GODFREY OKOYE UNIVERSITY
ENUGU, ENUGU STATE, NIGERIA
www.gouni.edu.ng

B.S. INDUSTRIAL PHYSICS

The Core Curriculum Minimum Academic Standards (*CCMAS*)

September, 2023.

Overview

In this document, the Core Curriculum and Minimum Academic Standards (CCMAS) for the education and training of students studying for first degree in the programme of the Industrial Physics discipline in the Nigerian University System is prescribed. It is expected that the components of the minimum standards described here will enable the graduates of the programme to acquire sufficient theoretical and practical knowledge to contribute to national advancement and be competitive in the globalised environment. Institutions are expected to use these standards as the minimum guidelines in the innovative design of their own specific programmes.

Philosophy

The programme aims at using sound knowledge of physical principles and analytical skills to develop new products, manage/operate industrial systems, as well as ensure optimization of industrial processes. The aim of the four-year programme in Industrial Physics is to produce graduates who will not only have a good foundation of physics, but will at same time possess adequate training and applicable knowledge of industrial operations.

The programme's curriculum is therefore specifically designed to enable graduates begin their careers in industry by instilling in them knowledge of scientific skills and techniques needed in relevant industries. Graduates will be equipped with special expertise in key industrial activities such as semiconductor technology, instrumentation, electronics and communications engineering, materials science and technology, energy and power and industrial research.

Objectives

The objectives of the programme are to:

1. provide students with a broad and balanced foundation of Industrial Physics knowledge and practical skills;
2. instil in students a sense of enthusiasm for Industrial Physics and appreciation of its applications in different contexts;
3. develop in students the ability to apply their knowledge and skills in Industrial Physics to the solution of theoretical and practical problems;
4. develop in students through an education in Industrial Physics a range of transferable skills of value in physics and other areas; and
5. provide students with a knowledge and skills base for further studies in Industrial Physics or multi-disciplinary areas involving industrial physics.

Unique Features of the Programme

The unique features of the programme include:

1. the programme of Industrial Physics offers course on Physics entrepreneurship;
2. the students will apply knowledge gained in designing and fabrication of solar cells and panels;
3. build windmills and generate energy;

4. design and construct solar distillation systems;
5. install solar panels in houses;
6. use different materials: polymer, ceramics, metals and semiconductors for industrial applications; and
7. utilize modern electronics.

Employability Skills
1. Time management
2. Creativity
3. Resourcefulness
4. Critical thinking
5. Organisation

21st Century Skills
1. ICT skills
2. written and oral communication skills
3. teamwork
4. interpersonal skills
5. sound ethical standards
6. entrepreneurship
7. creativity
8. collaboration
9. critical thinking

Admission and Graduation Requirements

Admission Requirements
1. The entry requirements for four-year degree programme shall be at least passes at credit level at the Senior Secondary Certificate (SSC) or equivalent in five subjects at not more than two sittings. Such subjects include, English Language, Mathematics, Physics, Chemistry and Biology/ Agriculture. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100 Level. Acceptable UTME subjects are: English Language, Physics, Mathematics and Chemistry.
2. Candidates with at least two 'A' level passes in Physics and any of Mathematics, Chemistry or Biology at the GCE Advanced Level or IJMB or JUPEB, may be considered for admission into 200 Level, provided they satisfy the 'O' level requirements.

Graduation Requirements
Expected duration for UTME candidates shall be 4 years and students are required to pass a minimum of 120 units, while for Direct Entry students, expected duration for graduation shall be 3 years and would be expected to pass a minimum of 90 units which must include all compulsory courses.

Global Course Structure

100 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 111	Communication in English	2	C	15	45
GST 112	Nigerian Peoples and Culture	2	C	30	-
MTH 101	Elementary Mathematics I	2	C	30	-
MTH 102	Elementary Mathematics II	2	C	30	-
COS 101	Introduction to Computing Science	3	C	30	45
PHY 101	General Physics I	2	C	30	-
PHY 102	General Physics II	2	C	30	-
PHY 103	General Physics III	2	C	30	-
PHY 104	General Physics IV	2	C	30	-
PHY 107	General Physics Practical I	1	C	-	45
PHY 108	General Physics Practical II	1	C	-	45
CHM 101	General Chemistry I	2	C	30	-
CHM 102	General Chemistry II	2	C	30	-
CHM 107	General Chemistry Practical I	1	C	-	45
CHM 108	General Chemistry Practical II	1	C	-	45
GOU-IPH 161	MATHCAD	2	C	15	45

GOU-IPH 162	MATHLAB for Physics	2	C	15	45
GOU-IPH 194	Semiconductor Technology	2	C	15	45
	TOTAL	33			

200 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 212	Philosophy, Logic and Human Existence	2	C	30	-
ENT 211	Entrepreneurship and Innovation	2	C	15	45
PHY 201	General Physics V (Elementary Modern Physics)	2	C	30	-
Course Code	**Course Title**	**Unit(s)**	**Status**	**LH**	**PH**
PHY 202	Electric Circuits and Electronics	2	C	30	-
PHY 204	General Physics IV (Waves and Optics)	2	C	30	-
PHY 205	Thermal Physics	2	C	30	-
PHY 207	Experimental Physics I	1	C	-	45
PHY 208	Experimental Physics II	1	C	-	45
GOU-IPH 223	Computer Programme for Physics I	2	C	15	45
GOU-IPH 224	Computer Programme for Physics II	2	C	15	45
GOU-IPH 236	Renewable Energy Sources	2	C	15	45
GOU-IPH 237	Welding and Fabrication	2	C	15	45
GOU-IPH 238	Optical Systems Design	2	C	15	45
GOU-IPH 239	Engine Design Physics	2	C	15	45

GOU-IPH 240	Radar Physics	2	C	C	45
GOU-IPH 241	Physical Metallurgy I	2	C	E	45
	TOTAL	30			

300 Level

Course Code	Course Title	Unit(s)	Status	LH	PH
GST 312	Peace and Conflict Resolutions	2	C	30	-
ENT 312	Venture Creation	2	C	15	45
PHY 303	Electromagnetism I	3	C	45	-
PHY 305	Quantum Physics	3	C	45	-
PHY 306	Statistical and Thermal Physics	3	C	45	-
PHY 307	Experimental Physics III	1	C	-	45
PHY 308	Experimental Physics IV	1	C	-	45
PHY 314	Solid State Physics I	3	C	45	-
PHY 315	Electronics	2	C	30	-
PHY 398	12 WEEKS SIWES	3	C		
GOU-IPH 383	Applied Geophysics	2	C	15	45
GOU-IPH 384	Physical Metallurgy II	2	C	15	45
GOU-IPH 385	Chemical Metallurgy	2	C	15	45
GOU-IPH 386	Corrosion and Protection	2	C	15	45
GOU-IPH 387	Robotic Systems	2	C	15	45
	TOTAL	33			

400 Level

Course Code	Course Title	Units	Status	LH	PH
PHY 401	Quantum Mechanics	2	C	30	-
PHY 403	Mathematical Methods in Physics	2	C	30	-
PHY 423	Solid State Physics II	3	C	45	-
PHY 415	Science of Materials	2	C	30	-
PHY 432	Electromagnetic Theory II	3	C	30	-
PHY 455	Student Research Project	6	C	-	-
PHY 490	Physics Entrepreneurship	2	C	15	45
GOU-IPH 416	Borehole Geophysics	2	C	15	45
GOU-IPH 417	Thin Films Technology	2	C	15	45
	TOTAL	24			

Course Contents and Learning Outcomes

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;

5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and 7. write simple and technical reports.

Course Contents

Sound patterns in English Language (vowels and consonants, phonetics and phonology. English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations). Sentence in English (types: structural and functional, simple and complex). grammar and usage (tense, mood, modality and concord, aspects of language use in everyday life). Logical and critical thinking and reasoning methods (logic and syllogism, inductive and deductive argument and reasoning methods, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities: pre-writing (brainstorming, outlining); writing (paragraphing); post writing (editing and proofreading). Types of writing: summary, essays, letter, curriculum vitae, report writing, note making, etc. Mechanics of writing. Comprehension strategies: (Reading and types of Reading, Comprehension Skills, 3RsQ). Information and Communication Technology in modern language learning. Language skills for effective communication. Major word formation processes. Writing and reading comprehension strategies. Logical and critical reasoning for meaningful presentations. Art of public speaking and listening; and report writing.

GST 112: Nigerian Peoples and Culture **(2 Units C: LH 30)**

Learning Outcomes

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

1. analyse the historical foundation of the Nigerian culture and arts in pre-colonial times;
2. list and identify the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political unit;
4. analyse the concepts of trade, economic and self-reliance status of the Nigerian peoples towards national development;
5. enumerate the challenges of the Nigerian State towards nation building;
6. analyse the role of the Judiciary in upholding people's fundamental rights;
7. identify acceptable norms and values of the major ethnic groups in Nigeria; and
8. list and suggest possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents

Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and culture; peoples and culture of the ethnic minority groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; Colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in

Nigerian politics; Nigerian Civil War). Concept of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigeria people; trade, skill acquisition and selfreliance). Social justices and national development. Law definition and classification. Judiciary and fundamental rights; individual, norms and values (basic Nigeria norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts; cultism, kidnapping and other related social vices); re-orientation, moral and national values (The 3R's – Reconstruction, Rehabilitation and Re-orientation); re-orientation Strategies: Operation Feed the Nation (OFN), Green Revolution, Austerity Measures, War Against Indiscipline (WAI), War Against Indiscipline and Corruption(WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA; and current socio-political and cultural developments in Nigeria.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry) (2 Units C: LH 30)

Learning Outcomes

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

1. explain basic definition of set, subset, union, intersection, complements and use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. discuss various types of numbers; and
5. sole some problems using Binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements and venn diagrams. Real numbers, integers, rational and irrational numbers, mathematical induction, real sequences and series, theory of quadratic equations and binomial theorem. Complex numbers, algebra of complex numbers, the argand diagram. De-Moivre's theorem, nth roots of unity. circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes

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

1. identify the types of rules in differentiation and Integration;

2. describe the meaning and function of a real variable, graphs, limits and continuity; and 3. solve some applications of definite integrals in areas and volumes.

Course Contents

Function of a real variable, graphs, limits and idea of continuity; the derivative, as limit of rate of change; techniques of differentiation; extreme curve sketching; integration as an inverse of differentiation; methods of integration; definite integrals and application to areas and volumes.

COS 101: Introduction to Computing Sciences (3 Units C: LH 30; PH 45)

Learning Outcomes

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

1. explain basic components of computers and other computing devices;
2. describe the various applications of computers;
3. explain information processing and its roles in the society;
4. describe the Internet, its various applications and its impact;
5. explain the different areas of the computing discipline and its specializations; and
6. demonstrate practical skills on using computers and the internet.

Course Contents

Brief history of computing. Description of the basic components of a computer/computing device. Input/Output devices and peripherals. Hardware, software and human ware. Diverse and growing computer/digital applications. Information processing and its roles in society. The Internet, its applications and its impact on the world today. The different areas/programs of the computing discipline. The job specializations for computing professionals. The future of computing.

Lab Work: Practical demonstration of the basic parts of a computer. Illustration of different operating systems of different computing devices including desktops, laptops, tablets, smart boards and smart phones. Demonstration of commonly used applications such as word processors, spreadsheets, presentation software and graphics. Illustration of input and output devices including printers, scanners, projectors and smartboards. Practical demonstration of the Internet and its various applications. Illustration of browsers and search engines. How to access online resources.

PHY 101: General Physics I (2 Units C: LH 30)

Learning Outcomes

On completion of the 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.

Course 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.

PHY 102: General Physics II **(2 Units C: LH 30)**

Learning Outcomes

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

1. describe the electric field and potential, and related concepts, for stationary charges,
2. calculate electrostatic properties of simple charge distribution using Coulomb's law, Gauss's law and electric potential;
3. describe and determine the magnetic field for steady and moving charges;
4. determine the magnetic properties of simple current distributions using Biot-Savart and Ampere's law;
5. describe electromagnetic induction and related concepts, and make calculations using Faraday and Lenz's laws;
6. explain the basic physical of Maxwell's equations in integral form;
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of ac voltages and currents in resistors, capacitors, and Inductors.

Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PHY 103: General Physics III **(2 Units C: LH 30)**

Learning Outcomes

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

1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive, and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents

Heat and temperature (temperature scales). Gas laws. General gas equation. Thermal conductivity. First Law of thermodynamics (heat, work and internal energy, reversibility). Thermodynamic processes (adiabatic, isothermal, isobaric). Second law of thermodynamics (heat engines and entropy). Zero's law of thermodynamics. Kinetic theory of gases. Molecular collisions and mean free path. Elasticity (Hooke's law, Young's, shear and bulk moduli). Hydrostatics (Pressure, buoyancy, Archimedes' principles). Bernoulli's equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

PHY 104: General Physics IV **(2 Units C: LH 30)**

Learning Outcomes

On completion, the students should be able to:

1. describe and quantitatively analyse the behaviour of vibrating systems and wave energy;
2. explain the propagation and properties of waves in sound and light;
3. identify and apply the wave equations;
4. explain geometrical optics and principles of optical instruments.

Course Contents

Simple harmonic motion (SHM): energy in a vibrating system, Damped SHM, Q values and power response curves, forced SHM, resonance and transients, coupled SHM. Normal modes. Waves: types and properties of waves as applied to sound; Transverse and Longitudinal waves; Superposition, interference, diffraction, dispersion, polarisation. Waves at interfaces, Energy and power of waves, the 1-D wave equation, 2-D and 3-D wave equations, wave energy and power, phase and group velocities, echo, beats, the doppler effect, propagation of sound in gases, solids and liquids and their properties. Optics: Nature and propagation of light; reflection, refraction, and internal reflection, dispersion, scattering of light, reflection and refraction at plane and spherical surfaces, thin lenses and optical instruments, wave nature of light; Huygens's principle, interference and diffraction.

PHY 107: General Practical Physics I **(1 Unit C: PH 45)**

Learning Outcomes

At the end of the 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 PHY 101. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

PHY 108: General Practical Physics II **(1 Unit C: PH 45)**

Learning Outcomes

On completion of the 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 PHY 102. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

CHM 101: General Chemistry I **(2 Units C: LH 30)**

Learning Outcomes

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

1. define atom, molecules and chemical reactions;
2. explain 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;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using Le Chatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. 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. Introduction to electrochemistry and radioactivity.

200 Level

CHM 102: General Chemistry II **(2 Units C: LH 30)**

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 its 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 and 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.

CHM 107: General Chemistry Practical I **(1 Unit C: PH 45)**

Learning Outcomes

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

1. describe the general laboratory rules and safety procedures;
2. collect scientific data and correctly carrying out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents

Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Chemistry Practical II **(1 Unit C: PH 45)**

Learning Outcomes

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

1. identify the general laboratory rules and safety procedures;

2. collect scientific data and correctly carrying out Chemical experiments;
3. identify the basic glassware and equipment in the laboratory
4. identify and carry out preliminary tests which includes ignition, boiling point; melting point, test on known and unknown organic compounds;
5. execute solubility tests on known and unknown organic compounds;
6. execute elemental tests on known and unknown compounds; and
7. conduct functional group/confirmatory test on known and unknown compounds which could be acidic / basic / neutral organic compounds.

Course Contents

Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

GOU- IPH 161: MATHCAD (2 Units; Compulsory; LH = 15; PH = 45)

Senate-Approved Relevance

This course is fashioned in line with the philosophy of Godfrey Okoye University towards producing Physics graduates who will be outstandingly excellent in learning, balanced in character and personality and ready to pursue epistemic unity in all its ramifications. Through the course, students will be exposed to concepts complementary with applications that will advance the capacity of those graduates in the design and programming and simulation of Mathematical and physics equations using MATHCAD. The course is also developed in agreement with Godfrey Okoye University's mission and vision to empower their graduates with skills for the labour market.

Overview

Mathcad is computer software for the verification, validation, documentation and re-use of mathematical calculations in engineering and science. Released in 1986 on DOS, it introduced live editing of typeset mathematical notation in an interactive notebook, combined with automatic computations. Mathcad's central interface is an interactive notebook in which equations and expressions are created and manipulated in the same graphical format in which they are presented. This approach was adopted by systems such as Mathematica, Maple, Macsyma, MATLAB, and Jupyter.
Mathcad today includes some of the capabilities of a computer algebra system but remains oriented towards ease of use and documentation of numerical engineering applications.

Objectives

The objectives of this course are to:
1. Define MATHCAD as a computational tool.
2. Describe the applications of MATHCAD in Physics.
3. Give examples of simulations achieved by MATHCAD.
4. Explain the processes involved in installing MATHCAD software.
5. State the system requirements for MATHCAD software to function well.
6. State the advantages of using MATHCAD software above other mathematical analyzing tools.
7. Describe how to present a 3D simulation using MATHCAD.

8. Identify the processes involved in solving complex mathematical equations, using MATHCAD.
9. Plot and report the results as detailed graphs.
10. Perform calculations of both numerical and symbolic expressions using MATHCAD.
11. State the challenges of using MATHCAD software in simulating 3D equations.
12. Understand the lifespan of the software and renewal conditions.

Learning outcomes

On the completion of this course, the students will be able to:

1. Develop innovative ideas and skills in representing physics equations.
2. Install MATHCAD software for personal and public use for a fee.
3. Identify the sections and compositions of MATHCAD software and their uses.
4. Provide a reasonable explanation for the existence of physical equations.
5. Skillfully use scientific and engineering tools for analyzing difficult equations.
6. Analyze complex physical equations in classical and quantum physics easily.
7. Plot graphs of advanced physical equations.

Course Contents

Introduction. MATHCAD basics. Getting started with MATHCAD. Online resources. Creating a MATHCAD worksheet. Working with Math graphics. Other objects. Worksheet management. Computational features. Management and data array. 2D plot. 3D plots. Symbolic calculations. Programming. Advanced Computational features and functions. Experiment on project motion. Application to statistical physics. Application to thermal physics.

Minimum Academic Standards

Computer programming workshop with NUC-MAS requirements facilities: MATHCAD software, Desktops, Laptops, MATHCAD textbooks, PTC Mathcad, Printers UPS, Scanners, Internet facilities.

GOU-IPH 162: MATHLAB for Physics (2 units; Compulsory; LH =15; P = 45)

Senate-Approved Relevance

This course exposes students to high performance technical computing which will be of immense benefit to students of Industrial Physics. The course is proposed in response to the mission of Godfrey Okoye University to produce graduates who are ready for the labour market, and who are outstanding in their areas of study, balanced in character and personality and ready to pursue epistemic unity in all its ramifications. The course will expose students to concepts complementary with applications that will advance the producing capacity of those graduates in the design and programming and simulation of Mathematical and physics equations using MATHLAB.

Overview

MATHLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. The name MATHLAB stands for matrix laboratory. MATHLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computations.

MATHLAB is an interactive system whose fundamental data element is an array that does not require dimensioning. This course will allow students to solve many technical computing problems, especially those with matrix and vector formulations. In a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran.

Objectives

The objectives of this course are:

1. Define MATHLAB as a computational tool in physics.
2. Install the latest version of MATHLAB for course use.
3. Develop an algorithm for the wave equation using MATHLAB.
4. Compute variables and run the codes.
5. Solve mathematical problems like quadratic equations using MATHLAB.
6. Create a model for the dependent variables in the wave equation.
7. Simulate simple harmonic motion using the equation in MATHLAB.
8. Plot the graph of the linear equation and show the coordinates of the points.
9. Identify the slope and coordinates of the graph.
10. Define data analysis and visualization using MATHLAB.
11. Explore types of scientific and engineering graphics using MATHLAB.
12. Develop a software prototype to solve problems involving classical physics.

Learning outcomes

On the completion of this course, the students will be able to:

1. Visualize vector and matrix data.
2. Work with data files.
3. Work with data types.
4. Automate commands with scripts.
5. Write programs with branching and loops.
6. Read data from files.

7. Save and load variables.
8. Plot data.
9. Customize plots.
10. Export graphics for use in other applications.
11. Create and run live scripts.
12. Analyze and Visualize with Vectors.
13. Perform calculations with vectors.
14. Access and modify values in vectors.
15. Format and share live scripts.

Course Contents
Introduction. The main features of MATHLAB. Variables. Functions. Basic arithmetic operations. Intrinsic functions. Matrices and arrays. Graphical user interface. Desktop tools. Development environment. Graphics. Programming. 3D visualization. Applications in signal processing. Imaging. Mapping. Customized Plots.

Minimum Academic Standards
Computer programming laboratory with NUC-MAS requirements facilities: MATHLAB software, Desktops, Laptops, MATHLAB textbooks, programming and circuit simulation.

GOU-IPH 194: Semiconductor Technology (2 Units; Compulsory; LH =15; P = 45)

Senate-Approved Relevance

This course is intended to give students a solid educational experience and to inculcate a strong personality in them which will promote epistemological dialogue. It aligns with Godfrey Okoye University's mission and vision to produce graduates who will be outstandingly excellent in learning, balanced in character and personality and to empower the graduates with skills for the labour market. Furthermore, this course is fashioned in line with the philosophy of Godfrey Okoye University towards producing Physics graduate who will advance their knowledge in semiconductor technology and their applications.

Overview

The semiconductor industry is the aggregate of companies engaged in the design and fabrication of semiconductors and semiconductor devices, such as transistors and integrated circuits. It formed around 1960, once the fabrication of semiconductor devices became a viable business. Semiconductors typically have band gaps ranging between 1 and 4 eV, whilst insulators have larger band gaps, often greater than 5 eV. The thermal energy available at room temperature, 300 K, is approximately 25 meV and is thus considerably smaller than the energy required to promote an electron across the band gap. This means that there are a small number of carriers present at room temperature, due to the high energy tail of the Boltzmann-like thermal energy distribution. It is the ability to control the number of charge carriers that makes semiconductors of great technological importance.

Semiconducting materials are very sensitive to impurities in the crystal lattice as these can have a dramatic effect on the number of mobile charge carriers present. The controlled addition of these impurities is known as doping and allows the tuning of the electronic properties, an important requirement for technological applications. This course will empower graduates to work in semiconductor manufacturing companies and other electrical /electronics firms.

Objectives

The objectives of this course are to:

1. State the differences between a conductor, an insulator, and a semiconductor.
2. Explain the electron and the hole flow theory in semiconductors and how the semiconductor is affected by doping.
3. Define the term "diode" and give a brief description of its construction and operation.
4. Explain how the diode can be used as a half-wave rectifier and as a switch.
5. Identify the diode by its symbology, alphanumeric designation, and colour code.
6. List the precautions that must be taken when working with diodes and describe the different ways to test them.
7. Define transistors.
8. State the difference between a diode and a transistor.
9. Differentiate between intrinsic and extrinsic semiconductors.
10. Name three elements used in semiconductor study and manufacturing.
11. Relate and identify the advantages of one semiconductor element over the other.
12. State the advantages of semiconductors.

Learning outcomes

On the completion of this course, the students will be able to:

1. Explore the world of semiconductors as a tool for advanced electronics.

2. Draw the orbital configurations of semiconductor elements such as silicon, germanium and arsenic.
3. Identify the differences between intrinsic and extrinsic semiconductors.
4. State the reason why intrinsic semiconductors materials are better and more conductive than extrinsic ones.
5. Describe the energy band of a semiconductor.
6. Define the relationship between diodes and transistors.
7. Explain doping and dopants in semiconductor.
8. Identify types of transistors and their different applications.
9. State the advantages of semiconductors over conductors and insulators.
10. Construct simple circuits using diodes and transistors.
11. Analyze the lifespan of diodes as a semiconductor.

Course Contents

Introduction. Semiconductors. Conductors. Insulators. Physics–chemical properties of semiconductors. Preparations in simple purification. Growth of sample crystals. Evaluation of chemical structure properties. Doping effects. Diodes. Transitors. Current-voltage characteristics of semiconductors. Mechanical and Metallurgical properties. Thermodynamics and kinetic considerations in crystal growth. Chemical vapour transportation techniques. Intrinsic semiconductors. Extrinsic semiconductors.

Minimum Academic Standards

Semiconductor laboratory with NUC-MAS requirements facilities. Wafer probers, imaging stations, ellipsometers, CD-SEMs, ion mills, C-V systems, interferometers, source measure units (SME), magnetometers, optical and imaging systems, profilometers, reflectometers, resistance probes, resistance high-energy electron diffraction (RHEED) system, X-ray diffractometers.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes

A student who has successfully gone through this course should be able to:

1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding, etc.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 15; PH 45)

Learning Outcomes

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

1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation, and risk taking
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;
6. describe stages in enterprise formation, partnership and networking including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

Concept of Entrepreneurship (Entrepreneurship, Intrapreneurship/Corporate Entrepreneurship,). Theories, Rationale and relevance of Entrepreneurship (Schumpeterian and other perspectives, Risk-Taking, Necessity and opportunity-based entrepreneurship and Creative destruction). Characteristics of Entrepreneurs (Opportunity seeker, Risk taker, Natural and Nurtured, Problem solver and change agent, Innovator and creative thinker). Entrepreneurial thinking (Critical thinking, Reflective thinking, and Creative thinking). Innovation (Concept of innovation, Dimensions of innovation, Change and innovation, Knowledge and innovation). Enterprise formation, partnership and networking (Basics of Business Plan, Forms of business ownership, Business registration and Forming alliances and join ventures). Contemporary Entrepreneurship Issues (Knowledge, Skills and Technology, Intellectual property, Virtual office, Networking). Entrepreneurship in Nigeria (Biography of inspirational Entrepreneurs, Youth and women entrepreneurship, Entrepreneurship support institutions, Youth enterprise networks and Environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

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

Learning Outcomes

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

1. identify the circumstances, discoveries and people that launched modern physics;
2. enumerate and understand the postulate of relativity;
3. explain the problem of simultaneity and calculate time changes from one frame of reference to another;
4. describe relativistic length contraction;
5. describe the relativistic mass-energy relation;
6. explain the work of Planck, Bohr and Heisenberg; and
7. explain the uncertainty principle and the other features of Quantum mechanics.

Course Contents

Special relativity. Defects in Newtonian mechanics. The speed of light. The Lorentz transformation. Transformation of velocities. Experimental basis of quantum theory. Black body radiation. Electrons and quanta. Bohr's theory of atomic structure. De-Broglie hypothesis. The uncertainty principle. Schrodinger's equation and simple applications.

PHY 202: Electric Circuits and Electronics (2 Units C: LH 30)

Learning Outcomes

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

1. explain electric circuit and electronics;
2. mention all entire the different circuit theorem;
3. apply the concept to solve simple problems;
4. differentiate between N-type and P-type semiconductor; 5. solve basic A.C problems; and
6. design simple circuit.

Course Contents

D.C. Circuits. Kirxhoff's Laws. Sources of e.m.f and current. Network analysis and circuit theorems. A.C. Circuits. Inductance, capacitance, and the transformer. Sinusoidal wave-forms, r.m.s and peak values. Power, impedance and admittance series. RLC circuit, Q factor, and resonance. Network analysis and circuit theorems. Filters. Electronics, semiconductors, the pnjunction, field effect transistors, bipolar transistors, characteristics and equivalent circuits, amplifiers, feedback, oscillators.

PHY 204: General Physics IV (Waves and Optics) (2 Units C: LH 30)

Learning Outcomes

At the end of the course, the student should be able to;

1. explain the purpose and use of mathematical tools relating to waves and optics;
2. account the difference between wave equation of motion and the Newtonian mechanics; 3. discuss the working principle of optical system; and
4. design optical instruments.

Course Contents

Wave phenomena; Acoustical waves; the harmonic oscillator; waves on a string; energy in wave motion; longitudinal waves; standing waves; group and phase velocity; Doppler effect; Physical Optics; Spherical waves; interference and diffraction, thin films; crystal diffraction, holography; dispersion and scattering. Geometrical Optics; Waves and rays; reflection at a spherical surface, thin lenses, optical lenses; mirrors and prisms.

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

Learning Outcomes

Upon the successful completion of this course, the student should be able to:

1. explain and understand the basic foundation of classical thermodynamics;
2. explain the basic application of thermodynamics laws and potentials;
3. apply some real life applications; and
4. further apply the course to their respective field of learning.

Course Contents

The Foundations of classical thermodynamics including the zeroth and definition of temperature. The first law: work, heat and internal energy. Carnot cycles and the second law. Entropy and irreversibility. Thermodynamic potentials and the Maxwell relations. Application: qualitative discussion of phase transitions. Third law of thermodynamics. Ideal and real gases. Elementary kinetic theory of gases including Boltzmann counting, Maxwell-Boltzmann law of distribution of velocities. Simple applications of the distribution law.

PHY 207/208: Experimental Physics I & II (2 Units C: PH 90)

Learning Outcomes

Upon the completion of the course, the students should be able to:

1. identify the two physical quantities to be measured as independent and dependent variables; 2. determine the relationship between the two variables in form of graph;
3. determine some physical constants such as acceleration due to gravity, force constant of a spring, refractive index of a prism and focal length of converging and diverging lenses using different methods;
4. determine momentum of inertia of a fly wheel and determine coefficient of static and dynamic friction for wood.

Course Contents

The laboratory course consists of a group of experiments drawn from diverse areas of Physics (optics, electromagnetism, mechanics, Modern Physics, etc.). It is accompanied by seminar studies of standard experimental techniques and the analyses of famous and challenging experiments.

GOU-IPH 223: Computer Programme for Physics I (2 Units; Compulsory; LH = 15; P =45)

Senate-Approved Relevance

This course is intended to ensure solid educational experiences to students, in agreement with Godfrey Okoye University's mission to inculcate a strong personality that will promote epistemological dialogue, and to produce graduates who will be outstandingly excellent in learning, balanced in character and personality and ready to pursue epistemic unity. A course on Computer Programme for Physic students will certainly empower them with skills for the labour market, including advancing their knowledge in the use of programming languages for advanced computing and quantum analysis.

Overview

Computer programming is the process of writing code to facilitate specific actions in a computer, application or software program and instructing them on how to perform. Computer programmers are professionals that create instructions for a computer to execute by writing and testing code that enables applications and software programs to operate successfully. Computers can do amazing things, from basic laptops capable of simple word processing and spreadsheet functions to incredibly complex supercomputers completing millions of financial transactions a day and controlling the infrastructure that makes modern life possible. But no computer can do anything until a computer programmer tells it to behave in specific ways.

Based on the requirements or purposes of these instructions, students who go through this course can operate a number of complex functions through computer programming. The objectives and learning outcomes below address the multi-layered worlds and challenges in computer programming.

Objectives

The objectives of this course are:

1. State the steps involved in solving a logical problem using a programming language.
2. Define an algorithm and write a problem-solving algorithm.
3. Identify terminologies used in programming languages.
4. Define flow charts and state their uses.

5. Design a simple algorithm for buying goods from an online store.
6. Draw a flowchart showing the links of the algorithm till the final stage.
7. Define variables and identify the types of variables used in programming languages.
8. Explain loops and state their uses.
9. State different types of programming languages and their uses.
10. Identify the principles of good programming.
11. Code a problem-solving algorithm in C-programming language and run the codes.
12. Debug codes of errors and implement the programme.

Learning outcomes

On the completion of this course, the students will be able to:

1. Define computer programming.
2. List four programming languages and their functions.
3. Define variables as an important programming tool.
4. State three kinds of variables.
5. Represent three kinds of variables in a line of code.
6. Build an algorithm for a CBT panel
7. Design the flowchart pathway for the algorithm.
8. Define the steps taken in debugging a code.
9. State the procedure involved in running a code in C-programming language.
10. State the advantages of programming in Physics.
11. Identify ways to document a code.
12. Develop a programming algorithm with a programming style.
13. Code and run the algorithm using C-programming language to ascertain results.

Course Contents

Introduction. Problem-solving methods. Algorithm development. Designing. Coding. Debugging. Documenting programs. Using techniques of a good programming language style. Programming language. Programming algorithm development. A widely used programming language should be used in teaching the above. Graphic designing. Web development. Looping. C-programming language. Flow chart. Python.

Minimum Academic Standards

Computer programming laboratory with NUC-MAS requirements facilities: C language software, C++ language software, Javascript, Python software, projector, Laptops

GOU-IPH 224: Computer Programme for physics II (2 Units; Compulsory; LH =15, P =45)

Senate-Approved Relevance
This course is fashioned to empower students of Industrial Physics with concepts complementary with applications that will advance their knowledge in the use of programming languages, identification of programming language structures and applying the knowledge in solving relevant issues in Physics topics. It aligns with Godfrey Okoye University's mission to give solid educational experiences to students; to inculcate in them a strong personality that will promote epistemological dialogue, to produce graduates who will be outstandingly excellent in learning, balanced in character and personality and to empower their graduates with skills for the labour market.

Overview
This course is a continuation of Computer Programme for Physics I. Computer programming is the process of writing code to facilitate specific actions in a computer, application or software program and instructing them on how to perform. Computers can do amazing things, from basic laptops capable of simple word processing and spreadsheet functions to incredibly complex supercomputers completing millions of financial transactions a day and controlling the infrastructure that makes modern life possible.

At its most basic, computer programming is little more than a set of instructions to facilitate specific actions. Based on the requirements or purposes of these instructions, students will be taught how to enable applications and software programs to operate successfully. They will also be guided to execute complex actions as reading data from temperature sensors to adjust a thermostat, sorting data to complete intricate scheduling or critical reports or taking players through multi-layered worlds and challenges in games.

Objectives
The objectives of this course are to:

1. State the principles of a good programmer.
2. Define the processes involved in writing a structured program.
3. Develop an algorithm to solve a question under classical mechanics.
4. Code the algorithm using C++ programming language.
5. Identify the benefits of C++ language over C-programming language.
6. Name three software used to code in C-programming language.
7. Difference between data science and web development.
8. Identify how to use python language in analyzing data in Physics.
9. Solve mathematical physics questions using python language.
10. Identify steps involved in solving a logical problem using C++ and python.
11. Code a problem-solving algorithm in C++ programming language and run the codes.
12. Debug codes of errors and implement the programme.

Learning Outcomes

1. Define an algorithm and write a problem-solving algorithm.
2. Identify terminologies used in advanced programming languages like C++ and python.
3. Design a flowchart for solving problems involving quantum physics.

4. Design a simple algorithm for determining the time of flight of a projectile.
5. Define variables and identify the types of variables used in programming languages.
6. Identify loops and state their uses in C++ language.
7. Install C++ language software like visual studio code and code blocks.
8. State the procedure involved in running a code in C++ programming language.
9. State the advantages of programming in C++ over C language.
10. Identify ways to document a code in both C and C++ programming languages.
11. Develop a programming algorithm with a programming style in python.
12. Estimate the cost of developing software using the programming languages taught.

Course Contents

Introduction. Principles of good programming. Structured programming concepts. Debugging. Testing. String processing. Internal searching and sorting. Recursion. Use a programming language different from C++ language. C-language. Looping. Coding. Algorithm development. Python. Variables. Data science. Flow chart. Java. Discuss Job Opportunities.

Minimum Academic Standards

Computer programming laboratory with NUC-MAS requirements facilities. . C language software, C++ language software, python software, projector, Laptops

GOU-IPH 236: Renewable Energy Source (2 Units; Compulsory; LH = 15; P =45)
Senate-Approved Relevance
In line with the philosophy of Godfrey Okoye University to pursue education as dialogical process of acquisition and dissemination of knowledge, the course is fashioned towards producing physics graduates who have the capacity and creative ability in the fields of energy and technologies associated with energy production. The course also aligns with the university's mission to produce graduates who are ready to provide solution to the energy needs of Enugu and the country.

Overview
Energy keeps the world alive. It is an important index for evaluating nation's status as per capital of electrical energy. Energy can be classified into renewable and non-renewable. Non-renewable energies comprises of fossil fuels which come in three principal forms from which many other products are derived such a coal, crude oil and natural gas. With the fossil energy crisis and international policies about oil, attention to developing an alternative energy resources that will augment the conventional energy sources to meet the world energy demands and mitigate the adverse impact on the environment and climate due to release of gases such as $S0_2$, NO_2, CO_2, CO, chlorofluorocarbon that induce greenhouse effect causing rise in the surface temperature of the earth by increasing the amount of heat trapped in the lower atmosphere.

The importance of this course is to solve the energy need in line with sustainable development goals (SDGs) numbers 1, 7 and 13, through the development alternative energy by building solar energy systems and inverter systems that can stand-alone thereby reducing carbon dioxide emissions that affect climate and environment.

Objectives
The objectives of the course are to:
1. Describe the concept of energy.
2. State the sources of energy.
3. Identify different kinds of energy.
4. Differentiate between different kinds of energy.
5. Design and construct simple energy collection equipment.
6. Describe operational principles of renewable energy equipment.
7. Determine the cost of installations.
8. Describe the maintenance of installations.
9. Explain how renewable energies mitigate the impact on environment and climate.
10. State the advantages and disadvantages.
11. Determine the initial challenges of deploring renewable energy.
12. Determine the life span of the components.

Learning outcomes
On completion of the course, students should be able to:
1. Describe energy.
2. Differentiate between Renewable and non-renewable energies.
3. Explain renewable energy generations.
4. Design and construct equipment's for renewable energy exploitation.
5. Construct and design solar panel.
6. Calibrate the energy needs of buildings

7. Install and maintain equipment.
8. Execute service equipment.
9. Market Renewable energy components.
10. Start renewable energy business.

Course content

Energy. Biomass. Solar energy source. Biofuel. Classification of combustion of solid biomass. Production of gaseous and liquid fuels from biomass. Anaerobic digestion for biogas. Pyrolysis of bio-oil. Fermentation for ethanol and vegetable oils for biodiesel. Municipal solid waste (MSW) solar radiation components, measurements/estimation of solar radiation, extra solar radiation, solar water heating, selective surface evacuated collectors, flat plat collectors, heat losses, collectors' efficiency. Solar photovoltaics silicon p-n junction. Construction PV technologies. Current – Voltage and power and voltage characteristics. Applications and system. Solar home systems. Wind energy and power. Characteristic of the wind. Estimation of wind speed distribution, horizontal and vertical axis turbines and electricity. Hydro power principles and flow rate. Turbines. Turbine efficiency. Environmental impact of geothermal energy. Ocean energy and tidal power.

Minimum Academic standards

Renewable energy laboratory with NUC-MAS requirements facilities: Anaerobic digesters, solar charger, batteries, inverters, flat solar panels, basic lift and drag balance, Nozzle flow apparatus, thristor and diode converter, controller, PLC trainer, heat transfer exp base unit Thermal control process apparatus, centrifugal compressor module, Kaplan Turbine.

GOU-IPH 237: Welding and Fabrication (2 Units; Compulsory; LH = 15; PH = 45)

Senate-Approved Relevance
This course is developed to introduce students to the very important and lucrative welding business and advance the producing capacity of those graduates in creative works in Welding and Fabrication. It is developed as a response to the need in the society and in agreement with Godfrey Okoye Uuniversity's mission and vision to empower their graduates with skills for the labour market.

Overview
Welding is a leader in today's high-tech approach to manufacturing. Students will learn several different welding processes including arc, gas and plastic welding along with learning plasma cutting and oxy-fuel cutting. This class is highly project-oriented and predominately a hands-on class. The student will learn many welding-related skills in the program. This course will be an eye-opening of the fundamentals of welding and Fabrication. The students are empowered with both theoretical and practical knowledge of the course which will give them an edge over their contemporaries in the labour market.
On completion of the course, the students can work in any metallic manufacturing industry or would choose to become self-employed by owning a Welder infrastructure. Eventually, the graduate in turn becomes an employer of labour.

Objectives

The objectives of the course are to:

1. Explain the concept of welding.
2. Explain welding processes.
3. Describe the safety measures in welding.
4. Classify metals according to their strength and durability.
5. State the methodologies employed in welding.
6. Identify tools used in welding.
7. Mention the gasses used in welding.
8. Describe the applications of welding.
9. Estimate the average cost of metal fabrication.
10. State the advantages and disadvantages of welding and Fabrication.
11. Weld and fabricate a solid metallic body for storage.

Learning Outcomes
On completion of this course, students should be able to:

1. Define Welding and Fabrication
2. Explain the safety measures to be put in place during the art of welding.
3. Differentiate the gasses used in welding and their specific applications.
4. Identified metals and their strength descriptions.
5. Analyze and estimate the cost of fabricating a sizable safety contour.
6. Fabricate and weld metallic go-kart.
7. Prepare containers for Welding and Cutting.
8. Practice Arc welding.
9. Exhibit shield Flux in Arc Welding.
10. Write specifications for filler metals and electrodes.
11. Practice fire safety in Arc Welding.
12. Practice oxyfuel gas-cutting methods.

Course content

Definitions. Safety in Welding. Cutting. Allied Processes (Filter Plate). Lens Shade Selector (Filter Plate). Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping. Arc Welding and Cutting Noise. Fire Safety in Welding and Cutting. Oxyfuel Gas Welding. Heating Safety. Preparing Containers for Welding or Cutting. Welding: Welding Symbols Charts (Wall & Desk Chart). Standard Symbols for Welding. Brazing. Nondestructive Examination. Filler Metals and Electrodes. Specification for Carbon Steel Electrodes for Shielded. Metal Arc Welding. Specification for Bare Stainless Welding Electrodes and Rods. Specification for Bare Aluminum and Aluminum – Alloy Welding electrodes and Rods. Specification for Tungsten and Tungsten-Alloy Electrodes for Arc Welding and Cutting. Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding. Welding Procedures and Performance Qualifications. Standard Methods for Mechanical Testing of Welds, Shielded Flux Cored Arc Welding. Guide for the Visual Inspection of Welds. Oxyfuel Gas Cutting Process. Set criteria for describing oxygen-cut surfaces and oxygen cutting surface roughness gauge. Recommended practices for heat shaping and straightening with ox fuel gas heating torches and plasma. Recommended practices for air carbon arc gouging and cutting. Recommended practices for gas tungsten arc welding.

Minimum Academic Standards
Welding and Fabrication workshop with NUC-MAS requirements facilities: Gas Metal Arc Welding (GMAW/MIG) machine, Gas Tungsten Arc Welding (GTAW/TIG) machine, Shielded Metal Arc Welding (SMAW) machine, Flux Cored Arc Welding (FCAW) machine, charged electrodes, wires, electrode feeds, chipping slag hammer, C-clamps, ball peen hammer, electrode tip cleaners, flint strikers, needle nose and linesmen cutting pliers, cold chisels, flat-head and Phillips screwdrivers, round and flat files, levels and squares, welding helmet ear plugs, solid boots, welding gloves, angle grinding wheel, steel, shielding gas.

GOU-IPH 238: Optical Systems Design (2 Units; Compulsory; LH =15; PH =45)

Senate-Approved Relevance
This course is developed to introduce students to the very important field of photonics and optical systems. It is developed as a response to the need in the society and in agreement with Godfrey Okoye Uuniversity's mission and vision to empower their graduates with skills for the labour market. It also responds to the mission of the university to inculcate the skills necessary for making graduates outstandingly excellent in learning, balanced in character and personality and ready to contribute to the growth of the society.
Overview
Optical Systems design emphasizes first-order, system-level estimates of visual performance. Building on the basic principles of optical design, this course uses numerous examples to illustrate the systems-engineering processes of requirements analysis, feasibility and trade studies, subsystem interfaces, error budgets, requirements flow-down and allocation, component specifications, and vendor selection. Optical system design is an introductory tool to advanced photonics and optical intelligence.

At the end of this course, the students will be empowered with intermediate knowledge of photonics and the design of optical instruments. Having garnered basic experience in the fundamentals of optics, they can go ahead to build state-of-the-art optical tools for intelligent visualization.

Objectives

1. Define photonics and optical system technology.
2. Explain the principles of optical system design.
3. Analyze the tools and components used in optical designs.
4. Describe the Geometrical structure of optical instruments.
5. Define aberrations and distinguish image qualities.
6. Determine the challenges involved in sorting long-lasting photonics devices.
7. State the advantages and disadvantages of designing optical systems.
8. Determine the cost of installation and handling of optical system devices.
9. Describe how the knowledge of optical system devices contributes to national security.
10. Highlight the maintenance culture of optical systems.
11. Determine the life-span of an optical device.
12. Estimate the working conditions of a good optical device.

Learning Outcomes

This course will enable students to:

1. Describe the concepts and terminology of systems.
2. Describe engineering as applied to optical system development.
3. Calculate geometrical-optics parameters such as image size, image location, FOV, and IFOV.
4. Determine the parameters for ground-sample distance (GSD).
5. Distinguish the various types of optical aberrations.
6. Estimate blur size and blur-to-pixel ratio.
7. Identify the effects of blur size on MTF.
8. Explain Ground-resolved distance (GRD).
9. Explain the image quality formed by an optical device.
10. Quantify radiometric performance.
11. Compare detector types and properties.
12. Predict the performances of combining optical, source, and detector parameters.
13. Develop detector-selection tradeoffs and specifications such as sensitivity, dynamic range, uniformity and operability.
14. Explain optical component specifications.

Course content

Introduction. Systems design. System engineering. Geometrical optics. Aberrations and image quality. Radiometry. Optical sources. Detectors and FPAs. Opt mechanics. Specifications of optical components. Optical transmission. Optical systems combination. Optical components specifications. Irradiation. Dynamic range. Radiometric performance. Ground resolved distance. Ground sample distance.

Minimum Academic Standards

Optics and Photonics workshop with NUC-MAS requirements facilities: Microscope, laser scriber, wafer breaker, diamond scriber, autocollimators, electronic autocollimators, interferometers, automatic goniometers, focometers, collimators, testing telescopes, diopter telescopes, camera testing instruments, binocular testing instruments, alignment telescopes, and alignment collimators, bar cleaver, bar stacker/unstacker, bar tester, chip tester, chip visual inspection, chip sorter, LED prober, and VCSEL prober, beam profiling camera, scanning slit beam profilers.

GOU-IPH 239: Design Engines Physics (2 Units; Compulsory; LH = 15; PH= 45)

Senate-Approved Relevance
This course aims to enable students to develop an understanding of fundamental physics concepts in kinematics, mechanics, mechanical and electromagnetic waves, and electricity /electromagnetism while exploring robotics, computer programming, computer-aided design (CAD) and rapid product development. Students who go through this course will be outstandingly excellent in creative works in the area of physics and engineering. The need for this course aligns with the mission of Godfrey Okoye University to produce Physics graduates who have advanced capacity to design marketable engine products.

Overview
In this course, Design Engines Physics, students apply principles of physics and engineering to an iterative cycle of product design. In this course, working individually and in teams, students complete a series of design challenges to develop key skills in computer programming, 3-D modelling software, engineering technology, and physics concepts. The course culminates with competition-ready, semi-autonomous devices presented as marketable products designed to serve a specific purpose in the local community. These projects promote critical thinking, communication, collaboration, and creativity and provide a foundation for data collection, analysis, reflection, presentations and technical writing skills.

By successfully completing the course, students will be prepared for success in science and engineering as well as in high-demand careers like automation and advanced manufacturing. The students will be prepared for the workforce at the end of this course, especially in the design and manufacturing industries. They will be able to design working engines for simple machines, automobile systems and heavy-duty devices.

Objectives
The objectives of the course are to:
1. Describe the concept of design in engines.
2. State the methodology of engine design.
3. Differentiate multifunctional engines from simple engines.
4. Explain the kinematics of engine design.
5. Explore mechanics of engines.
6. Interpret electromagnetic wave charts for design engines.
7. Describe the importance of robotic systems in system engines.
8. Enumerate the disadvantages of poor engine design.
9. Develop skills in computer programming.
10. Model 3-D prototypes of simple engines.
11. Analyze faults resulting from poor engine maintenance.
12. Determine the cost of engine design and construction.

Learning outcomes
At the end the course, students will be able to:
1. Explore the world of motion, especially in engines.
2. Explain how things move and what motion is all about.
3. Develop kinematic concepts of motion.
4. Apply the knowledge of kinematics to a design challenge.

5. Construct the design cycle.
6. Deploy the knowledge of the construction of the design to solve multiple engineering design problems.
7. Analyze motion, given their understanding of kinematics.
8. Make measurements and calculations.
9. Explore the need for design engines for transportation and logistics.
10. Embark on design challenges to prove their mastery of the course.
11. Design engine prototypes that can move a specified distance, project an object over a specified range, launch an object vertically at a specified height, or stop a moving object at a specified distance.

Course Contents
Introduction. The design Process. Introduction to kinematics. Mechanics. Force. Energy. CAD. 3D Modeling. Robotics. Electricity. Electromagnetism. Robotic devices. Engine System Analysis. Student-Designed Capstone Project. Design engine for transportation. Logistics. Engine prototypes. Multiple engineering design problems. Wave charts.

Minimum Academic Standards
Automobile Design Engines workshop with NUC-MAS requirements facilities: Sensors, actuators, mechanical components, electronics controllers, motor wiring systems, power distribution trainers, motor control training systems, basic rotating machines, mechatronics systems, process controller, thermal process , controller, analytical process controller, AC/DC electrical systems, power & control electronics, hydraulic and pneumatic systems, pumps systems, mechanical drives, sensors packages, programmable controller systems, pump systems, mechanical drives, Computer Aided Design (CAD), Finite Element Analyzer, Autocad Mech.

GOU-IPH 240: Radar Physics (2 Units; Compulsory; LH = 15; PH = 45)

SENATE-Approved Relevance
This course has the goal to train students in the area of Radar physics. It will advance the producing capacity of graduates of Industrial Physics in creative works in RADAR system technology, networking and remote sensing. The graduate is empowered to work under information communication technology as a technologist, radar scientist or professional data tracker. It is part of the mission of Godfrey Okoye University to produce graduates who are spurred by needs in their environment to be creative in solving societal problems and to contribute to the labour market.
Overview
This course will go through radar equations, waveforms, the Doppler effect, synthetic aperture radar (SAR) and antenna, propagation and radar applications to name a few.
The course is aimed at helping new graduates to work in the radar or remote sensing branches of industrial physics. One of the core uses of Radar is to send and receive valuable information in the form of waves. RADAR is helpful in detecting incoming signals during war and is also used by a geologist for earthquake detection. Archaeologists use this technology for the detection of buried artefacts. It is also used to understand the environment and climatic changes. Therefore the knowledge this course offers would abound with the students after graduation. They will be able to work extensively in information technology industries, geological establishments and environmental management networks.

Objectives

The objectives of this course are to:

1. Define the concept of radar.
2. State the branches of radar technology.
3. State the use of radar technology in information technology.
4. Explains the applications of radar in Physics.
5. Describe the advantages and disadvantages of radar technology.
6. Explain the operational principles of radar technology.
7. Examine the conditions necessary for the accurate performance of radar technology.
8. Distinguish radar from optical and infrared sensing devices.
9. Explain the radar transmission of electromagnetic energy towards a target.
10. Explain how to measure the range of transmissions of a radar system.
11. Identify the tools used in the design of radar systems.
12. Estimate the lifespan of the equipment for radar system installation.

Learning Outcomes

On successful completion of this course, the students will be able to:

1. Explain the interactions of radiation with the earth's surface and atmosphere.
2. Determine how to implement the knowledge of radar systems in the design of new sensors.
3. Address specific problems in information technology using radar sensing.
4. Differentiate infrared and optical sensing from radars.
5. Define remote sensing instrumentation in radar physics particularly.
6. Describe the basic interpretation skills of remote sensing products.
7. Analyze the requirements for some relevant applications in remote sensing.
8. Set up and launch simple radar systems for data transfer.
9. Describe the characteristics of images formed by synthetic apertures
10. Identify the importance of Antennas in radar communication
11. Estimate the cost of setting up a radar network
12. Identify and plot the waveforms of a radar network.

Course Contents

Introduction. Radar concept and equations. Physics of EM waves. Interaction with matter. Radar configurations. Basic Radar Functions. Noise and Signal-to-Noise ratio. RCS definition. The Doppler Effect. Scattering regimes. High-frequency scattering. Doppler phenomenology. Doppler shift. Introduction to Synthetic-aperture radar (SAR) and fundamentals. Image formation. Image interpretation. SAR distortions (layover, foreshortening, shadow). Antennas. Propagation and radar applications. Waveforms. Tracking. Recognition and phased arrays. Airborne and space-borne radar systems. Space-based radar.

Minimum Academic Standards

RADAR network workshop with NUC-MAS requirements facilities: RF signal generators, Spectrum analyzer with tracking generator, Oscilloscope, Power supplies, Function generators, High-speed FPGAs, 10 GbE backbone, LPKF S103 rapid prototyping circuit mill, vector network analyzers, antennas, antenna trainer with variable frequency, motorized antenna unit, Doppler radar training system, RF training kit, passive radar research prototypes.

GOU-IPH 241: Physical Metallurgy I (2 Units; Elective; LH = 15; PH = 45)

Senate-Approved Relevance

Through this course, the university intends to impart quality education aimed at producing graduates who are highly skilled and knowledgeable in the evaluation of physical metallurgy for economic uses. This corresponds with the vision of the Godfrey Okoye University to produce Physics graduates with strong personality that will promote epistemological dialogue. Students who are strong in learning, balanced in character and personality and ready to pursue epistemic unity in all ramification. The course also has the goal to provide solution for metallurgical problems in the environs of Enugu and beyond. Students who undertake this course can properly evaluate Physical processes of metallurgical production for various economic usage.

Overview

Materials science, also known as materials science and engineering, is a multidisciplinary field that deals with the discovery and design of new materials. Always new materials open the door to new technologies, whether they are in chemical, civil, construction, nuclear, agricultural, aeronautical, biomedical, electrical, or mechanical engineering. The materials science engineering includes the study of the relations between the synthesis, forming, properties, structure, and performance of materials that enable an engineering function. The materials properties of interest can be electrical, mechanical, optical or magnetic; the engineering function can affect industries involved in electronics, communications, transportation, manufacturing, medicine, recreation, environment, and energy.

Metallurgy is an applied science based on a clear understanding of the structures and properties of metals and their alloys. Metallurgy has long occupied the dominant position as the most important engineering materials; steel being by far the most important over the last few centuries. However, increasingly in many areas other materials such as ceramics, plastics and composites are challenging this position. The study of this Course will help graduates to discover new materials that will enhance technology.

The Objectives

The objectives of this course are to:

1. Differentiate the relationship between material structure and properties, especially in metallic materials on a physical basis.
2. Examine the Solid state transformations.
3. Discuss alloy design.
4. Discuss fracture behavior of materials.
5. Explain microstructural engineering concepts.
6. Determine the relationship between processes and thermodynamics.
7. Discuss the structure and properties of metals.

Learning Outcomes

On completion of this Course, students should be able to:

1. Explain the relationship between atomic transport processes and structural defects that control the change of material microstructure.

2. State the importance of phase transformation in controlling the microstructure.
3. Explain the properties of metallic materials.
4. Discuss the effect of heat treatment or cold and hot treatment on the microstructure and behavior of materials.
5. Examine the principles of solid-liquid and solid-state transformations.
6. Discuss hardening processes in steel.
7. State important applications of physical metallurgy.

Course Content
Structures of metals. Cavities. Solid solutions. Annealing. Diffusion in solid solutions. Interstitial diffusion. Nucleation and growth kinetics. Precipitation hardening. Marten site reactions. Iron-carbon alloy systems. Hardening of steel. Non-ferrous alloy systems. Alloy theory-terminal solid solutions. Intermediate phases. Fe-C system. Steel and iron Microstructures with phase relations. Free energy-composition diagrams. Applications of physical metallurgy.

Minimum Academic Standard
Laboratory facilities: Optical microscope, XRD diffraction machine, polishing machines, Micro hardness testing machine, Automated Rockwell hardness tester, Electro polishing for EBSD, High temperature furnance, low temperature furnance, low speed cutter, image analyzer, DSC/TGA machine, Cornish rolls, Gates rock Breaker, Hendrie bolt hoff sample grinder, iron sampling floor, Cornish feeder, Automatic feed trough, Richards sptizlute, coarse collom jigs, convex continuous round table, Hendy improved challenge ore feeder, stamp battery, amalgamated plates, frue vanner, Richards movable sieve, water tanks, steam drying tables

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe roles of international organisations, media and traditional institutions in peace building.

Course Contents
Concepts of peace, conflict and security in a multi-ethnic nation; types and theories of Conflicts: ethnic, religious, economic, geo-political conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory; root causes of conflict and violence in Africa: indigene and settlers phenomenon, boundaries/boarder disputes, political disputes, ethnic disputes and rivalries, economic inequalities, social disputes; Nationalist Movements and Agitations; selected conflict case studies: Tiv-Junkun, Zango Kartaf, chieftaincy and land disputes, etc.; peace building, management of conflicts and security: Peace &

Human Development; approaches to peace & conflict management: (religious, government, community leaders etc.); elements of peace studies and conflict resolution: conflict dynamics assessment scales: constructive & destructive; justice and legal framework: Concepts of Social Justice, the Nigeria legal system; insurgency and terrorism; peace mediation and peace keeping; Peace & Security Council (International, National and Local levels); agents of conflict resolution: conventions, treaties community policing; evolution and imperatives; Alternative Dispute Resolution (ADR): (a) dialogue (b). arbitration, (c). negotiation (d). collaboration, etc.; roles of International Organizations in conflict resolution. (a). The United Nations, UN and its Conflict Resolution Organs. (b). The African Union & Peace Security Council (c). ECOWAS in Peace Keeping; media and Traditional Institutions in peace building; managing post-conflict situations/crisis: Refugees. Internally Displaced Persons (IDPs); and the role of NGOs in post-conflict situations/crisis.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, students, through case study and practical approaches, should be able to:

1. describe the key steps in venture creation;
2. spot opportunities in problems and in high potential sectors regardless of geographical location;
3. state how original products, ideas, and concepts are developed;
4. develop business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and 9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity Identification (Sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap); new business development (business planning, market research); entrepreneurial finance (venture capital, equity finance, micro finance, personal savings, small business investment organizations and business plan competition); entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, ecommerce business models and successful e-commerce companies); Small Business Management/Family Business; leadership & management, basic book keeping, nature of family business and Family Business Growth Model; negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods); opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, Idea pitching); technological solutions (the concept of market/customer solution, customer solution and emerging technologies; Business Applications of New Technologies: Artificial Intelligence (AI), Virtual/Mixed Reality (VR), Internet of Things (IoTs), Blockchain, Cloud Computing, Renewable Energy, etc.; Digital Business and E-Commerce Strategies).

PHY 303: Electromagnetism I **(3 Units C: LH 45)**

Learning Outcomes

On the completion of the course, the student should be able to:

1. explain basic physical laws and concepts in electricity and electromagnetism;
2. use fundamental laws and relation to solve problems in electricity and electromagnetism;
3. explain Maxwell's equation as a fundamental law of nature integral and the differential form of the equation;
4. give solution for Maxwell's equation for electrostatic field; and
5. elucidate the Lorentz's transformation of the electric and magnetic field.

Course Contents

Electrostatics and magnetostatics. Laplace's equation and boundary value problems. Multiple expansions. Dielectric and magnetic materials. Faraday's law. A.C. Circuits. Maxwell's equations. Lorentz's covariance and special relativity.

PHY 305: Quantum Physics **(3 Units C: LH 45)**

Learning Outcomes

Upon the successful completion of the course, the student should be able to:

1. discuss the process leading to the development of quantum physics (origin of quantum physics);
2. classify and explain the basic difference between classical and quantum physics;
3. explain the purpose and use of mathematical tools of quantum mechanics;
4. solve Schrodinger equation for simple 1D and 3D system; and
5. apply mathematical and physics skills to solve modern physics problem.

Course Contents

Wave-particle duality and the uncertainty principle. Basic principles of the quantum theory. Energy levels in potential wells. Reflection and transmission of potential barriers. Atomic and molecular structure. Nuclear reactions. Fission and fusion. Magnetic resonance and elementary particles.

PHY 306: Statistical and Thermal Physics **(3 Units C: LH 45)**

Learning Outcomes

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

1. describe the laws of thermodynamics from both a macroscopic and microscopic point of view;
2. apply the laws of thermodynamics to real physical system and processes;
3. describe the properties of ideal gases using Boltzmann statistics;
4. describe the differences between systems of bosons and fermions and how they arise from microscopic consideration.

Course Contents

Basic concept of statistical mechanics. Microscopic basis of thermodynamics and applications to macroscopic systems. Condensed states. Phase transformations. Quantum distributions. Elementary kinetic theory of transport processes. Fluctuation phenomena and applications.

PHY 307/308: Experimental Physics III & IV **(2 Units C: PH 90)**

Learning Outcomes

Upon completion of the course the student should:

1. be familiar with the basic physical principles underlying a variety of fundamental phenomenon in solid state;
2. classify solid state matter according to their bandgap;
3. account for the characteristic physical properties of different categories of sold materials, with an emphasis on the crystalline state;
4. give a wide spectrum of theoretical approach to model the mechanical, thermal and electrical properties of solid materials;
5. define superconductivity qualitatively relate it to lattice vibration and density of states.

Course Contents

A session long of series of mini courses on important experimental techniques. Topics to be covered include electronics, optics, electricity, atomic, molecular nuclear and low temperature physics, statistics and data handling and scientific writing.

PHY 314: Solid State Physics I **(3 Units C: LH 45)**

Learning Outcomes

Upon completion of the course, the student should be able to:

1. demonstrate knowledge of arrangement of atoms, crystal, lattice, unit cell, translational vector;
2. account for the basic physical principles underlying a variety of fundamental phenomenon in solid state;

3. classify solid state matter according to their bandgap;
4. explain the characteristic physical properties of different categories of solid materials, with an emphasis on the crystalline state;
5. elucidate a wide spectrum of theoretical approach to model the mechanical, thermal and electrical properties of solid materials; and
6. define superconductivity and qualitatively relate it to lattice vibration and density of states.

Course Contents

Crystal structure and crystal binding. Elastic properties. Lattice vibrations. Superconductivity.

PHY 315: Electronics **(2 Units C: LH 30)**

Learning Outcomes

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

1. explain the properties of semiconductors;
2. identify and list the properties of p-n junction, capacitors and inductors;
3. state the characteristics and uses of the components in rectification;
4. explain Op amps and analog computers; and
5. list and explain the transistor parameters, power supplies and causes of break down voltages.

Course Contents

Semiconductors, p-n junction. Capacitors and inductors. Transistors: Bipolar, FET. Amplifiers. Feedback. Transformers. Diodes: characteristics and uses in rectification. Zener diodes. Voltage doublers. Operational amplifiers (Op amps) and analog computers. Digital electronics: binary, octal and hexadecimal codes. Number system, designs and construction of simple circuits. Multivibrators: astable, monostable and bistable. Transistor parameters, power supplies, causes of break down voltages. Rectification.

GOU-IPH 383: Applied Geophysics (2 Units; Compulsory; LH = 15; PH = 45)

Senate-Approved Relevance

This course will ensure that students of Godfrey Okoye University experience an organization system for solid educational and acquisition of knowledge. The course will empower students with skills in seismic processing and groundwater exploration. Analysis of the earth's crust and overview of the environment above the earth's surface. The creation of the course was inspired by Godfrey Okoye University's commitment to produce graduates who will be outstandingly excellent in learning, balanced in character and personality and who have the required skills for the labour market. Through this course, the university intends to advance the producing capacity of its graduates in the knowledge of Geophysics as an indisputable study of the earth's physical characteristics.

Overview

The rocks do not differ only by their macroscopic or microscopic properties studied by field geologists or petrologists. They also differ in their chemical and physical properties. Hence as

the rocks differ according to their origin, structure, texture, etc. they also differ by their density, magnetisation, resistivity, etc. The bad news is that the physical properties do not always clearly correlate with geological classifications and do not necessarily easily translate into geological terms.
Therefore Applied Geophysics is the use of physics to study the interior of the Earth, from land surface to the inner core.

Objectives

The objectives of this course are to:

1. Define the concept of geophysics.
2. State the applications of physics in the geophysical examination.
3. Describe the importance of studying the physics of the earth.
4. Explain the advantages and disadvantages of seismic processing is applied.
5. Determine the lifespan of the earth's crust.
6. Determine the thickness of the crust.
7. Describe the process of hydrocarbon exploration in Geophysics.
8. Identify shallow structures of the earth for engineering site investigations.
9. Explain the processes of exploring groundwater sources using seismic methods.
10. Identify five minerals and other economic resources gotten through geophysical surveys.
11. Describe the processes involved in locating narrow mine shafts or other forms of buried cavities.
12. Identify the processes of locating buried pipes and cables.

Learning outcomes

On the completion of this course, the students will be able to:

1. Create the mapping of archaeological remains.
2. Establish in detail the problems involved in geophysical surveys.
3. Locate buried objects using seismic methods.
4. Map "apparent" physical properties.
5. Identify boundaries where physical property values change.
6. Create a detailed map of locations and depths of actual physical property values.
7. Describe how physical properties relate to geophysical work.
8. Determine a suitable geophysical survey, and design an effective and efficient field survey.
9. Identify possible sources of error, noise and misinterpretation.
10. Analyze geophysical data.
11. Plot the data, and apply appropriate processing and analysis.
12. Interpret results in terms of geological or geotechnical methods.
13. Correlate with prior and alternative information, and decide if the results are adequate for the particular problem.

Course Contents

A general survey of the elementary theory. Field methods of geophysical investigation. Computational methods. Curve fitting techniques. Methods of interpretation. Earth seismicity. Gravity. Minerals and rocks. Structure geology and petroleum. Origin. Migration and accumulation of petroleum sedimentary basin. Basins in Nigeria. Data acquisition methods. Data processing methods. Geophysical modelling techniques. Remote sensing. Basic concepts. Image processing. Image interpretation. Satellite data reception and transmission.

Minimum Academic Standards

Geophysics laboratory with NUC-MAS requirements facilities: Resistivity meter, simple land magnetometer, Gravity meter, Software for processing and interpretation of these data. Gravimeter, gravitational wave sensor, magnetometers, Electronic Distance Measurement (EDM) instruments, total stations, Global Positioning System (GPS) devices, Automatic levels, Ground Penetrating Radar (GPR), microgravity meter, MATRIX logger, Electromagnetic conductivity meter, geophone, seismographs, hand Lens, rock hammers, compasses, and field books.

GOU-IPH 384: Physical Metallurgy II (2 Units; Elective; LH = 15; PH = 45)

Senate-Approved Relevance

This course is geared towards producing physics graduates that will properly evaluate physical processes of metallurgical production for economic usage. It is intended to produce graduates with strong and excellent learning and personality culture, who are ready to pursue research to provide solutions to metallurgical problems in the locality of Enugu and beyond. This goal aligns with Godfrey Okoye University philosophy, which promotes through education, as dialogical process, the acquisition and dissemination of knowledge for societal wellbeing.

Overview

Material science also known as material science and engineering is a multidisciplinary field that deals with the discovery and design of new materials. Always new materials open the door to new technologies whether they are in chemical, civil, construction, nuclear, agricultural, aeronautical, biomedical, and electrical or mechanical engineering. The material science engineering includes the study of the relations between the synthesis, forming, properties, structure and performance of materials that enable an engineering function. The materials properties of interest can be electrical, mechanical optical or magnetic; the engineering function can affect industries involved in electronics, communications, transportation, manufacturing, medicine, recreation, environment, and energy.

Metallurgy is the art and science of making metals and alloys in shapes and with characteristics suitable for practical use. It is an applied science based on clear understanding of the structures and properties of metals and their alloys. Metallurgy has long occupied the dominant position as the most important engineering materials; steel being by far the most important over the last few centuries. However, increasingly in many areas other materials such as ceramics, plastics and composites are challenging this position. The relatively recent development of material science and engineering is a merger of metallurgy with others like glass and ceramic technology, mineralogy, physical and inorganic chemistry, solid state physics, and polymer science in modern techniques to include all structural and functional materials, thus making it one of the widest of study discipline.

Objectives

The objectives of this course are to:

1 .Describe the behavior of alloy systems.
2. Explain the diffusion laws.
3. State different transformation processes in metal and alloy systems.
4. Discuss the divorced eutectic, super cooling, interface calculation.
5. Identify nucleation and growth reaction.
6. Explain the kinetics of solid state.
7. Examine the different processes.

8. Describe optical microscopy.

Learning outcomes

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

1. Differentiate between ideal and non- ideal behavior of alloys.
2. State diffusion laws.
3. Identify transformation stages in metals.
4. Differentiate between homogeneous and heterogeneous nucleation.
5. Explain dendritic solidification divorced eutectic, super cooling interface calculation.
6. Identify a segregated precipitation.
7. Interpret optical microscopy of images gotten.

Course Content

Ideal and non-ideal behavior of alloy systems. Diffusion laws. Kirkendall effective. Activation energy. Uphill diffusion. Transformation in metals and alloys. Solidification and solid state transformation. Nucleation and growth reactions. Homogeneous and Heterogeneous nucleation. Dendritic. Solidification. Divorced eutectic. Super cooling. Interface. Calculation. Kinetics of solid state. Transformation. C-curve. Segregation precipitation reaction. Diffusional. Phase Transformation. Process. Short range. Diffusional. Long range diffusional process like polymorphic. Transformation. Massive transformation. Recrystallization. Precipitation transformation. Order disorder. Eutectoid. Spinoidal transformations. Optical microscopy. Construction. Image formation and resolution.

Minimum Academic Standard

A metallurgical workshop with NUC- MAS requirement facilities: bucking plates and taylor hand crusher, sampling table, ore bins, pounding block, upright engine, morel agate mortars, dynamo, 50V by 50 A, dynamo, 2 V by 50 A, revolving barrel, depositing table, leaching tubs, milling room, blake challenge rock breaker, larger amalgamating pans, small amalgamating pans, settler, tank, space to grow in, store room, drilling machine, carpenters bench, ball mill, lithographic notes, toilet room, lockers, basins, assay room, students desks, pulp balances, muffle furnances, crucible furnances, stack, iron table, black smiths forge, anvil, glass cases, electric lantern, electric blue print frame, chemical hoods, steam driers, gas driers, scanning probe microscopy, spectrophotometers, rheometers/viscometers, digital pressure meter

GOU-IPH 385: Chemical Metallurgy (2 Units; Elective; LH = 15; PH = 45)

Senate-Approved Relevance

Imparting quality education aimed at producing graduates who are highly skilled and knowledgeable in the evaluation of physical metallurgy for economic uses is in line with the vision of the Godfrey Okoye University to produce physics graduates with strong personality that will promote epistemological dialogue. The course intends to provide solution for metallurgical problems in the Enugu locality of the university and its environs. The goal of this course also aligns with the philosophy of Godfrey Okoye University to produce physics graduates that will properly evaluate chemical processes of metallurgical production for various economic usage.

Overview

Chemical metallurgy is the science of obtaining metals from their concentrates, semi products, recycled bodies and solutions, and of considering reactions of metals with an approach of disciplines belonging to chemistry. As such, it involves reactivity of metals and it is chiefly concerned with the reduction and oxidation, and the chemical performance of metals. Our need for the materials with specific properties have led to production of many metal alloys. It is essential to design an eco-friendly metallurgical process that would minimize waste, maximize energy efficiency. Such advances in metallurgy is vital for the economic and technical progress in the current era.

In this course students will study the various steps involved in the extraction of metals and the chemical principles behind these processes to produce material that are efficient and eco-friendly.

The Objectives

The objectives of this course are to:

1. Examine the basic concepts used in Metallurgy.
2. Discuss Materials Engineering with real-life practical examples
3. Examine and apply the principles of metal ion solvation and complexation in concentrated solutions. .
4. Explain the different types of extractants, diluents and modifiers, the different equipment used in industrial solvent extraction, and the application of solvent extraction in extractive metallurgy.
5. Explain the different types of ion exchange resins, ion exchange membranes, and different column elution protocols. The application of ion exchange in extractive metallurgy.
6. Examine the advantages and disadvantages of solvent extraction versus ion exchange.
7. Discuss the hydrometallurgical unit operations.
8. Explain the principles of solvometallurgy (solvent leaching, nonaqueous solvent extraction, nonaqueous ion exchange).
9. Compare between solvometallurgy and hydrometallurgy.

Learning Outcomes

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

1. Examine different raw materials and there pretreatments, ore processing methods, separation techniques through surface enlargement and reduction processes.
2. Discuss General characteristics of material processes.
3. Discuss the processes of chlorination, sulfation, oxidation, sinter roasting, alkali roasting, selective evaporation, selective decomposition, calcination, mat formation/melting, slag formation/melting.

4. Explain reducing melting processes, reducing evaporation processes, molten salt reduction, metallothermic reduction aluminothermic, silicothermic, magnesiothermal
5. Explain the flow chart of the production and refining of any metal depending on the physicochemical properties of that metal
6. State the general properties of hydrometallurgy, leaching methods (in-situ, heap, pressure leaching), dissolution processes and crystallization processes.
7. Discuss Precipitation with additives, precipitation with gases, selective precipitation under pressure; have knowledge about solvent extraction, McCabe-Thiele Diagrams and their applications, reaction kinetics.
8. Explain the extractive metallurgy of rare earths in all its aspects.
9. Examine the processing of spent nuclear fuel in all its aspects.

Course Content

Raw materials. Ore. concentrate and scrap. Pyro metallurgy. Formation of oxide. Chloride. Sulfur and Carbide with the help of Ellingham diagrams. Vapor pressure-temperature relationship of metallic components with the help of PT diagrams. Roasting. Evaporation. Calcination. Mat formation/melting. Slag formation/melting. Reduction. Reducing melting processes. Refining. Hydrometallurgy. Leaching. Solution processing. EMF series. Solvent extraction. Mc-Cabe Thiele diagrams. Electrometallurgy. Cementation. Reduction electrolysis. Refining electrolysis. Molten salt electrolysis. Polarization diagrams. General knowledge of reaction kinetics.

Minimum Academic Standard

A chemical metallurgical laboratory: iron chromatography, water quality meter, potentiostat, environment chamber resistivity meter and soil box, geosynthetic pressure vessel, multiaxial burst test frame, universal test machine, cavitation tester, erosion tester, impact tester, corrosion test cells, potentiostat, water immersion tanks, ultraviolet chambers, salt frog chambers, electrochemical test system, potential drop device, magnetic stirrer and heater, precision balance device

GOU-PHY 386: Corrosion and Protection (2 Units; Compulsory; LH = 15; PH = 45)
Senate-Approved Relevance
This course investigates the physical and chemical processes of metal degradation and provide solution to that effect. The goal of the course is to study how corrosion affects industries. The course is very useful for Enugu and its environs, localities that are saturated with small and big scale industries. Imparting quality education aimed at producing Graduates who are strong in personality that will promote epistemological dialogue is in line with the vision of the Godfrey Okoye University to produce physics graduates who are strong in learning, balanced in character and personality and ready to provide solution to societal needs.
Overview
Corrosion—the degradation of materials, including metals, concrete, polymers, and other materials—costs the global economy 3 to 5% of the global Gross Domestic Product (GDP) annually. Besides its financial impact, corrosion affects health, safety, and the environment. Corrosion affects all industries, such as oil and gas and resources sectors, and most aspects of human activities.
This course will enable students to evaluate corrosion processes and sort out optimal corrosion management practices to maximize efficiency, ensure safe and environmentally compliant operations.

The Objectives
The objectives of this course are to**:**
1. Discuss the principles of deterioration (corrosion) to prevent the deterioration of materials: metals, ceramics and polymers.
2. Explain the electrochemical basis of iron corrosion in both acidic and basic environments.
3. Identify the primary oxidation and reduction reactions for corrosion.
4. Differentiate between chemical and atmospheric corrosion.
5. Differentiate between general corrosion and localized corrosion.
6. Examine the conditions necessary for localized corrosion.
7. Describe what is meant by a passive metal.
8. Identify common passive metals.

Learning Outcome
On completion of this Course, students should be able to:
1. Explain and calculate the causes of deterioration of materials and to determine the ways of protection from corrosion.
2. State the importance of corrosion in engineering applications.
3. Differentiate between corrosion types.
4. State the properties of corrosion type and emergence theories.
5. Determine the thermodynamics and kinetics of the corrosion reaction.
6. Explain why stainless steel is more corrosion resistant than other steel.
7. Describe methods for minimizing corrosion, including sacrificial anodes, impressed voltage and chemical schemes.
8. Identify the electrochemical basis behind the methods used to minimize corrosion.

Course Content
Introduction to Corrosion. Corrosion Control. Corrosion Mechanisms. Thermodynamics of deterioration. Kinetics of deterioration (corrosion). Different corrosion types. Passivation. Measurement of deterioration. Corrosion galvanic and concentration cells. Pit and crevice

corrosion. Environmentally induced cracking. Effect of material structure on deterioration. Corrosion of different materials. Corrosion in selected environments. Atmospheric corrosion and oxidation. Cathodic protection. Methods of minimizing corrosion. Corrosion issues in industries.

Minimum Academic Standard

A chemical laboratory with NUC-MAS requirement: iron chromatography, water quality meter, potentiostat, environment chamber resistivity meter and soil box, geosynthetic pressure vessel, multiaxial burst test frame, universal test machine, cavitation tester, erosion tester, impact tester, corrosion test cells, potentiostat, water immersion tanks, ultraviolet chambers, salt frog chambers, electrochemical test system, potential drop device, magnetic stirrer and heater, precision balance device.

GOU-IPH 387: Robotic Systems (2 Units; Compulsory; LH= 15; PH = 45)

Senate-Approved Relevance

This course is fashioned to equip students with concepts complementary with applications that will advance the producing capacity of those graduates in creative works of design, programming and construction of robots and high-tech robotic devices. The course is developed in line with Godfrey Okoye University's mission to produce graduates who will be outstandingly excellent in learning, balanced in character and personality and ready to pursue epistemic unity in all its ramifications. Through this course, students will be empowered with skills for the labour market.

Overview

This course is an overview of robotic and automated systems technology. The student will be introduced to basic manufacturing techniques, robot terminology, and different types of automation, safety, basic robotic programming, interfacing robotic communications, automated work cells, and robotic applications.

In our world of today where technological advancement has become the new order, the knowledge of Robotics can never be overemphasized. The world of the near future will be a world saturated with robotic technology in every field of life. Robots have been confirmed as the nearest version of humanity as many are programmed with advanced artificial intelligence which enables them to perform billions of calculations and analyses in nanoseconds. Therefore, the functionality of such robots outweighs the human brain. Recently robotic parts are configured with advanced silicon technology that clones human resemblances. Students are shown the fundamentals of Robotics systems and in practice, how they can build a robot from scratch.

Objectives

The objectives of this course are to:

1. Define Robotics.
2. Describe the relationship between robotics and artificial intelligence.
3. Explain the processes involved in robotic system design.
4. Differentiate between the hardware and software of a robotic system.
5. Describe the steps in programming a robot.
6. Analyze the automated manufacturing as a step in robotics system design.
7. Determine the cost of designing and constructing a prototype robotic system.
8. Describe the maintenance process for a robotic system.
9. Design and construct a control system with robotic features.
10. Discuss the usefulness of artificial intelligence in robotic systems.
11. Enumerate the basic applications of a robotic system.
12. Determine the lifespan of tools used in the design and manufacturing of robots.

Learning Outcomes

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

1. Explain the meaning and applications of Robotic systems.
2. Define the types of manufacturing systems and their relationship to Robotics and Automated Manufacturing.
3. Explain the major components of robotic systems.
4. Discuss the function of the robot arm, controller, and power source.
5. Define end-of-arm tooling.
6. Define teaching/programming devices and data storage.
7. Explain the definition of the characteristics term of robotic systems.
8. Explain the Degree of Freedom, Position Axes, and Orientation Axes.

9. Define Work Envelope.
10. Define Tool Center Point.
11. Explain the critical specifications of payload, degrees of freedom, repeatability, accuracy, work envelope dimensions, speed, programming support, and environmental requirements.
12. Locate and identify all components of the robotic cell including all equipment, operator interfaces, tooling, perimeter guarding, safety devices, etc.
13. Identify and practice all safety considerations related to operating the robotic cell.

Course Content

Introduction. Devices. Roles in Robotic safety. Classification of robotic systems. Arm geometry of robotic systems. Open-loop systems. Closed-loop systems. Sensors used robotic systems. End-of-arm tooling. Robotic applications. Methods of programming in robotics systems. Numbering systems for robotic application. Robotics and Artificial Intelligence. Power ON procedure for robots. Position and Orientation Axes. Coordinate systems. Jogging of robots. Design of simple robotic system prototype.

Minimum Academic Standards

Computer hardware workshop with NUC-MAS requirements facilities: Analog and Digital Motor Control Teaching Set, Transducer and Instrumentation Trainer kit, Pneumatic and Electro pneumatic Trainer Kit, Hydraulic Trainer, Inverted Metallurgical Microscope, Robotics Training System, wheels, nuts, bolts, and battery holders, switches, batteries, wires, resistors and LEDs, microcontrollers, pliers, wire cutters, soldering irons, test equipment, oscilloscope, multimeter, variable power supply, signal generator, logic probe, frequency meter, insulation displacement connector, RJ45 network connector.

400 Level

PHY 401: Quantum Mechanics (2 Units C: LH 30)

Learning Outcomes

Upon completion of the course, the student should be able to:

1. demonstrate a clear and structured approach for solving problems;
2. compute the angular momentum of a wave function using operators;
3. describe and compute Eigen functions of the angular momentum operators;
4. explain the relationship between quantum spin and angular momentum; and
5. apply spin operators to a simple ½ system to perform calculations.

Course Contents

The formulation of quantum mechanics in terms of state vectors and linear operators. Threedimensional spherically symmetric potentials. The theory of angular momentum and spin.
Identical particles and the exclusion principle. Methods of approximation and multielectron atoms.

PHY 403: Mathematical Methods in Physics (2 Units C: LH 30)

Learning Outcomes

After successfully completing the course, the student should be able to:

1. use complex analysis in solving physical problems;
2. solve ordinary and partial differential equation of second order that are common in the physical science;
3. use the orthogonal polynomials and other special functions; 4. use fourier series and integral transformation; and

5. use the calculus of variations.

Course Contents

Linear Algebra and Functional Analysis. Transformations in linear vector spaces and matrix theory.

Hilbert space and complete sets of orthogonal functions. Special functions of Mathematical Physics: the gamma function, hypergeometric functions, Legendre functions, Bessel functions, Hermite and Laguerre function. The Dirac Delta function. Integral Transforms. Fourier Series: Fourier series and Fourier transforms. Laplace transform. Applications of transform methods to the solution of elementary differential equations of interest in physics and engineering. Partial differential equations. Solution of boundary value problems of partial differential equations by various methods which include: separation of variables, the method of integral transforms, SturmLiouville theory. Uniqueness of solutions. Calculus of residues and applications to evaluation of integrals and summation of series. Applications to various physical situations, which may include electromagnetic theory, quantum theory and diffusion phenomena.

PHY 415: Science of Materials **(2 Units C: LH 30)**

Learning Outcomes

After successfully completing the course, the student should be able to:

1. differentiate between ductility and hardness;
2. differentiate between toughness and hardness;
3. explain glass transition temperature, amorphous semiconductor and fibre optics;
4. distinguish between cis and trans polymers;
5. explain steel phase diagram;
6. explain interface properties; and
7. discuss the principles of imaging techniques in nano structures.

Course Contents

General introduction of materials. Mechanical properties of materials: stress, strain, ductility, hardness, toughness and fatigue. Non–Crystalline materials: glasses, amorphous, semiconductors, fibre optics. Organic materials: conducting polymers, organic metals. Alloys: steel, phase diagram. Surfaces: reconstruction, relaxation, work function. Interfaces: magnetoresistance, integral and fractional quantum hall effect, giant magnetoresistance, heterostructures. Nanomaterials: Imaging techniques, electrical and thermal properties.

PHY 423: Solid State Physics II **(3 Units C: LH 45)**

Learning Outcomes

After studying the course, the student should be able to:

1. explain the dielectric properties of solid;
2. define dielectric constant, polarizability and susceptibility;
3. explain magnetization of materials;
4. differentiate between diamagnetism and Para magnetism; 5. differentiate between ferromagnetism and anti-ferromagnetis; and
6. explain magnetic resonance and the various imperfection in solids.

Course Contents

Dielectric properties. Magnetism: paramagnetism and diamagnetics. Ferromagnetism and antiferromagnetism. Magnetic resonance. Imperfections in solids.

PHY 432: Electromagnetic Theory II **(3 Units C: LH 45)**

Learning Outcomes

On completion of the course, the student should be able to:

1. use Maxwell's equation describe propagation of electromagnetic waves;
2. solve for retarded and advanced potentials; 3. classify and design antenna arrays; and
4. apply radiation from moving charges.

Course Contents

Maxwell equations. Poynting vectors. Propagation of electromagnetic waves. Polarization, reflection and refraction of electromagnetic waves. Retarded and advanced potentials.

Transmission lines, wave guides, resonant cavities, antenna arrays and radiation from moving charges.

PHY 455 Student Research Project **(6 Units C: PH 270)**

The course offers students the opportunity to do research in contemporary physics and under the supervision of staff. A detailed report on the research is presented by the students when the project is completed.

Learning Outcomes

On completion of this course, student should be able to:

1. apply knowledge in design and fabrication of solar panels;
2. build wind mills and generate energy;
3. design and construct solar distillation systems; and

4. install solar panels in houses.

Course Contents

Fabrication and installation of solar panels for electricity generation. Design and construction of solar cookers. Design and construction of solar distillation systems. Demonstration of different forms of renewable energy.

GOU-IPH 416: Borehole Geophysics (2 Units; Compulsory; LH = 15; PH = 45)

SENATE-Approved Relevance

Borehole geophysics is the science of recording and analyzing measurements of physical properties made in wells or test holes. Probes that measure different properties are lowered into the borehole to collect continuous or point data that is graphically displayed as a geophysical log. Multiple logs typically are collected to take advantage of their synergistic nature much more can be learned by the analysis of a suite of logs as a group than by the analysis of the same logs individually. This course is developed in response to the commitment of Godfrey Okoye University to produce graduates who excel in academics and moral character and who are ready to champion the course of societal development, especially in the area of water exploration and borehole drilling for efficient water supply in Enugu and its environs. Geophysics, being an indisputable study of the earth's physical characteristics, the students are empowered with the skills required to analyze the earth's crust and discover water channels below the earth's crust.

Overview

Water is a very rare and costly commodity in Enugu. This course is designed to resolve the challenge of water in Enugu and its environs. The course gives basics for the interpretation of graphically displayed data from logs which can be used in groundwater, oil, and environmental investigation to obtain information from wells. It is an introduction to the measurements of physical properties that are done in wells. It explains the different techniques and tools that are used to collect the data. The rocks do not differ only by their macroscopic or microscopic properties studied by field geologists. They also differ in their chemical and physical properties. Hence as the rocks differ according to their origin, structure, texture, etc. they also differ by their density, magnetization, resistivity, etc.

Borehole geophysics is used in groundwater and environmental investigations to obtain information on good construction, rock lithology and fractures, permeability and porosity, and water quality. The geophysical logging system consists of probes, cable and draw works, power and processing modules, and data recording units. State-of-the-art logging systems are controlled by a computer and can collect multiple logs with one pass of the probe.

Objectives

The objectives of this course are to:

1. Define the concept of geophysical drilling.
2. State the applications of geophysics in borehole drilling.
3. Describe the importance of studying the physics of borehole drilling.
4. Explain the advantages and disadvantages of seismic processing in borehole drilling.
5. State the list of hydrogeologic units.
6. Explain the processes involved in examining groundwater quality.
7. Define logging in borehole drilling.
8. State the types of logging in borehole drilling.
9. List five types of equipment used in logging.
10. Integrate borehole geophysics logging with water-quality sampling.

11. Define wells, types of wells and the process of well construction and conditions.

Learning outcomes

On the completion of this course, the students will be able to:

1. Define the fundamentals of rock physics.
2. Explain the recovery factor of hydrocarbon reservoirs.
3. Integrate the relationship between borehole measurements and surface measurements.
4. Describe the scale limitation of the surface data and the limitations of borehole data.
5. Explain the concept of good logging.
6. Explain surface seismic methods in borehole geophysics.
7. State the tools used in borehole drilling.
8. Conduct ground surface analysis for tracking water channels.
9. Mention the ways of accumulating data in borehole seismic methods.
10. Describe borehole imaging and pore pressure prediction.
11. State the uses of borehole radars and acoustic televiewers in borehole drilling.
12. Estimate the cost of borehole drilling.

Course Contents

Concept of logging techniques. Electrical logging methods. Conventional resistivity logs. Focused electrode logs. Induction logs. Micro-resistivity logs. Self-potential. Gamma-ray logs. Induced polarization. Dip meter. Porosity logs. Sonic logs. Formation - density. Neutron logs. Neutron-density logs. Determination of lithology. Porosity. Saturation. Permeability in clay. Logs in reservoir characterization.

Minimum Academic Standards

Geophysical laboratory with NUC-MAS requirements facilities: Dip meter for measuring depth, Resistivity logging tool, Density logging tool, software for processing and interpretation, a geophysical work station laboratory, Fluid temperature meter fluid resistivity meter, mechanical calliper, optical and acoustic televiewers, natural gamma, borehole flow meters, heat-pulse flow meter, flow impeller, electric resistivity meter, secchi disk, moisture analyzer, probes, gauges, reflective goniometer, petrographic microscope.

GOU-PHY417: Thin Film and Solar Technology (2 Units; Compulsory, LH = 15; PH = 45)

SENATE-Approved Relevance

This course is fashioned in line with the philosophy of Godfrey Okoye University towards producing physics graduates who are armed with concepts complementary with applications that will advance the producing capacity of those graduates in the knowledge of thin film deposition and processing. This knowledge will empower them with skills in the production of semiconductor devices, memory chips, silicon wafers for solar cell design, anti- reflective coating for glasses and many more. On graduation, the student is empowered with both theoretical and practical knowledge to fit in any solar cell manufacturing company and thin film research center.

Overview

Thin film technologies are processes for depositing and processing thin layers from a few microns thick down to individual atomic layers. The materials used as the substrate and the applications vary widely and we are surrounded by them in our everyday lives: Pro-cessors and memory chips on silicon wafers for modern microelectronics, hard coatings on drill bits, decorative iridescent layers on gemstones, antireflective coatings on glasses, antibacterial metal coatings on medical devices, flexible solar cells or even coatings for food packaging and medicines on miles of foil.

To be able to deposit such thin layers with well -defined characteristics, the atoms and molecules that form a layer are usually collected from the gas phase at very low pressure (vacuum) so that the concentrations can be closely controlled. When the layer is formed by condensation or re-sublimation, the process is called physical vapour depos-ition (PVD). On the other hand, when a layer is formed through chemical reactions, it is called chemical vapour deposition (CVD). Thin film technologies also include methods for modifying, masking and removing the coatings. Students who do this course can offer advice on how to choose the appropriate physical and chemical conditions for particular application as well as conditions specific to production facility.

Objectives

The objectives of this course are:

1. Define thin film technology.
2. Define the concept of deposition in thin film technology.
3. State the applications of thin film technology.
4. Analyze the relationship between thin film and solar technology.
5. State the processes involved in the design of flexible solar cells using thin film deposition.
6. Identify instruments used in the study of thin film.
7. State the commonly used types of thin film materials.
8. Describe the differences between physical and chemical deposition.
9. Explain the benefits of thin film applications.
10. State the characteristics of thin film.
11. Explain the process of electroplating using thin film deposition.
12. Describe the structure and morphology of thin film.

Learning outcomes

On the completion of this course, the students will be able to:

1. Define the concept of thin film.
2. Explain deposition in thin film technology.
3. Describe the deposition techniques in thin film.

4. State the applications of thin film technology.
5. State the similarities between thin film and solar technology.
6. Estimate the lifespan of a thin film material.
7. Identify instruments used in thin film analysis.
8. Define Nucleation as the process of growth of thin films.
9. Mention materials developed using thin film technology.
10. Define the concepts of stress and strain in thin films.
11. Describe the methods involved in measuring the stress and strain of thin film materials.
12. Explain the process of manufacturing thin film photovoltaic cells.
13. Develop a thin film optical and protective coating material as a final project.

Course Contents

Introduction to thin films. Deposition of thin films. Characterization of deposited films. Methods of deposition. Physical technique. Chemical techniques. Scanning electron microscope (SEM). Transmission electron microscope (TEM). Solution growth technique (SGT). Chemical vapour deposition (CVD). Physical vapour deposition (PVD). Epitaxial growth. Molecular Beam Epitaxy. Sputtering. Spray pyrolysis. Spin coating. Sol-gel Dip coating. X-ray diffraction.

Minimum Academic Standards

Thin film technology laboratory with NUC-MAS requirements facilities: Batch systems (single chamber or multiple wafers) cluster tool (multi-chamber or single wafers), factory or free standing laboratory, bench top, polymers, carbon-based compounds, sputtering devices, cellulose nitrate, cellulose acetate, polyester, sputter coaters, carbon coaters, thermal evaporators, and PLD systems, digital micrometers, four point probe, PVD, electron beam evaporator, magnetron sputtering device, effusion cells, ion beam sputtering device, glow discharge, PECVD, reactive ion etcher, atomic layer deposition device.

Minimum Academic Standards

Equipment

Description	Quantity
Meter rule	40
½ Meter rule	40
Venier Callipers	10
Screw Gauge	10
Beaker-various sizes	10 each
Chemical Balance	5
Travelling Microscope	15
Spring Balance (various)	5 each
Stop Watch	20
Retort Stand	20
Slotted Weights	
Spiral Spring	
Knife Edge	

Inclined Plane	10
Prisms (various)	
Optical Pins (boxes)	15
Drawing Board	15
Optical Benches	10
Converging lens (Various Focal lengths)	10 each
Ray box	10
Diverging lens (various focal lengths)	10 each
Ammeter (various types and ranges)	0 each
Voltmeter (various types and ranges)	10 each
Rheostat (various ranges)	10each
Resistors (various ranges)	20 each
Resistance box (various ranges)	5 each
Key	20
Potentiometer	10
Metre bridge	10
Galvanometers (various types and ranges)	10 each
Daniel Cell	10
Leclanche Cell	10
Calorimeter	10
Thermometer (various types and ranges)	100
Battery (various ranges)	10
Lee's conductivity apparatus	5
Connecting wires (various Lengths)	20 each
Boyle's Law apparatus	5
Linear expansion apparatus	5
Equation of State of Ideal gas apparatus	5
Maxwellian velocity distribution apparatus	5
Tuning fork (various)	10
Resonance tube	10
Ripple tank	10
Air Track	10
Specific gravity bottle	10
Glass Capillary tubes	100
Young's Modulus apparatus	5
Rectangular glass block	20
Moment of inertia& angular momentum apparatus	5
Free fall apparatus	5
Phite Screen	10
Lens Holder	100
Sonometer box	10
Concave mirror (various radii)	20 each
Convex Mirror (various radii)	20 each
Bunsen Burner	10
Spectrometer	5
Mercury Lamps	5
Sodium Lamps	5

Water Distillation apparatus	2
Battery Charger and accessories	2
Wall Clock	2
Refrigerator	2
Centre-zero (universal moving coil) Galvanometer	5
Thermal Conductivity apparatus	5
Vapour Pressure apparatus	20
Oscilloscope (various types)	10
Dry Batteries	20

Intermediate and Advanced Physics

As in the case of General Physics, the list below is not exhaustive. Some of the equipment listed under General Physics are also used in this level and so need not be listed here.

	Description	Quantity
1.	Signal generator (various types)	10
2.	Low voltage power supply	10
3.	H.T. Power Supply	5
4.	Transformers (various grades)	5
5.	Avometers 5 6. Refractometers 5 7. Polarimeter	5
8.	Leser spectral unit with power supplies	5
9.	Michelson interferometer	5
10.	Digital Meters	5
11.	Plotters	10
12.	Capacitance meter	10
13.	Recorder	10
14.	Video Monitor	5
15.	Stabilizers	10
16.	Pulse generators	5
17.	Microscope	5
18.	Amplifier	10
19.	Multivibrator 5	
20.	Transistor (various types)	
21.	Radioactive Source	2 22. Ionization Chamber 5
23.	Ratemeter	5
24.	Digital Counter	5
25.	Diffraction grating	5
26.	X-ray tube	5
27.	Cathode ray tube	5
28.	Helmholtz Coils	
29.	Electric oven	
30.	Thermocouple	5

31.	Filters		
32.	Electromagnet	5	
33.	GM – Counter	5	
34.	Atomizer		5
35.	Frank Hertz Tube		5
36.	Cadmium Lamp and accessories		5
37.	Lummer-Gehrcke Plate		5
38.	Coils	5	
39.	Inductors		
40.	Capacitors		
41.	Thermistor		5
42.	Photocell		
43.	Diodes		
44.	Loudspeaker		
45.	Digital Multimeter		5
46.	Function generator (various ranges)	5	
47.	Biprisms		
48.	Simpson meter		5
49.	Noise generator		5
50.	Flux Meter		5
51.	Microphones		
52.	Coaxial cable		

53. Electrostatic voltmeter 5 54. Van de graaf Generator 2 55. Luminescence tube 5 56. Immersion heater 5

57.	Diesel engine model four stroke		2
58.	Model of four stroke engine	2	
59.	Micro-computers		20
60.	Softwares		Several

Staffing

Academic Staff

There should be a minimum of six academic staff available for the industrial physics programme.

Staff-Student Ratio

Determination of the number of academic staff required for an academic programme is contingent on the approved staff-student ratio for each discipline. The approved Staff-Student ratio for Sciences Discipline is 1:20.

Staff – Mix by Rank

Academic staff in the Universities are broadly classified into three categories; Professorial (Professor/Reader), Senior Lectureship and Lecturers Grade I and below. The Professorial cadre should constitute a maximum of 20 percent of the staff strength while the remaining two should constitute 35 and 45 percent respectively.

Academic Support Personnel

Teaching Assistants/Demonstrators to help lecturers in the conduct of tutorials, practicals and field work.

Senior Administrative Staff

The faculty shall have the following senior administrative staff who shall be responsible to the Dean:

1. Faculty Officer – not below Assistant Registrar
2. Two Executive Officers
3. A Secretary

The services of the administrative support staff are indispensable in the proper administration of Departments and Faculty offices. It is important to recruit very competent, computer literate senior staff. Each Department should have a Secretary to each Head of Department.

Technical Support Personnel

The services of technical support staff, which are indispensable in the proper running of laboratories and workshops, are required. It is important to recruit very competent senior technical staff to maintain teaching and research equipment. They are also to undergo regular training to keep them abreast of developments in equipment operation and maintenance.

Junior Staff

The faculty shall have non-teaching support staff who shall be responsible to the Dean such as Secretary, Clerical Officer, Driver, etc. Each Department shall have a Secretary, Clerical Officer and other support staff as may be required.

Library

Universities should leverage on available technology to put in place rich databases and other electronic/digital library and information resources. In addition well stock and current hardcopies of reference and other textual materials should be provided centrally at the level of the Faculty. A well network digital library should serve the entire university community. Availability of wireless facilities (Wifi) with adequate bandwidth should enhance access to these electronic resources.

In any case, there should be internet ready workstations available in the library for least 25% of the total student enrolled in each academic programme. The funding of the library should be in line with NUC guidelines.

Classroom, Laboratories, Workshops and Offices

Classroom Accommodation

The NUC standard requirement of $0.65m^2$ per full-time student is maintained. Thus the minimum total space requirement of a Faculty or Department shall be the product of its total Full Time Equivalent student enrolment (FTE) and the minimum space requirement per full-time equivalent i.e. (FTE) $0.65m^2$.

Office Accommodation

In this respect, each academic staff should have an office space of at least 25 square metres taking into cognisance the status/cadre of the staff.

In addition, there should be for the Faculty, a Dean's office and for each Department a Head of Department's office with attached offices for their supporting staff as specified below in m^2:

Professor's Office	-	18.50
Head of Department's Office	-	18.50
Tutorial Teaching Staff's Office	-	13.50
Other Teaching Staff Space	-	7.00
Technical Staff Space	-	7.00
Secretarial Space	-	7.00
Staff Research Laboratory	-	16.50
Seminar Space/per student	-	1.85
Laboratory Space	-	7.50

Laboratories and Equipment

To achieve the benchmark statements for any programme, there should be:

1. minimum number of identifiable laboratories for each programme which should be in accordance with the recommended space requirements and, in addition, be adequately equipped; and

2. at least one large and reasonably equipped central laboratory for teaching and research.