is the equivalent of 15 contact hours of classroom teaching or 30 hours of laboratory work. Most of the course units in the Department carry the weight of 3 or 2 credit units, suggesting that they are taught for 45 or 30 hours in the semester or 3 or 2 one-hour periods per week. In courses with strong practical component, this means that there are 15 hours of teaching and 45 hours of practical to qualify for 2 credit units or 30 hours of teaching and 45 hours of practical for 3 credit unit courses. However, there are fewer 3 credit unit courses which suggest that more work is required to be done in 45 contact hours per semester or the equivalent in terms of practical and classroom teaching.
At the end of each semester, a final examination is given to bring the course to final conclusion. The final examination in each course unit is weighted 60% of the component while CA/assignments carries the weight of 40% of total marks for the course.
No student can pass in a course unit if he/she fails to subm