SYLLABUS FOR SCI - J155

PHYSICS

GENERAL OBJECTIVES

At the end of the courses in this syllabus, candidates should be able to:

1. describe various physical phenomena at the microscopic and macroscopic levels;
2. analyse and apply Physics laws and principles to solve real life problems;
3. design, implement and draw meaningful inferences from the results of experiments;
4. explain natural and physical phenomena using Physics laws and concepts;
5. develop and enhance creativity in students in their day to day activities;
6. prepare students for further and higher studies in Physics and Physics related courses; and
7. acquire adequate Physics knowledge that will enable them to cope with modern technological trends.

FIRST SEMESTER COURSES

PHY 001: MECHANICS AND PROPERTIES OF MATTER (3 UNITS)
PHY 002: HEAT, WAVES AND OPTICS (3 UNITS)

SECOND SEMESTER COURSES

PHY 003: ELECTRICITY AND MAGNETISM (3 UNITS)
PHY 004: MODERN PHYSICS (3 UNITS)

COURSE DESCRIPTION

PHY 001: Mechanics and Properties of Matter (3 UNITS)

SPECIFIC OBJECTIVES

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

i. differentiate between fundamental physical quantities and derived quantities;
ii. apply the concept of dimensional analysis;
iii. define and explain various physical laws in relation to mechanics and solve problems using the laws, principles and theories of mechanics;
iv. describe and explain physical phenomena in relation to fluid mechanics; and
v. acquire basic physical techniques for carrying out experiments in mechanics.

Course Content

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
1.	Physical quantities and units	Definition of Units, Unit Conversion and Measurements, Methods of Measuring Length, Mass and Time. Basic and Derived Units, Dimensional Analysis.	Definitions to include length, mass and time. Dimensional Analysis to involve length, mass and time only. Students should be made to explain:

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
			i. the importance of dimensional analysis; and ii. the difference between weight and mass. Emphasis should also be placed on: i. Error analysis and significant figures; and ii. Graphical analysis. **Suggested experiment/activity:** i. Measurement of length, mass and time using relevant measuring instruments.
2.	Vectors	Addition and Subtraction of Vectors, Resolution of Vectors. Vector Multiplication, Vectors in Cartesian Coordinate System.	Scalar and vector quantities, and vector representation are pre-requisites.
3.	Kinematics	Types of Motion	Translational, random, oscillatory, and rotational.
		Linear Motion	Distance, displacement, uniform speed, uniform velocity, uniform acceleration
		Graphs of kinematic equations. Average and instantaneous speed, velocity and acceleration. Motion in two and three dimensions. Relative motion in one and two dimensions, Free Fall, Projectile Motion.	**Suggested experiment/ activity:** i. Measurement of velocity, ii. Measurement of acceleration. iii. Computer simulation of a free-falling body
4.	Dynamics	Newton's Laws of Motion, types of Force, Frictional force, Equilibrium of Forces, Motion in inclined planes, Centre of Mass and Centre of Gravity, Moment of a Force, Linear Momentum and its Conservation Laws, Elastic and Inelastic Collisions. Collision in two Dimensions.	Students should be made to understand: i. Equilibrium of parallel forces ii. Equilibrium of forces acting at a point. **Suggested experiment/activity:** i. Investigation on the proportionality of acceleration and force. ii. Investigation of the laws of equilibrium for a set of coplanar forces. iii. Investigation of contact forces – static and dynamic friction. iv. Verification of the principle of conservation of momentum.

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
5.	The Gravitational Field	Newton's Universal Law of Gravitation, Field Strength, G and its Measurement, Gravitational Potential, Kepler's Laws of Planetary Motion, Satellite Motion and Escape Velocity.	Students should note these points: i. The relationship between Gravitation constant G and the field strength g. ii. Variation of field strength g with altitude. iii. Application to parking orbits.
6.	Work, Energy and Power	Work, Energy: Sources, Types, Conversion and Conservation, Principle of Conservation of Mechanical Energy, Power.	Students should be able to: i. differentiate between Renewable and non-renewable sources with examples. ii. convert units of power to include kilowatt-hour and horse-power.
7.	Circular and oscillatory motions	Angular Displacement, Angular Velocity, Angular Acceleration and Torque, Angular Momentum, Centripetal Acceleration, Centripetal Force, Rotational Kinetic Energy, Work Done in Rotation, Conservation of Angular Momentum. Simple Harmonic Motion, Energy in Simple Harmonic Motion, Damped and Forced Oscillations, Resonance.	Students should be able to: i. differentiate between centripetal and centrifugal acceleration. ii. differentiate between centripetal and centrifugal forces. **Suggested experiment/activity:** i. Investigation of the relationship between period and length of simple pendulum and hence calculations of acceleration due to gravity (g). ii. Rigid Body and Torsional Oscillation – Moment of Inertia.
8.	Elasticity	Hooke's Law, Elastic Limit, Elastic and Plastic Deformations, Ductile and Brittle Substances, Stress, Strain, Elastic and Plastic Behaviour, Young's Modulus, Energy Stored, Energy per Unit Volume, Shear Modulus, Bulk Modulus.	**Suggested experiment/activity:** i. Elasticity of materials – Hooke's law experiments.
9.	Hydrostatics	Matter (solid, liquid and gases), Density, Pressure in Fluids, Change of Phases, Archimedes' Principle, Principle of Floatation, Stokes' Law, Terminal velocity.	**Suggested experiment/activity:** i. Measurement of density, relative density, pressure and terminal velocity.
10.	Hydrodynamics	Molecular Properties of Fluids, Turbulent and Laminar flow, Viscosity, Surface Tension, Adhesion, Cohesion, Capillarity, Drops and Bubbles, Bernoulli's Principle and Pitot-static Tube Principle, Pascal Principle, Reynold's	Students should be able to: i. differentiate between laminar and turbulent flow ii. explain forces in fluids – surface tension and capillarity iii. apply the continuity equation. **Suggested experiment/activity:**

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
		Number, Poiseuille's Equation.	i. Determination of viscosity of a viscous fluid.

PHY 002: Heat, Waves and Optics **(3 Units)**

SPECIFIC OBJECTIVES

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

i. explain the concept of ideal gas, heat, temperature and modes of heat transfer;
ii. explain light as an electromagnetic phenomenon and identify the components of the electromagnetic spectrum;
iii. locate by graphical means and by calculation the position of images formed by mirrors and lenses;
iv. explain the dual nature of light – the particle nature and the wave nature, and the principles of sound propagation; and
v. apply the knowledge of basic concepts of heat, optics and sound waves in performing related laboratory experiments.

Course Content

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
1.	Temperature and Thermometry	Concept of Heat and Temperature, Thermal Equilibrium, Temperature Scales, Practical Thermometers, Expansion of Solids and Liquid.	Students should be able to distinguish heat and temperature. **Suggested experiment/activity:** i. Calibration curve of a thermometer using the laboratory mercury thermometer as a standard. ii. Demonstration of the use of basic temperature measuring instruments.
2.	Heat and Energy	Heat Capacity, Specific Heat Capacity, Latent Heat, Specific Latent Heat. Thermal Conductivity, Stefan-Boltzmann's law.	Students should be able to explain the concept of 'blackbody'. **Suggested experiment/activity:** i. Measurement of specific heat capacity of water or metal by mechanical and electrical methods. ii. Measurement of specific latent heat of fusion of ice. iii. Measurement of the specific latent heat of vaporization of water.
3.	Ideal gases	Gas Laws	Boyle's law, Charles' law, Pressure law, Dalton's law of partial pressure.

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
		Equation of State, Kinetic Theory of Gases, Pressure of a Gas, Kinetic Energy of a Molecule.	**Suggested experiment/activity:** i. Verification of gas laws.
4.	Thermodynamics	Work Done by Gas, Internal Energy of Gas, First and Second Law of Thermodynamics, Heat engines, Concepts of Isothermal and Adiabatic Processes.	Students should be exposed to the: i. application of thermodynamic processes. ii. differences between Carnot cycle and Otto-cycle (refrigerators, air-conditioners).
5	Waves	Classification of Waves, Wave characteristics, Graphical Representation of Waves, Wave Equation, Progressive and Stationary Waves, Properties of waves, Principle of Superposition, Interference.	Students should be able to distinguish between characteristics of wave (wavelength, frequency, wave speed, etc.) and properties of wave (reflection, refraction, diffraction and interference) **Suggested experiment/activity:** i. Demonstration of wave using the ripple tank.
6	Electromagnetic Waves	Electromagnetic Spectrum. Applications of Components of the Electromagnetic Spectrum.	Students should be made to understand the various components of electromagnetic spectrum according to increasing frequency or decreasing wavelength.
7	Sound Waves	Pitch, Loudness, Quality, Intensity of Sound, Decibel, Beats and Application, Doppler Principle of Sound, Waves in Strings and Pipes.	**Suggested experiment/activity:** i. measurement of the speed of sound in air. ii. Investigation of the variation of fundamental frequency of a stretched string with length. iii. Investigation of fundamental frequency of stretched string with tension.
8	Geometrical Optics	Rectilinear Propagation of Light. Laws of Reflection and Refraction, Reflection on Plane and Curved Mirrors, Refraction at Plane Surfaces, Total Internal Reflection, Critical Angle, Dispersion by Prism.	**Suggested experiment/activity:** i. Measurement of the focal length of a concave mirror. ii. Verification of Snell's law of refraction. iii. Measurements of the refractive index of a liquid and a solid.
9	Lenses and Optical Instruments	Lenses, Formation of Images by Lenses, Lens power, the Eye, Defects of Vision. Optical Instruments (camera,	**Suggested experiment/activity:** i. Determination of focal length of a converging lens

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
		refractor and reflector telescopes, simple microscope, compound microscope and ophthalmoscope).	
10	Wave Theory of Light	Wave-Particle Nature of Light, Huygens' Principle. Interference and Diffraction, Coherence Sources, Young's Double-Slit Fringes, Diffraction of Light Waves, Resolving Power, Diffraction Grating Polarization and its Applications.	**Suggested experiment/activity:** i. Investigation of interference phenomenon – Young's double slit experiment. ii. Experiment with diffraction – Measurement of the wavelength of a monochromatic light. iii. Measurement of the speed of light. iv. Investigation of polarization – Optical activity experiments.

PHY 003: Electricity and Magnetism (3 Units)

SPECIFIC OBJECTIVES

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

i. state the fundamental laws in electricity and magnetism;
ii. explain the relationship between the electrostatic force and the electric field;
iii. describe and explain the interaction between the electric field and the magnetic field;
iv. solve problems using the laws, principles and theories of electricity and magnetism; and
v. identify and describe some industrial applications of the electromagnetic theory.

Course Content

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
1.	Electrostatics	Coulomb's Law, Gauss' Law and Applications, Concept of an Electric Field, Uniform Electric Fields, Electric Force Between Point Charges, Electric Field at a Point, Electric Potential, Potential Due to a Point Charge and Charged Sphere, Relationship Between Electric Field and Electric Potential, Equipotential Surfaces.	Revision of electric current, potential difference, resistance and resistivity, Ohm's law, Ohmic and non-Ohmic conductors, resistors in series and parallel are required.
2.	Capacitors	Capacitors and Capacitance, Dielectric and Relative Permittivity, Effects of Dielectrics, Capacitors in Series and Parallel, Energy Stored in a Capacitor, Charging and	Revision of charges, voltage, capacitance and dielectric is necessary.

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
		Discharging in C-R Circuit, Time Constant.	
3.	Current Electricity	Electric Current, Potential Difference, Resistance and Resistivity, Ohm's Law, Ohmic and Non-Ohmic Conductors, Resistors in Series and Parallel, Electromotive Force and Circuit, Electrical Power, Electrical Energy and Efficiency, Cells in Series and Parallel, Kirchoff's Laws, Temperature Coefficient of Resistance, Principle of Potentiometer and Wheatstone Bridge, Galvanometer.	Students should have pre-requisite knowledge on electric current, ohm's law, resistivity, ohmic and non-ohmic conductors, and resistance in series and parallel. **Suggested experiment/activity:** i. Verification of Joule's law. ii. Measurement of resistivity of the material of a wire. iii. Experimental verification of Ohm's law. iv. Investigation of variation of resistance with temperature. v. Experiment with the Wheatstone bridge. vi. Emf and internal resistance of cells. vii. Comparison of emf – The Potentiometer. viii. Basic electro-chemistry experiments.
4.	Magnetic Field	Earth's Magnetic Field, Concept of Magnetic Field, Magnetic Flux and Flux-Density (of Solenoid, Straight Conductor and Narrow Circular Coil).	Students should be made to understand the concept of magnetic field and magnetic flux. **Suggested experiment/activity:** Determination of the polarity of a magnet.
5.	Force on Conductor and Moving Charge	Force on a Current-Carrying Conductor, Force on a Moving Charge, Force Between Current-Carrying Conductors, Fleming's Left-Hand Rule, Torque, Application to Moving-Coil Meters, Ampere's Law, Biot-Savart's Law.	Students should be able to state Fleming's left-hand rule, Ampere's law and Biot-Savart's law.
6.	Electromagnetic Induction	Faraday's Law, Lenz Law, Fleming Right-Hand Rule, Dynamo, Transformer, Eddy Current, Current in L-R Circuit, Self and Mutual Inductance, Energy in Coil, Motors and Generators.	Students should be able to state Fleming's right-hand rule, Faraday's law and Lenz law.

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
7.	Alternating Current (A.C) Circuit	Characteristics of Alternating Current, Resistive Circuit, Capacitive Circuit, Inductive Circuit, Capacitance-Resistance Circuit, Inductance-Resistance Circuit, L-C-R Series Circuit, Resonance L-C-R Circuit, Power in A.C Circuits, Parallel Circuit.	Students should be able to explain period, frequency, peak value and Root-Mean-Square value as applied to an alternating current and voltage. Students should be exposed to the concept of admittance and susceptance. **Suggested experiment/activity:** Alternating currents – The R-L-C circuits.

PHY 004: Modern Physics **(3 Units)**

SPECIFIC OBJECTIVES

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

i. describe the structure of the atom and its energy spectrum;
ii. explain the wave-particle duality of matter and the limitation of Classical Physics;
iii. describe the nature and properties of x-rays;
iv. explain the interaction of radiation with matter and solve problems in related topics in modern physics;
v. explain the concept of semi-conductors and apply principles of modern physics to life sciences and digital technology.

Course Content

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
1.	Atomic Structure	The Nucleus (proton and neutron), The Electron, Specific Charge, Isotopes, Millikan's Experiment, Cathode Ray Oscilloscope, Types of Spectrum, Spectra Series.	Revision on the basic concepts of atomic structure. Students should be made to describe the Hydrogen Spectrum. **Suggested experiment/activity:** i. Geiger-Marsden experiment. ii. Experiment with mass spectrometer. iii. Millikan's Oil Drop Experiment – determination of e/m ratio.
2.	Elements of Modern Physics	Defect of the Wave Theory, Blackbody radiation, The Ultraviolet Catastrophe, Photo-	Students should be able to differentiate between Photoelectric emission and thermionic emission.

S/N	TOPICS	SUB-TOPICS	DETAILS & NOTES
		Electric Emission, Thermionic Emission, Bohr's Theory of the Hydrogen Atom and Energy Levels of the Atom, Excitation, Fraunhofer Lines. Interaction of Radiation with Matter, Laser Principle.	
3.	X-Rays	Nature and Properties of X-Rays, Crystal Diffraction, Bragg's Law, Moseley's Law, X-Ray Spectrum, Minimum Wavelength Value. X-Ray Absorption Spectra.	Revision of X-ray production and the main features of modern X-ray tube.
4.	Wave-Particle Duality	Duality, Electron Diffraction, De Broglie Formula. Momentum and Energy, Compton Effect. Heisenberg's Uncertainty Principle.	Students should be able to explain the dual nature of light (as a wave and as a particle).
5.	Radioactivity and Nuclear Energy	Radioactivity, Mass Defect and Nuclear Binding Energy, Nuclear Reactions, Nuclear Fission and Nuclear Fusion, Geiger-Muller Tube, Radioactive Decay – Half-Life and Decay Constant. Isotopes. Nuclear Energy, Einstein Mass-Energy Relation.	**Suggested experiment/activity:** i. Use of basic radiation detection instruments. ii. Measurement of half-life.
6.	Introduction to Semiconductors	Semiconductors: Types, Energy Bands, Doping; p-n Junction Diodes, Half and Full Wave Rectification, The Bridge as a Rectifier. Transistor as an Amplifier and a Switch.	i. Simple model of band theory in Solids, temperature dependence of resistance of metals and intrinsic semiconductors. ii. Simple application and operation of semiconductors is required. **Suggested experiment/activity:** i. Basic semiconductor diode characteristics.
7.	Applied Physics	Basic Applications of Physics to the Life Sciences. Fundamental Principles and Applications of Ultrasound, X-Ray and Nuclear Magnetic Resonance. Power generation: Solar, geothermal, tidal, etc.	Purpose and principle of CT scan should be treated. Basic applications of Physics to power generation required.

Recommended Texts

1. Michael, N. & Philip, P. (1995). *Advanced Level Physics.* London: Heinemann.
2. Yong, P. L., Anyakoha, M. W. & Okeke, P. N. (2002). *University Physics (Also for Polytechnics and Colleges).* Onitsha: Africana-FEP Publishers Ltd.
3. Giambattista, A., Richardson, B. & Richardson, R. C. (2010). *College Physics.* Boston: McGraw Hill Higher Education.
4. Tom, D. (2008). *Advanced Physics.* London: Hodder Education.
5. Okeke, P. N & Anyakoha, M. W. (2005). *Senior Secondary Physics.* London: Macmillan.
6. Halliday, D., Resnick, R. and Walker, J. (1997). *Fundamentals of Physics*. New York: Wiley and Sons.
7. Jim, B. (2000). *New Understanding Physics for Advanced Level*. London: Nelson Thornes.
8. Jewett, J. W & Serway, R. A (2008). *Physics for Scientists and Engineers.* Bemount: Thompson Higher Education.
9. Mee, C., Crundell, M., Arnold, B. and Brown, W. (2008). *International A/AS Level Physics*. U.K: Hodder Education.
10. Hans, C. O and John, T. M. (2007). *Physics for Engineers and Scientists*. U.S.A: W. W. Norton & Company Inc.
11. Young, H. D. and Freedman, R. A. (2003). *University Physics with Modern Physics*. U.S.A: Pearson.