PHYSICS

SYLLABUS

INTERIM JOINT MATRICULATION BOARD

INTERIM JOINT MATRICULATION BOARD EXAMINATION (IJMBE) PHYSICS SYLLABUS (REVISED 2012)

Introduction

The IJMB Physics syllabus is evolved from the current prescribed 'A' level Physics syllabus of many leading universities and also the first year physics syllabus of science programs of Nigerian universities. Proper study of the present SSCE syllabus has been made so as to incorporate properly the concepts, principles and ideas.

The IJMB syllabus is structured with conceptual approach. The broad concepts of Motion, and Time, Matter, Energy, Waves, geometric optics, Electric and Magnetic fields, Atomic Physics, Nuclear Physics and Electronics are considered and each concept forms a part on which other sub concepts are further based.

Aims/Objectives

The aims and objectives of the present syllabus in Physics are to:

a. Provide a proper understanding of the basic concepts, principles and approach of Physics and their relevant applications to general science and technology.
b. Develop scientific skills and attitudes as prerequisites for further scientific activities and endeavours.
c. Recognize the usefulness and limitations of different scientific methods and appreciate their applicability to various disciplines.
d. Develop attitudes relevant to science such as concern for accuracy, precision, objectivity, intuition, initiative and inventiveness.

SPECIFIC OBJECTIVES

The following knowledge and skills appropriate to Physics will be developed:

1. Knowledge and understanding of:
   Scientific phenomena, laws, definitions, concepts and theories.
   Scientific and technical terminology, symbols, units and conventions.
   The use of scientific units and apparatus, techniques of operation of different scientific devices.
   Appreciation of scientific and technological application in various forms.

2. Information handling and problem solving abilities such as the ability to:
   Locate, select, organize and present information from a variety of sources of scientific interest.
   Analyze and evaluate information from one form to another.
   Use the available information to identify patterns, trends and draw suitable inferences from the available data and provide reasonable explanation from these inferences.

3. Experimental and problem solving techniques, which enable the students to:
   Follow instructions in an unambiguous manner.
   Carry out experimental procedures using different types of units and apparatus taking care of proper precautions and safety measures.
   Make and record proper observations of the experimental measurements and estimates with care on units and precision.
   Do a proper analysis of a given experimental data and come to some general conclusions of the results.
   Identify problems, plan and carry out suitable investigations with proper choice of techniques and apparatus.

The course is planned so as to cover two semesters with duration of 24 weeks per semester and with 6 lecture hours and 3 hours of practical for Physics in a week. The remaining weeks of the year's program is meant for detailed revision, tutorials, mock examination, etc.

Note:

i. All students are expected to be familiar with basic mathematics concepts.
ii. S.I. units are to be used throughout except in special cases where C.G.S units are to be introduced.
iii. Though the structure of syllabus is based on logical development; the order of presentation may be varied depending on the need and circumstances.
iv. Details of practical work are attached at the end.

Examination Structure

There will be two theory papers, each of three hours duration and one practical examination (Paper III) of three hours duration.

1. Paper I

Section A:	Ten short questions covering the topics included in sections B, C and D
Section B:	Mechanics (2 questions)
Section C:	Heat and Behaviour of matter (4 questions)
Section D:	Vibrations and Waves (2 questions)

Candidates will answer all questions in section A, one question from each of sections B and D and two questions from section C.

The compulsory questions carry 40 marks and other questions 20 marks each and a total of 120 marks are allotted to Paper I.

2. Paper II

Section A:	Ten short questions, covering the topics included in section B, C, D
Section B:	Geometrical optics (2 questions)
Section C:	Electricity and Magnetism (4 questions)
Section D:	Modern Physics and Electronics (2 questions)

Candidates will answer all questions in section A, including one question from each of sections B and D and two questions from section C.

The compulsory questions carry 40 marks and other questions 20 marks each and a total of 120 marks are allotted to Paper II.

3. Paper III (Practical Examination)

A three-hour practical paper based on the syllabus will be set. The objective of the practical examination is to test whether the candidates have worked through a satisfactory course and are also capable of handling simple apparatus as well as data analysis.

There will be 3 questions. Question 1 is on data analysis, which is compulsory, and questions 2 and 3 are, on actual experiments to be performed and a student has to answer one of these 2 questions. Each question carries 30 marks and a total of 60 marks are allotted for Paper III.

In Colleges and centres with large number of candidates conduct of practical examination for all at the same time may be difficult, hence a maximum of 4 alternative papers for Paper III will be made, ensuring that same standard is maintained. Centres with small number of candidates can have an early option of a particular alternative paper based on the availability of units and equipments. General information on items and apparatus needed for different alternatives will be provided in advance.

All the 3 papers together carry 300 marks and total is weighted for 80% and 20% weightage is given by teachers over a large number of tests, tutorials assignments, laboratory work, etc. as continuous assessment contribution.

During both theory and practical examinations, candidates will be allowed to use non-programmable electronic calculators.

DETAILED SYLLABUS

FIRST SEMESTER SYLLABUS

S/NO:	TOPICS AND CONTENTS	ACTIVITIES / PRACTICAL GUIDE	INSTRUCTIONAL MATERIALS	DURATION
1.	GENERAL PHYSICS AND MECHANICS **(a) Physical Quantities, Units and Dimensions** Fundamental and derived units in S.I. system, multiples and sub multiples units in S.I. and CGS units. Dimensions of Physical quantities and their use in checking and deriving relationships. Scalars and vectors and their addition. Measurements, errors and uncertainties. **Notes:** Ascertain base quantities and their units. Systematic work on dimensional analysis. Distinction between different	(A) Selected expts in: (a) Mechanics (b) Heat (c) Properties of matter About 12 to 13 expts are to be covered during practicals (3 hours/week) (B) Reasonable amount of tutorials are to be undertaken		4 hours

	types of errors	working out lot of numerical examples		
	(b) Kinematics Linear motion. Nonlinear motion. Distance – time and velocity-time graphs. Relative velocity and acceleration. Motion with constant acceleration free fall. Projectile motion – time of flight and range.	Equations of motion. Horizontal and inclined plane motion to be discussed.		6 hours
	(c) Dynamics Concepts of force, momentum. Mass and weight units Newton's laws of motion. Conservation of linear momentum. Completely elastic and completely inelastic head on collisions. Coefficient of restitution. Impulse. Different types of forces.			6 hours 2 hours
	(d) Work, Energy and Power Work, energy and power units. Conservation of energy, potential energy, kinetic energy and internal energy. Dissipative forces with examples.			4 hours
	(e) Circulation Kinematics of uniform circular motion. Angular velocity and angular acceleration. Centripetal force and radial acceleration. Centrifuge. Banking of tracks, motion of a cyclist. Conical pendulum.	Clearly show the Proof of $a = \frac{u^2}{R}$ is expected		5 hours
	(f) Gravitational Field Force F = mg on a mass in a gravitational field. Newton's inverse square law. Kepler's laws of Planetary motion. Gravitational constant G. Field near the surface of the	Measurement of G not necessary		

	Earth. Density of Earth. Satellite motion, synchronous orbit, velocity of escape. Weightlessness. Solar system. Mass of the sun. Gravitational potential. **(g) Simple Harmonic Motion** Sinusoidal motion. Frequency period amplitude. Relations for displacement, velocity and acceleration δ a = $-w^2x$ free oscillations. Theory of simple pendulum, spring and mass liquid column. Energy inter-change. Damped and forced oscillations. Experimental decay and resonance. **(h) Rotation of Rigid Bodies** Moment of Inertia. Radius of gyration. M.I. of (i) thin ring (ii) circular disc (iii) annulus about axes perpendicular to the plane. MI of thin rod with axis perpendicular to length at one end and at centre. Parallel and perpendicular axis theorems. Angular momentum, couple, torque. KE of rotating body. Rolling bodies. Conservation of angular momentum. **(i) Statics and Hydrostatics** Composition of forces at a point. Moments, couples. Resultant of a number of coplanar forces. Conditions for equilibrium. Centre of Gravity. C.G. of different types of laminae. Sensitivity of beam balance. Hydrostatic pressure. Variation with depth. Laws of floatation and applications.	Detailed theory of damped oscillations and resonance not required. Practical expts in: (a) rigid body dynamics (b) properties of matter (c) sound and (d) basic optics experiments About 12 expts in total to be done during the semester Similarities between linear and rotational motion are to be emphasized.		4 hours 7 hours 4 hours

2.	HEAT **(a) Thermometry** Thermometric substance and property. Temperature scales: Celsius, thermodynamic and International. Fixed points ice, steam and triple point. Practical thermometers. $\frac{T}{100} = \frac{(x_t - x_0)}{x_{100} - x_0}$ Charles's law and absolute zero Liquid in glass, resistance, thermocouple, gas thermometers. Optical pyrometer.	Provide detailed explanation on the operation of different types of thermometers		6 hours
	(b) Heat and Energy Heat as a form of energy. Unit Joule Internal heat energy. Conversion from other sources of energy to heat and vice versa (qualitative discussion)	Qualitative discussion is required		2 hours
	(c) Calorimetry Specific heat capacity. Method of mixtures. Electric method. Continuous flow for a liquid. Newton's law of cooling correction. Specific latent heat of fusion and evaporation. Definitions and measurement.	Practical application to be stressed.		4 hours
	(d) Transfer of Heat Energy Heat conduction. Definition of thermal conductivity. Method of measurement for good conductor and bad conductor. Double glazing. Heat convection. Qualitative treatment and examples. Radiation of e.m. radiation. Electromagnetic spectrum – various wave length regions. Detectors of thermal radiation. Heat absorption	**Notes:** Searle's apparatus Lee's Disc methods to be highlighted		7 hours

	and emission. Perfect absorber. Ideal black body Stefan's law. Wien's law. Kirchoff's law. Radiative equilibrium. Prevost's theory.			
3.	BEHAVIOUR OF MATTER **(a) Phases of Matter: Atomic View Point** Density. Solids, liquids and gases. Inter-atomic forces. Thermal agitation and its importance to inter-atomic forces in solids, gases and liquids. Melting and evaporation from molecular point of view. Latent heats as energies of partial or total atomic/molecular separation. Saturated and unsaturated vapours. S.V.P and its effects on gas pressure temperature and solutes.	Differences between saturated and unsaturated vapour to be discussed.		6 hours
	(b) Kinetic Theory of Gases and Thermodynamics Assumptions of kinetic theory. Pressure formula derivation. Maxwell's distribution of velocities, Boyles law. Dalton's law. Gas constant and Boltzman's constant. Various forms of the Gas law. General concept of equation of state. Isothermal bulk modulus and cubic expansivity derived for a perfect gas work done by an expanding gas. Cv and Cp and their relationship. Isothermal and adiabatic changes. Internal kinetic energy of gas. Proof of Pv^{r} = constant and $Tv^{(1-r)}$ = constant. Nonideal gases. Andrew's experiment. Vander Waal's equation – critical state. First law of thermodynamics. Work from graphs. Carnot and Otto	Worked example and tutorials should be given		9 hours

	cycles. Refrigerator concept of entropy. **(c) Elasticity** Stress and Strain. Hook's law. Elastic limit, yield, fracture concepts for ductile and brittle materials. Three moduli of elasticity. Measurement of Young's modulus of wire. Strain energy in extension. Compressibility of liquid.	Demonstrate the concept of elasticity by explaining, solving questions and problems that relate to concept.		4 hours
	(d) Thermal Expansion Linear and cubic expansivities and their relationship. Measurement of coefficients for a solid and liquid. Cracking of cooled glasses. **(e) Surface Tension** Surface tension of liquid and surface energy. Molecular explanation. Angle of contact. Excess pressure across a curved surface. Measurement of surface tension by capillary method and Jaeger's method. Applications of surface tension. **(f) Surface Friction** Coefficients of static and dynamic friction. Characteristics of frictional forces. Measurements of coefficients of friction. **(g) Fluids in Motion** Streamline flow, turbulent flow. The ideal liquid. Bernoulli's law Aerofoil. Viscosity mechanisms at molecular level in liquids and gases. Poiseulle's formula. Terminal velocity. Stoke's law. Measurement of viscosity by Poiseuille's and Stoke's methods. Effect	Examples should be provided. Importance of surface tension should be mentioned. Advantages and disadvantages of friction should be mentioned.		2 hours 4 hours 2 hours 6 hours

	of temperature on viscosity. Applications of viscosity.			
4.	VIBRATIONS AND WAVES **(a) Vibration** Simple harmonic motion. Wave features. Frequency, period, amplitude, phase angle, relations between them. **(b) Progressive Waves** Longitudinal and transverse waves. Examples. U = u sin (wt - kx) and equivalent forms of expressions. Velocity, frequency, period, wavelength amplitude and intensity (decibels) of the waves. Flow of energy. Discussion of waves on water surfaces strings, bars. Sound waves. Reflections with and without phase change. Measurements of speed of sound. Doppler effect and applications. **Note:** Use of ropes, strings, ripple tank be highlighted. **(c) Stationary Waves** Formation of waves u = V (sin wt sinkx). Nodes, antinodes, characteristics of sound waves. Sonometer, gas columns. Quantitative treatment of resonance tube. **(d) Propagation of Waves: Interference and Diffraction** Huygen's construction.	Use of ropes, strings and ripple tank is highlighted.	Simple pendulum, spring, etc	2 hours 7 hours 4 hours 7 hours

	Application to reflection and refraction and to spreading beyond an aperture. Field of waves from two adjacent sources cases of ripple tank and light. Young's double slit experiment and equivalent forms. Measurement of wavelength of light. Interference in thin films. Newton's rings. Blooming of lens surface. Coloured fringes with white light. Coherence. Conditions for interference. Diffraction at single slit. Multiple slits diffraction grating Bragg's law. **(e) Polarization of Light** Concepts of polarization. Ways of producing polarized light. Dichroic crystals. Polaroid. Rotation of plane of polarization. Nichol prism. Malu's law. Brewster's law. Optical activity. Polarimeter applications.			4 hours
5.	GEOMETRIC OPTICS **(a) Reflection** Plane mirrors; inverted image. Deviation on the mirror, optical lever. Spherical mirrors: terminology sign convention (real-is-positive). Derivation of u-v-f relation and r = 2f. Linear Magnification $m = \frac{v}{u}$ Graphs of I_v vs I_u ; m vs u Location of images by non-parallax method. Measurement of focal length for convex and concave mirrors. Spherical aberration. Parabolaid.			6 hours

	Applications like in periscope, Kaleidoscope, search light be emphasized. **(b) Refraction by Plane Surface** Absolute and relative refractive index (n. sini) is a constant through a series of layers. Real depth and apparent depth. Critical angle and total internal reflection. n for a liquid using concave mirror and air-cell methods. Prisms minimum deviation formula. Dispersion and dispersive power. The spectrometer adjustment and use to measure n. measurement of wavelength using grating. Total reflection prisms as mirrors and inverters. Highlight the applications. Prism binoculars, optical fibres, mirage, etc.			7hours
	(a) Refraction by Spherical Surfaces Derivation of paraxial relation for convex, concave surfaces. Thin lens formula sign convention. Measurement of focal length by auto collimation, by u-v measurement and by displacement of lens. Magnification power of two lenses in contact. Chromative aberration and its correction. Other types of aberrations. The eye: construction, main defects and their corrections.	Expts in optics electricity and magnetism and simple expts in modern physics (12 in total) to be carried out		6 hours
	(b) Optical Instruments Angular magnification. Compound microscope magnification with image at near point. Astronomical telescope. Magnification			8 hours

	with image at infinity. Terrestrial telescopes and binoculars. Camera: construction, variable focus aperture, exposure. Measurement of velocity of light by Michelson's method, Foucault's method.			

SECOND SEMESTER SYLLABUS

S/NO:	TOPICS AND CONTENTS	ACTIVITIES / PRACTICAL GUIDE	INSTRUCTIONAL MATERIALS	DURATION
1.	**ELECTRICITY AND MAGNETISM** **(a) Electrostatics: Electric Field and Potential** Electrostatic effects, electrification, electron transfer. Charging by contact and by induction. The electroscope. Coulomb's inverse square law in a medium of permittivity Є. S.I units of permittivity. Comparison in magnitude of electric force with gravitational force. $F = qE$ for a stationary charge q in an electric field intensity E. Radial lines of force from a point charge. Electrostatic potential. Equipotential lines. Details of use of electroscope application like lightening conductors. **(b) Electric Flux and Gauss' Theorem** Electric fields around isolated charges and around conductors. Electric flux and Gauss theorem. Field and potential near a sphere, an infinite cylinder and between parallel plates. Shielding. Electric breakdown. The electron volt.	Reasonable amount of tutorials and problem-solving to be attempted		6 hours 4 hours

	(c) Capacitance Definition unit. Parallel plate capacitor, practical forms. Capacitor in series and in parallel. Energy stored in a capacitor, derivations. Action of a dielectric. Measurement of capacitance and E. Charging and discharging of a capacitor. Different types of capacitors and their uses.			6 hours
	(d) Current Electricity Mechanism of conduction in metals. Ohm's law. Resistivity and temperature coefficient. Electromotive force. Joule's power law. Resistances in series and in parallel Kirchoff's laws. Division of voltage and current. EMF, internal resistance and terminal potential difference. Multirange meter. Conversion of galvanometer to voltmeter and ammeter. The Wheatstone Bridge. Meter bridge. The potentiometer; use in measuring voltage, current and resistance. Accuracy of measurement.	Conduct experiment to investigate physical phenomenon in the area of electricity and produce qualitative and quantitative explanation for a variety of familiar situation. Discuss: a. Different types of cells b. Factors affecting resistance		8 hours
	(e) Magnetic Force Force F = q ʋB on a charge of with velocity η across field of magnetic induction B unit of B. Force on a conductor of length l with current I in a field of magnetic induction B is F = B.I.ℓ. (proof). Couple on a coil in uniform and radial fields. Moving coil meter. Magnetic moment of a coil. Path of an electron in electric and magnetic fields. Crossed field. The cyclotron. Discuss			10 hours

	magnetic lines of force and different types of magnets.			8 hours
	(d) Magnetic Effects of Current Biot-Savart Law in vacuum. Definition and units of μ. Magnetic induction near a long straight wire and on the axis of a coil. Helmholtz coil. Ampere's Theorem. Magnetic induction due to finite and infinite solenoids and torroid using Ampere's theorem. Field pattern due to these systems. Force between two parallel currents. Definition of Ampere. Current balance Biot-Savart law in a medium of permeability μ.			4 hours
	(e) Magnetic Materials Qualitative introduction of Dia, para and Ferromagnetism. Remnant magnetism in ferromagnets. Hysterisis concept. Magnetic moment of a bar magnet. Couple on a bar magnet suspended in a magnetic field. Magnetic field of the Earth.	5 weeks of (3 hours/week) laboratory period		6 hours
	(f) Electromagnetic Induction Magnetic flux and flux linkage in circuits. The Faraday/Neumann law. Lenz's law. EMF induced in a moving rod and rotating coil. A.C. and D.C. generators and D.C. motors. Back emf; self-inductance and mutual inductance. Energy stored is in inductance. Induction coil. Transformer. Emphasize different applications.	Remaining time used for revision of practicals and discussion of various types of data analysis		8 hours

	(g) Alternating Currents A.C. concept, R.M.S. value, A.C. measurement. Advantages of A.C. for power supply. Current through an inductance and capacitance. Reactance, phase and vector representation. Series L.C.R. circuits. Impedance using vector diagram. Power factor and resonance Oscillations in a series L.C.R. circuit.			
2.	MODERN PHYSICS AND ELECTRONICS **(a) Electron in Fields** Electrolysis. Electric discharge. Ionization. The electron. Millikan's oil drop experiment. J. J. Thomson's experiment. Thermionic emission. Electron motion in magnetic field: circular path and its applications. Electron motion in electric field: parabolic path and energy gain. Cathode ray oscilloscope. Time base, focusing and applications. **(b) Photoelectricity and Atomic Spectra** Outline of the experimental results Planck's constant and quanta of light energy. Einstein's photoelectric theory. Photons. Stopping potential. Photocells. Characteristic spectra of elements, lines and series spectra. Continuous spectra. Emission and absorption spectra. Rutherford's nuclear model. Bohr's theory for hydrogen like atoms. Details of energy levels, energy level diagrams, explanations of observed spectra using			10 hours 10 hours

	Bohr's theory. Lyman, Balmer, Paschen, Brackett and Hund series. Excitation and Ionization potentials. Laser principle and operations. **(c) Wave Particle Duality and X-Rays** Wave particle duality: De Broglie hypothesis. Momentum and energy. Electron diffraction. Nature and properties of x-rays. Basic idea of production of x-rays. Line and continuous spectrum. Bragg law. Mosley's law. Application of x-rays.			8 hours
	(d) Radioactivity and Nuclear Energy α, β, γ rays. Properties. The Geiger-Muller tube and counter. Cloud chamber. Bubble chamber. Decay and half-life of radioactive nuclei (detailed treatment). Radioactive series. Proton, Neutron. Isotopes. Nuclear composition. Bainbridge mass spectrometer. Concept $E = mc^2$. Concept of binding energy. Variation of B.E. with atomic number. Release of energy by nuclear fission and nuclear fusion. Application: Reactors, radioisotopes, dating, radiotherapy, etc. **(e) Electronics** Thermionic emission. Work function. Half wave, full wave rectification by diodes (tube and semiconductors). Triode as an amplifier and L.C. oscillator. Modulation and demodulation of radio carrier wave. Fundamentals			10 hours 10 hours

	of semi-conductors and semi-conductor devices. Transistor configuration. Amplification. Feedback. Digital Electronics –basic logic gates. **(f) Medical Physics** Basic applications of Physics to life sciences. Fundamental principles and application of ultrasound, x-ray and nuclear magnetic resonance. Biomechanics. Blood pressure. Elements of nuclear medicine. Radioisotope detection and applications.			8 hours

Recommended Texts / Reference Materials:

1. Advanced Level Physics" – 6th or 7th edition by Nelkon and Park published by Heinemann Educational Books Ltd.
2. Advanced Physics - Keith Gibbs. (Cambridge University Press 1994).
3. Advanced Physics - Steve Adams and Jonathan Allday (Oxford University Press, 2000).
4. Advanced Physics - Three Volumes – Tom Duncan.
5. College Physics - Scars, Zemansky and Young (Addition Wesley Publishing Co).
6. Introductory University Physics - Emeke E. Ike (Enic Publishers, Jos)