LATEST EDITION

PHYSICS

JUPEB SYLLABUS

SYLLABUS FOR SCI - J155
PHYSICS

GENERAL OBJECTIVES

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

1. describe the properties of matter and waves, and 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; and
6. prepare students for further and higher studies in Physics and Physics related courses.

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:

1. differentiate between fundamental physical quantities and derived quantities;
2. explain and apply the concept of dimensional analysis;
3. define and explain various physical laws in relation to mechanics;
4. describe the phases of matter;
5. describe and explain physical phenomena in relation to fluid mechanics; and

6. solve problems using the laws, principles and theories of mechanics.

Course Content

Topics	Sub-Topics	Details and notes
Units	Order of Magnitude, Definition of Units: length, mass, time; Unit Conversion and Measurements, Methods of Measuring Length, Mass and Time. Basic and Derived Units, Dimensional Analysis (L, M, T only).	Revision of types of motion: translational, random, oscillatory, and rotational; Linear motion: distance, displacement, uniform velocity and uniform acceleration are required. The following suggested experiments will enhance the student's understanding of the topics covered in this course: 1. Error analysis and significant figures. 2. Measurement of velocity and acceleration. 3. Investigation on the proportionality of acceleration and force. 4. Investigation of the relationship between period and length of simple pendulum and hence calculations of acceleration due to gravity (g). 5. Verification of the principle of conservation of momentum. 6. Investigation of the laws of equilibrium for a set of coplanar forces. 7. Elasticity of materials – Hooke's law experiments. 8. Investigation of contact forces – static and dynamic friction. 9. Investigation of forces in fluids – surface tension and capillarity. 10. Rigid Body and Torsional
Vectors	Vector Representation, Addition and Subtraction of Vectors (geometrical method only), Resolution of Vectors. Vector Multiplication, Vectors in Cartesian Coordinate System.	
Particle Kinematics	Types of Motion: translational, random, oscillatory, and rotational. Linear Motion: distance, displacement, uniform velocity motion, uniform acceleration motion, graphs of kinematic equations. Instantaneous and Average Velocity and Acceleration. Motion in two or three dimensions. Relative motion in one and two dimensions, Free Fall, Projectile Motion.	
Dynamics	Newton's Laws of Motion, Types of Force, Newton's Universal Law of Gravitational, Equilibrium of Forces, 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. Motion in inclined planes, Frictional Forces.	Oscillation – Moment of Inertia.
The Gravitational Field	Kepler's Laws of Planetary Motion, Newton's Law of Gravitation, Field Strength, G and its Measurement, Gravitational Potential, Satellite Motion and Escape Velocity.	
Work, Energy and Power	Work, Energy Sources, Types of Energy, Conversion and Conservation of Energy, Power, the kilowatt hour, Principle of Mechanical Energy Conservation.	
Circular and oscillatory motions	Angular Displacement, Angular Velocity, Torque and Angular Acceleration, 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.	
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.	
Hydrostatics	Matter (solid, liquid and gases), Density, Pressure in	

	Fluids, Change of Phases, Archimedes' Principle, Principle of Floatation, Stokes' Law, Terminal velocity. Bernoulli's Principle, Pitot-static Tube Principle.	
Hydrodynamics	Molecular Properties of Fluids, Viscosity, Surface Tension, Adhesion, Cohesion, Capillarity, Drops and Bubbles, Bernoulli's Principle, Pascal Principle, Reynold's Number, Turbulent and Laminar Flow, Poiseuille's Equation.	

PHY 002: Heat, Waves And Optics (3 Units)

Specific Objectives

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

1. explain the concept of ideal gas;
2. explain the concepts of heat, temperature and modes of heat transfer;
3. explain light as an electromagnetic phenomenon and identify the components of the electromagnetic spectrum;
4. locate by graphical means and by calculation the position of images formed by mirrors and lenses;
5. describe the operation of various optical instruments and their applications;
6. explain the dual nature of light – the particle nature and the wave nature;
7. explain the properties of light arising from its wave nature; and
8. explain the principles of sound propagation.

Course Content

Topics	Sub-topics	Details and notes
Ideal Gases	Gas Laws: Boyle's Law, Charles' Law and Pressure Law. Equation of State, Kinetic Theory of Gases, Pressure of a Gas, Kinetic	Revision of Rectilinear propagation of light, laws of reflection and refraction, reflection on plane and curved mirrors, refraction at

	Energy of a Molecule.
Temperature and Thermometry	Concept of Heat and Temperature, Thermal Equilibrium, Temperature Scales, Practical Thermometers, Expansion of Solids and Liquid.
Heat and Energy	Heat Capacity, Specific Heat Capacity, Latent Heat, Specific Latent Heat, Internal Energy. Thermal Conductivity, Blackbody Radiation.
Thermodynamics	Work Done by Gas, Internal Energy of Gas, First and Second Law of Thermodynamics, Concepts of Isothermal and Adiabatic Processes.
Electromagnetic Waves	Electromagnetic Spectrum. Applications of Components of the Electromagnetic Spectrum.
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.
Lenses and Optical Instruments	Lenses, Formation of Images by Lenses, the Eye, Defects of Vision. Optical Instruments (camera, refractor and reflector telescopes, simple microscope, compound microscope and ophthalmoscope).

plane surfaces, total internal reflection, and critical angle are required.

The following suggested experiments will enhance the student's understanding of the topics covered in this course:

1. Calibration curve of a thermometer using the laboratory mercury thermometer as a standard.
2. Verification of Boyle's law.
3. Measurement of specific heat capacity of water or metal by mechanical and electrical methods.
4. Measurement of specific latent heat of fusion of ice.
5. Measurement of the specific latent heat of vaporization of water.
6. Change of state – The cooling curve experiment.
7. Measurement of the speed of sound in air.
8. Investigation of the variation of fundamental frequency of a stretched string with length.
9. Investigation of

Oscillations and Waves	Classification of Waves, Wave Parameters, Graphical Representation of Waves, Wave Equation, Progressive and Stationary Waves, Reflection, Refraction, Diffraction, Principle of Superposition, Interference.	fundamental frequency of stretched string with tension. 10. Resonance tube experiments – fundamental frequency and higher harmonics. 11. Measurement of the focal length of a concave mirror. 12. Verification of Snell's law of refraction. 13. Measurements of the refractive index of a liquid and a solid. 14. Measurement of the focal length of a converging lens. 15. Investigation of interference. phenomenon – Young's double slit experiment. 16. Experiment with diffraction – Measurement of the wavelength of a monochromatic light. 17. Measurement of the speed of light. 18. Investigation of polarization – Optical activity experiments.
Wave Theory of Light	Wave-Particle Nature of Light, Huygens' Principle. Interference and Diffraction, Coherent Sources, Young's Double-Slit Fringes, Diffraction of Light Waves, Resolving Power, Diffraction Grating Polarization and its Applications.	
Sound Waves	Pitch, Loudness, Quality, Intensity of Sound, Decibel, Beats and Application, Doppler Principle of Sound, Waves in Strings and Pipes.	

PHY 003: Electricity And Magnetism (3 Units)

Specific Objectives

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

1. state the fundamental laws in electricity and magnetism;
2. explain the relationship between the electrostatic force and the electric field;
3. explain the relationship between the magnetic force and the magnetic field;
4. describe and explain the interaction between the electric field and the magnetic field;
5. explain the effect of charges in motion;
6. describe and explain physical phenomena in electricity and magnetism;
7. solve problems using the laws, principles and theories of electricity and magnetism; and
8. identify and describe some industrial applications of the electromagnetic theory.

Course Content

Topics	Sub-topics	Details and notes
Electrostatics	Coulomb's Law, Gauss' Law and Applications, Concept of an Electric Field, Uniform Electric Fields, 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. The following suggested experiments will enhance the student's understanding of the topics covered in this course: 1. Verification of Joule's law. 2. Measurement of resistivity of the
Capacitance	Capacitors and Capacitance, Dielectric and Relative Permittivity, Capacitors in Series and	

	Parallel, Energy Stored in a Capacitor, Effects of Dielectrics, Charging and Discharging in C-R Circuit, Time Constant.	material of a wire. 3. Experimental verification of Ohm's law. 4. Investigation of the variation of resistance of a metallic conductor with temperature. 5. Investigation of variation of resistance with temperature. 6. Experiment with the Wheatstone bridge. 7. Emf and internal resistance of cells. 8. Comparison of emf – The Potentiometer. 9. Basic electro-chemistry experiments. 10. Alternating currents – The R-L-C circuits. 11. Basic semiconductor diode characteristics.
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.	
Magnetic Field	Earth's Magnetic Field, Concept of Magnetic Field, Magnetic Flux and Flux-Density-**B** (of Solenoid, Straight Conductor and Narrow Circular Coil).	
Force on Conductor and Moving Charge	Force on a Current-Carrying Conductor, Force on a Moving Charge, Force Between Current-Carrying Conductors, Fleming Left-Hand Rule, Torque, Application to Moving-Coil Meters, Ampere's Law, Biot-Savart's Law.	
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.	
Alternating Current (A.C) Circuit	Characteristics of Alternating Current (period, frequency, peak value and Root-Mean-Square value as applied to an alternating current and voltage), 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.	

PHY 004: Modern Physics (3 Units)

Specific Objectives

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

1. describe the structure of the atom;
2. describe the structure of the atom and its energy spectrum;
3. explain the wave-particle duality of matter;
4. explain the limitation of Classical Physics;
5. describe the nature and properties of x-rays;
6. explain the interaction of radiation with matter;
7. explain radioactive disintegration and calculate radioactive decay constants of different radioactive elements; and
8. explain the concept of semi-conductors.

Course Content

Topics	Sub-topics	Details and notes
Atomic Structure	The Nucleus (proton and neutron), The Electron, Specific Charge, Isotopes, Millikan's Experiment,	The following suggested experiments will enhance the student's understanding of the topics covered in this

	Cathode Ray Oscilloscope, Types of Spectrum, Hydrogen Spectrum, Spectra Series.	course: 1. Experiments on alpha particles, beta particles and gamma rays. 2. Measurement of long and short half-lifes. 3. Geiger-Marsden experiment. 4. Experiment with mass spectrometer. 5. Millikan's Oil Drop Experiment – determination of e/m ratio.
Elements of Modern Physics	Defect of the Wave Theory, The Ultraviolet Catastrophe, Photo-Electric Emission, Thermionic Emission, Bohr's Theory of the Hydrogen Atom, and Energy Levels of the Atom, Excitation, Absorption and Emission, Fraunhofer Lines. Interaction of Radiation with Matter, Laser Principle.	
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.	
Wave-Particle Duality	Electron Diffraction, De-Broglie Formula. Momentum and Energy, Duality, Compton Effect. Heisenberg's Uncertainty Principle.	
Radioactivity and Nuclear Energy	Radioactivity, Mass Excess and Nuclear Binding Energy, Nuclear Fission and Nuclear Fusion, Geiger-Muller Tube, Radioactive Decay – Half-Life and Decay Constant, Nuclear Reactions. Isotopes. Nuclear Energy, Einstein Mass-Energy Relation.	Simple application and operation of semiconductors is required

Introduction to Semiconductors	Intrinsic Semiconductors, Energy Bands in Solids, Doping of Semiconductors; p-n Junction Diodes, Half and Full Wave Rectification, The Bridge Rectifier. Transistor as an Amplifier and Switch.	
Applied Physics	Basic Applications of Physics to the Life Sciences. Fundamental Principles and Applications of Ultrasound, X-Ray and Nuclear Magnetic Resonance.	

RECOMMENDED TEXTS

1. Michael Nelkon & Philip Parker (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 Duncan (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 Breithaupt (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. Physics Writers Series Creation (2015). *Mechanics and Properties of Matter.* San Press Ltd. Enugu.
10. Physics Writers Series Creation (2015). *Waves Optics and Thermal Physics.* Ebenezer Production Ltd. Enugu.
11. Physics Writers Series Creation (2015). *Electromagnetism and Modern Physics.* San Press Ltd. Enugu.
12. Physics Writers Series Creation (2015). *First Year University Physics Practical.* Ebenezer Production Ltd. Enugu.
13. Mee, C. Crundell, M., Arnold, B. and Brown, W. (2008). *International A/AS Level Physics.* Hodder Education, U.K.