

COURSE SYLLABUS (DEPARTMENT OF PHYSICS, UNIVERSITY OF ABUJA)

PHY 101: Introductory Mechanics and Properties of Matter (3 Credit Units)

Units: Basic S.I Units, derived units, dimension analysis. Scalar and Vectors. Statics concurrent forces in equilibrium, non-concurrent forces. Moments of a force. Frictional forces. Elastic forces in static structures. Kinetics: Speed, velocity and acceleration, equation of motion for bodies moving with uniform acceleration and variable acceleration. Displacement and velocity-time graphs, free fall and vertical projection. Projectiles in two dimension and trajectory. Dynamics of particles: Forces and linear motion, conservation of momentum. Work, energy, power and efficiency. Elastic and inelastic collision. Rotational dynamics and gravitation. Motion of rigid bodies. Fluids at rest and fluids in motion.

PHY 102: Introductory Heat and Thermodynamics (2 Credit Units)

Thermometry: Thermometers and scales of temperature, linear expansion, volumetric expansion. Heat energy; specific heat capacity, latent heat. Thermodynamics: First and Second laws of Thermodynamics, isovolumetrics, adiabatic, isothermal processes. The carnot cycle, cryogenics. Thermal properties of gases: Boyless' and Charles' laws, the ideal gas law, the two

principal specific heat capacities of gas. Kinetic theory of gases: assumption of the kinetic theory. Maxwellian distribution. Deduction from the kinetic theory of gases, Avogadro's law, Graham's law of diffusion, Dalton's law of partial pressures. Transfer of heat: Conduction. The ideal radiator, intensity distribution in black body radiation.

Prevost theory, kirchoof's law, Stefan's law. Wiens displacement law.

PHY 103: Introductory Optics, Waves and Sound (3 Credit Units)

Elements of Geometric optics-Ray optics, reflection by plane mirrors, spherical mirrors, refraction at plane surface, refraction through thin lenses, Defects of lenses and correction, optical instruments.

Elementary treatment of wave properties: Propagation, interference, diffraction, polarization, wave motion: Transverse and longitudinal, forced vibrations, resonance, interference and beats.

Sound: Motion at supersonic speeds, intensity of sound, the resonance tube, frequency response of the ear, high fidelity. Ultrasonic, simple harmonic motion (s.h.m). Photoelectric effect, spectroscopy and atomic physics; continuous and line emission and absorption spectra. X-rays. Wave mechanics: qualitative treatment of the wave particle duality. The atomic nucleus and radioactivity.

PHY 104: Introductory Electricity and Magnetism (2 Units)

Coulomb's law, the electric field, the electric potential, capacitors, dielectrics, the electric circuit. Magnetic effects of currents: The

current balance measurements of the e/m ratio, mass spectrograph and isotopes. The cyclotron, chemical effects of electric current. Magnetism: Magnetic properties of materials, theory of magnetism, electromagnetic induction: AC and DC generators, electric motors, Eddy Currents. The transformer, alternating current circuit, radiation of electromagnetic waves (qualitatively). The full electromagnetic spectrum.

PHY 111: Basic Experimental Physics I (1 Credit Unit)

A 3 hour/week laboratory course covering basic experiments illustrative of the first semester, 100-level physics syllabus.

PHY 112: Basic Experimental Physics II (1 Credit Unit)

A 3 hour/week laboratory course covering basic experiments illustrative of the second semester, 100-level physics syllabus.

PHY 201: Classical Mechanics I (3 Credit Units) Pre-requisite: PHY 101

Newtonian Mechanics: Motion of a particle in one, two and three dimensions: systems of particles and collision theory. Newtonian gravitation; conservative forces and potentials: central force problems, accelerated frames of reference; rigid body dynamics. Oscillatory systems, including damped, forced and coupled oscillations. Normal Modes, fluid flow; equation of continuity, Bernoulli's equation.

PHY 202: Thermal Physics (3 Credit Units) Pre-requisite: PHY 102

The fundamentals of classical thermodynamics including the Zeroth and definition of temperatures; the first law of Thermodynamics: work, heat and internal energy, Carnot cycle and Second law of Thermodynamics: entropy and irreversibility; thermodynamic potentials and the Maxwell's relations. Application: qualitative discussion of phase transitions. Third law

of thermodynamics, Ideal and real gases. Elementary kinetic theory of gasses including Boltzman counting. Maxwell-Boltzman law of distribution of velocities. Simple application of the distribution law. Application of thermodynamics.

PHY 203: Waves and Optics (3 Credit Units) Pre-requisite: PHY 103

Wave Phenomena; Acoustical waves, the harmonic oscillator; wave on a string; energy in wave motion; longitudinal waves standing waves; group and phase velocity, Doppler effects, 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 204: Electrical Circuits and Electronics (3 Credit Units) Pre-requisite: PHY 104

DC circuits; Kirchhoff's laws, network analysis and circuit theorems. AC circuits. Inductance, capacitance, the transformer, sinusoidal wave forms, r.m.s and peak values, power, impedance and admittance, series RLC circuit, Q factor, resonance. Network analysis and circuit theorems, filters, electronics: semiconductors, the pn-junction, filters and rectifiers.

PHY 206: Elementary modern Physics (3 Credit Units) Pre-requisite: PHY 103

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's hypothesis, the uncertainty principle. Franck-Hertz experiment as evidence for energy levels in atoms.

PHY 207: Mathematical Methods in Physics I

Vector algebra, vector, dot and cross products, equations of curves and surfaces. Vector differentiation and applications. Gradient, Divergence and curl. Vector integration; line surface and volume integrals. Green's, Stoke's and Gauss's divergence theorems. Tensor products of vector space. Tensor algebra, symmetry, Cartesian tensors.

PHY 211: Basic Experimental Physics III (1 Credit Unit) Pre-requisite: PHY 111

A 3 hour/week laboratory course covering basic experiments illustrative of the first semester, 200-level physics syllabus.

PHY 212: Basic Experimental Physics IV (1 Credit Unit) Pre-requisite: PHY 112

A 3 hour/week laboratory course covering basic experiments illustrative of the second semester, 200-level physics syllabus.

SIW 200: Student Industrial Work Experience Scheme (3 credit Units): At the end of second semester 200-level and second semester vacation period, students spend 3 months in approved industrial establishment in the country to acquire industrial skills. The course also involves report writing and seminar presentations.

PHY 301: Classical Mechanics II (3 Credit Units) Pre-requisite: PHY 201

Pre-requisite: PHY 201. Degree of freedom; generalized coordinates. Lagrange's formulation of mechanics. Applications. The calculus of variations and action principle. Euler's equations. Hamilton's formulation of mechanics. Application. Invariance and conservation laws. Principle of virtual work and D'Alembert's principle, Canonical transformations. Hamilton-Jacobi equation, Poisson brackets.

PHY 302: Statistical and Thermal Physics (3 Credit Units) Pre-requisite: PHY 202

Basic concept of statistical mechanics, microscopic basis of thermodynamics and applications to microscopic system, condensed states, phase transformations, quantum distribution, elementary kinetic theory of transport processes, fluctuation phenomena, free energy and partition functions, applications

PHY 304: Electronics I (3 Credit Units) Pre-requisite: PHY 204

Thermionic emission, vacuum tubes. Diodes and transistors. Semiconductors: p-n junctions, characteristics of p-n junction; uses of diodes. Unipolar transistor and properties as amplifier. The junction transistor and characteristics. Transistor as an amplifier, classification of amplifiers. Transistor circuit cascade amplifier, negative and positive feedback. Delay time, power supplies. Cathode Ray Oscilloscope (CRO).

PHY 306: Solid State Physics I (3 Credit Units) Pre-requisite: PHY 206

Crystal structure and crystal binding, lattice properties, indexing crystal diffraction, Laue equations, reciprocal lattice, Brillouin zones, structure factor, interatomic forces, bonding types, elastic properties, lattice vibrations, elastic waves, dynamics of momentum and diatomic lattice phonons and inelastic neutron scattering, phonon dispersion, theories of the specific heat of solids, thermal conductivity. Imperfection in solids defect statistics, diffusion, ionic conductivity, color centers, amorphous solids, dislocation and strength of materials. Free electrons of metal, energy wave vector relations. Fermi surface and Fermi energy, cyclotron resonance. Hall effect, optical properties of metals, thermionic and field emissions.

PHY 307: Mathematical Methods in Physics II (3 Credit Units) Pre-requisite: PHY 207.

Linear Algebra and Functional Analysis: Transformation in linear vector space and matrix theory. Hilbert space and complete sets of

orthogonal functions. Special functions of mathematical physics. The gamma function, hypergeometric functions, hermite and Laguerre function. The Dirac Delta function, Bessel function.

PHY 310: Introductory Quantum Physics (3 Credit Units) Pre-requisite: PHY 206

Schroedinger's equation and simple applications. One dimensional harmonic oscillators. The hydrogen atom. Wave-particle duality and uncertainty principle, basic principles of the quantum theory, energy levels in potential wells: reflections and transmission of potential barriers; atomic and molecular structure and spectra;

PHY 312: Optics (3 Credit Units) Pre-requisite: PHY 203

Maxwell's equation and solutions. Interference, multiple beam interferometry. Fresnel and Fraunhofer diffraction, Slits, gratings Aerial arrays. Production of polarized light, double refracting crystals. Transmission and interference polarized light, analysis of polarized light. Polarizing microscope. Optical activity, rotary dispersion, Faraday Effect. Photo electricity and application.

PHY 313: Workshop Practice (2 Credit Units)

Introduction to workshop equipment and their uses in fabricating simple tools

PHY 314: Introduction to Space Science (2 Credit Units) [Elective course]

Introduction to Astronomy and Astrophysics, satellite Communication, introduction to atmospheric science, Space environment, Space craft systems and dynamics, Aero/Astrodynamic Engineering, Rocket Engineering, Cosmology, Origin of the universe and life, Space law and business development.

PHY 315: Electromagnetism (3 Credit Units) Pre-requisite: PHY 203

Coulomb's law, Laplace's and Poisson's equations, boundary-value problems. Magnetostatics; electric currents, magnetic field of steady currents, Ampere's law. Electromagnetic induction and Faraday's Laws. Electromagnetic oscillations and waves, Scalar and Vector Potentials. Magnetic and Electric energies, Poynting's vector.

PHY 316: Atmospheric Physics (2 Credit Units) [Elective]

Physics properties of the atmosphere. Atmospheric dynamics and thermodynamics. Radioactive transfer processes. Particles in the atmosphere. Cloud Physics.

PHY 317: Physics of Solid Earth (3 Credit Units) [Elective]

Origin, shape, structure and major deviations of the earth. The Earth's main magnetic field and its distribution. Electrical theory of the Earth's core and origin of the magnetic field, seafloor spreading, continental drift and plate tectonics.

PHY 318: Acoustics (2 Credit Units) [Elective]

Sound levels, spectrum measurement of levels, loudspeakers ultrasonic generators, microphones. Applications of acoustic devices to non-destructive testing, medicine, radar and sonar wave propagation in isotropic materials. Piezoelectric transducers, measurement of acoustic impedance, acoustics room measurement of reverberation time

PHY 319: Energy and Environment (3 Credit Units) [Elective]

Energy and power, demands and outlook, transformation of energy and its costs, thermal pollution, electrical energy from fossil fuels, hydroelectric generation, principles and problems, costs, capacity, storage, reserves, efficiency, new environmental effects, electrical energy from nuclear reactors, future energy

sources; breeder reactors, fission power, solar power, geothermal power, tidal power etc. Prospects and problems.

PHY 321: Advanced Experimental Physics I (1 credit Unit) Pre-requisite: PHY 211

A 3 hour/week Advanced laboratory course covering experiments illustrative of the first semester of 300-level physics syllabus.

PHY 322: Advanced Experimental Physics II (1 credit Unit) Pre-requisite: PHY 212

A 3 hour/week Advanced laboratory course covering experiments illustrative of the second semester, 300-level physics syllabus.

SIW 300: Student Industrial Work Experience Scheme (3 credit Units)

At the end of second semester 300-level and second semester vacation period, students spend 3 months in approved industrial establishment in the country to acquire industrial skills. The course also involves report writing and seminar presentations.

PHY 401: Quantum Mechanics I (Credit Units) Pre-requisite: PHY 310, PHY 301

The formulation of quantum mechanics in terms of state vectors and linear operators. Three dimensional spherically symmetric potentials. The theory of angular momentum and spin. Identical particles and the exclusion principle. Multi-electron atoms.

PHY 402: Quantum Mechanics II (3 Credit Units) Pre-requisite: PHY 401

Time-independent and time-dependent perturbation theory; Scattering theory, elastic potential scattering; Green's functions and partial wave methods. Self consistent approximation: Thomas-Fermi statistical model; Hartree's self-consistent approximation. Correction to the self-consistent approximation. Atoms and Molecules.

PHY 403: Nuclear & Particle Physics I (3 Credit Units) Pre-requisite: PHY 301

Nuclear structure: nuclear properties, nuclear size, nuclear charge, nuclear mass, nuclear spin and magnetic moment, nuclear force and potential, the deuteron, nuclear-nucleon scattering, Nuclear models: liquid-drop, shell and collective models. Radioactive decay: alpha, beta and gamma decays. Nuclear reactions

PHY 405: Electrodynamics (3 Credit Units) Pre-requisite: PHY 315

Poisson's and Laplace's equations and their methods of solution. Maxwell's equations applied to free space, and dielectric plane waves in dielectric and homogeneous conductors. Rate of energy flow in electro-magnetic field, Poynting vector. Electron theory of dielectric motion of electrons. Dispersion over wide frequency range. Electromagnetic waves in electron layers. Transmission lines; Transmission lines equations; Waveguides and Resonant cavities.

PHY 406: Mathematical Methods in Physics III (3 Credit Units) Pre-requisite: PHY 307.

Integral transforms and Fourier series; Laplace transforms. Application of transform methods to solutions of elementary differential equations in physics and engineering. Partial differential equations. Solution of boundary value problems of partial differential equations by various methods which include: separation of variables, methods of integral transforms. Sturm-Liouville theory; uniqueness solutions. Calculus of residues and applications to evaluation of integrals and summation of series. Applications to various physical situations which may include electro-magnetic theory, quantum theory and diffusion phenomena.

PHY 407: Solid State Physics II (3 Credit Units) Pre-requisite: PHY 306 [Elective]

Dielectric properties. Magnetism: Paramagnetism and

diamagnetism, ferromagnetism and anti-ferromagnetism; magnetic resonance, Super conductivity.

PHY 410: Nuclear and Particle Physics II (3 Credit Units) Pre-requisite: PHY 403 [Elective]

Nuclear instrumentation and radiation techniques, detectors. Nuclear spectroscopy. Neutron physics: production, detection of neutrons. Nuclear fission and nuclear fusion. Nuclear reactor and nuclear energy. Elementary particles: conservation laws, particle classification. Strong, electromagnetic, gravitational and weak interactions. Standard model of particle physics, the grand unification.

PHY 412: Computational Physics (3 credit units)

Use of numerical methods in physics; various methods of numerical integration, differentiation, numerical solutions of some differential equations in physics. Statistical analysis of experimental data.

PHY 413: Electronics II (3 credit units) Pre-requisite: PHY 304

Field effect transistor, transistor as voltage switch, basic switching circuits monostable and di-stable multivibrator circuits, binary divider (Eccles Jordan circuit) Schmitt trigger a stable multivibrator, current switching FET as a gate, coppers phase sensitive detection.

PHY 416: Atomic & Molecular Spectroscopy (3 Credit Units) Pre-requisite: PHY 401 [Elective]

The hydrogen atom; relativistic effect and spin. Identical particles and symmetry. Many electron atoms. Coupling schemes and vector model. Zeeman effect. Hyperfine structure. The diatomic molecule, the Frank-Condon principles, X-ray diffraction. Microwave methods. Resonance phenomena; ESR, MMR, and optical pumping and Moss Bauer scattering.

PHY 417: Introduction to Applied Geophysics (3 Credit Units) Pre-requisite: PHY 317 [Elective course]

Methods of geophysical survey: Gravity, Magnetic, Electrical, Electromagnetic and Seismic method.

- Gravity Surveying: The Bouguer anomaly, instruments, the survey, interpretation.

- Magnetic Surveying: Magnetic properties of rocks, the earth's magnetic field, instruments, magnetic surveying on the ground, aeromagnetic surveying, interpretation, application.

- Electrical resistivity surveying: The theory of current flow in solid material, the four electrode system of measurement. Resistivity survey and its interpretation: instruments, interpretation, field practice.

- Seismic Surveying: Outline of the methods of generation and propagation of elastic pulses, relationship between seismic velocities and elastic properties of rocks. Seismic measurement and their interpretation: Instruments, the reflection method, determination of velocities, the reflection method, determination of velocities, the refraction method, choice between seismic and resistivity methods,

- Applications of nuclear physics, electromagnetic prospecting, borehole measurements, electrical transport method.

PHY 419: Biophysics: (2 Credit Units) [Elective]

The basic structure of the cell. Nerve conduction. The behavior of striated muscle. Conducting tissue, electrodes, cell membranes, artificial membranes, Ion transportation in tissues. Neurotransmitters, covering all sense organs. Models of physiological systems.

PHY 421: Advanced Experimental Physics III (1 Credit Unit) Pre-requisite: PHY 321

A series of mini-courses on important experimental techniques and performance of laboratory experiments illustrative of 400-level physics syllabus. Data handling and scientific writing.

PHY 422: Research Project (6 Credit Units)

The course offers the student the student the opportunity to carry out research in contemporary Physics and under the supervision of a member of academic staff of department of Physics. The student will be required to present seminars and a detailed report on the research is presented by the student when the project is completed

PHY 425: Research Methods (1 Credit Unit)

Research: Meaning and its characteristics, purpose of and the required steps in research. The scientific methods of investigation, hypothesis. Choice of research topics and its design and characteristics. Techniques and procedure for carrying out project in Physics. Library search and referencing. Graphical presentation, sketches, illustrations, tables, drawings. Project reporting and Thesis writing.

PHY 418: Introduction to Telecommunication Systems (3 Credit Units) Pre-requisite: PHY 315 [Elective]

Transmission lines; Transmission lines equations; Waveguides and Resonance cavities. Modulation, radio and T.V. system, telephone instruments, line losses, noise, T & T networks, radar and navigational aids, data transmission

PHY 420: Introduction to Plasma Physics (2 Credit Units) Pre-requisite: PHY 315 [Elective]

Definition of plasma, temperature, Debye length, motion in E- and D-fields, time varying fields. Adiabatic invariants, fluid equations; drifts, waves in plasmas; electron plasma waves, sound waves, ion waves, lower hybrid frequency, electromagnetic waves, fusion and astrophysical plasma.