

BASIC ELECTRICITY/ APPLIED ELECTRICITY

PREAMBLE

This examination syllabus has been evolved from the Senior Secondary School Electricity curriculum. It is designed to test candidates' knowledge and understanding of electrical and electronic principles, maintenance and repair of domestic and industrial equipment and safe working procedures. The examination syllabus does not replace the curriculum.

OBJECTIVES

The objective of the syllabus is to test candidates':

- (1) knowledge and understanding of the basic concepts and principles of Basic Electricity/Applied Electricity;
- (2) ability to use tools and equipment in the maintenance and repair of electrical/electronic devices;
- (3) understanding of the principle of operation and the application of simple electrical/electronic devices;
- (4) understanding of safe working procedures and safety precautions in domestic and industrial installation.

EXAMINATION SCHEME

There will be three papers, Papers 1, 2 and 3 all of which must be taken. Papers 1 and 2 will be a composite paper to be taken at one sitting.

PAPER 1: will consist of fifty multiple-choice objective questions to be answered in 1 hour for 50 marks.

PAPER 2: will consist of three sections: Sections A, B and C as follows:

Section A will be compulsory for all candidates. It will consist of four questions out of which candidates will be required to answer any three.

Section B will be for candidates in Ghana only. It will consist of three questions out of which candidates will be required to answer two.

Section C will be for candidates in Nigeria, Sierra Leone and The Gambia only. It will also consist of three questions out of which candidates will be required to answer two.

Thus, candidates will be required to answer five questions in all. The paper will last 1 hour and carry 50 marks.

PAPER 3: will be a practical paper of two experiments both of which are to be carried out by candidates in 3 hours for 100 marks.

DETAILED SYLLABUS

SECTION A

(For all candidates)

TOPIC	NOTES
<p>1. DIRECT CURRENT CIRCUIT THEORY Structure of matter</p> <p>Resistors</p> <p>Conductors and insulators. Ohm's law and Kirchhoff's laws Power and energy</p>	<p>Qualitative treatment of the structure of atoms in relation to electric current.</p> <p>Types of resistors. Resistor colour code. Resistors in series and parallel. Power rating of resistors. Definition, examples and characteristics. Qualitative treatments only. Treatment should include calculations.</p>
<p>2. MAGNETIC FIELD AND ELECTROMAGNETISM Fundamentals of magnetism</p> <p>Concept of Electric field</p> <p>Capacitors</p>	<p>Types of magnet. Magnetic properties of materials: magnetic flux, magnetic flux density, permeability, magnetomotive force and reluctance.</p> <p>Electric field and properties: electric flux, electric flux density, electric field strength, permittivity and dielectric constant, potential gradient.</p> <p>Comparison between magnetic and electric circuits</p> <p>Types of capacitor. Capacitance and dielectric. Charge on capacitor, relationship between charge and applied voltage of a capacitor. Application of capacitors. Voltage rating.</p>

<p>Electromagnetic field</p>	<p>Series and parallel connection. Energy stored in a capacitor $(E = \frac{1}{2} QV = \frac{1}{2} CV^2)$: simple calculations.</p> <p>Magnetic field around a current-carrying conductor. Fleming's Right Hand Rule Force on a current-carrying conductor in a magnetic field ($F = BIL\sin\theta$).</p> <p>Lenz's law and Faradays law. Emf induced in a coil ($E = BLV\sin\theta$) Simple calculations involving force and e.m.f. only.</p>
<p>Self and Mutual Induction</p>	<p>Qualitative treatment of self and mutual induction.</p> <p>Energy stored in a coil ($E = \frac{1}{2} LI^2$).</p> <p>Application of electromagnetism as found in electric bell, security alarm system, solenoid, loudspeaker, buzzer, moving-coil instruments etc.</p>
<p>3. MEASURING INSTRUMENTS Moving-coil instrument</p> <p>Moving-iron instrument</p> <p>Digital instrument</p>	<p>Construction, advantages and disadvantages. Conversion of moving-coil instrument to ammeter and voltmeter. Calculations of shunts and multipliers.</p> <p>Construction, principles of operation, advantages and disadvantages.</p> <p>Multimeter, voltmeter, ammeter etc. Advantages and disadvantages.</p>
<p>4. DIGITAL ELECTRONICS Binary number</p> <p>Logic gates</p>	<p>Conversion of decimal numbers to binary numbers and vice versa.</p> <p>Series connection of switches - AND gate, parallel connection of switches - OR gate and inverter - NOT gate. Truth table for logic gates. General symbols for AND, OR, NOT, NAND and NOR gates. Boolean expression.</p>
<p>5. ALTERNATING CURRENT</p>	

<p>CIRCUIT THEORY Generation of e.m.f. in a single turn coil A.C. quantities</p> <p>RLC circuits</p>	<p>Plotting of labelled sinusoidal waveform for a complete cycle. A.C quantities (r.m.s., peak and average values, form factor, cycle, period and frequency)</p> <p>Solution of problems involving RL, RC and RLC series circuits.</p> <p>Conditions for resonance. Phasor diagram of series resonance.</p>
<p>6. TRANSFORMERS Types of transformer</p> <p>Principles of operation of a transformer</p> <p>Losses and temperature rise in transformers</p> <p>Efficiency of transformers Cooling of transformers</p>	<p>Transformer construction Type based on (i) construction (shell and core) and (ii) function (current and voltage). Operation and transformation ratio</p> <p>Transformer losses (copper and iron) Effect of losses and temperature rise in a transformer. Qualitative treatment only.</p> <p>Losses and efficiency of transformer Methods of cooling. Need for cooling.</p>
<p>7. POWER SUPPLY Power supply units</p> <p>Rectification</p>	<p>Power supply units: dry cell, solar cell, cadmium cell and accumulator. Block diagram of d.c. power supply. Functions of blocks of power supply.</p> <p>Half-wave and full-wave rectifications. Filtration and stabilization.</p>
<p>8. ELECTRICAL MACHINES A.C. motors (Single phase)</p> <p>Alternators</p> <p>A.C. motors (Three phase)</p>	<p>Types of single phase motor: split-phase, capacitor-start, capacitor-run. Application of single-phase motors.</p> <p>Principles of operation, parts and types. Relationship of speed, number of poles and frequency $f = \frac{Np}{60}$ (Hz)</p> <p>Principles of operation, parts, type and application</p>

	<p>Methods of starting: direct-on-line, star delta and auto transformer.</p>
D.C. generators	Principles of operation, parts and methods of connecting field windings.
D.C. motors	Principles of operation, parts, types (shunt, compound, series) and application.
9. ELECTRICAL ENERGY SUPPLY	
Generating station	Methods of generating electrical power: diesel engine, steam engine, hydro-electric, nuclear, gas turbine.
10. ELECTRICAL WIRING	
Electrical installation	Types of wiring: surface, conduit, trunking, ducting. Selection of materials, tools and accessories. Application of IEE wiring regulation regarding domestic installation.
Wiring	Cables and accessories. Current-carrying capacity of cable. Wiring of lighting and socket outlets and connection of plugs. Conduit, surface, trunking and ducting installations.
Protection	Protective devices Fuses and circuit breakers Discrimination of protective devices
Earthing	Reasons for earthing. Methods of earthing. Earth loop impedance.
Maintenance, Fault diagnosis and Repairs	Types of fault: short circuit, open circuit and earth leakage. Methods of diagnosing and repair of faults in an installation and equipment such as fluorescent fitting, electric iron, electric fan, blender etc.
Testing of an installation	Continuity test, insulation resistance test, earth leakage test and polarity test.
General Workshop Safety	Application of electrical safety regulations.

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SECTION B

(For candidates in Ghana only)

TOPIC	NOTES
<p>11. ELECTRON EMISSION Electron emission</p> <p>Thermionic emission</p> <p>Cathode Ray Tube(CRT)</p>	<p>Methods of emitting electrons: Thermionic emission, photo emission, secondary emission and field emission.</p> <p>Functions of electrodes, parameters and application.</p> <p>Functions of electrodes in CRT.</p>
<p>12. SEMICONDUCTOR Theory</p> <p>Diode</p> <p>Transistor</p>	<p>Properties of semiconductor materials. Differences between n-type and p-type semiconductor materials.</p> <p>Circuit symbol. PN junction diode. Barrier potential. Forward and reverse bias for a pn junction diode. Characteristics of a pn diode. Application of pn junction diode.</p> <p>Bipolar transistor: two pn junction devices (nnp and pnp). Configuration of bipolar transistor: CC, CB and CE. Principles of operation and mode of connection of the three configurations of a transistor. Characteristics of an npn transistor (common emitter). Unipolar transistor: p-channel and n-channel of field effect transistor (JFET). Principles of operation of JFET. Semiconductor devices and their application: diac, triac, SCR, LED and zener diode. Application of a photo transistor</p>

<p>13. COMMUNICATION Electromagnetic waves Modulation</p> <p>Amplifiers</p> <p>Operational amplifiers</p>	<p>Integrated circuits: simple integrated circuits and their uses.</p> <p>Characteristics of radio waves.</p> <p>Amplitude and frequency modulation and their waveforms.</p> <p>Advantages of frequency modulation (F.M.) over amplitude modulation (A.M.).</p> <p>Classifications: class A, class B, class AB and class C.</p> <p>Application and efficiency of an amplifier.</p> <p>Properties and construction of an ideal operational amplifier.</p> <p>Inverting and non-inverting op-amp.</p>
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SECTION C

(For candidates in Nigeria, Sierra Leone and The Gambia)

TOPIC	NOTES
<p>14. ELECTRICITY TRANSMISSION AND DISTRIBUTION</p> <p>TRANSMISSION</p> <p>DISTRIBUTION OF ELECTRICITY</p>	<p>Layout diagram of high voltage overhead transmission system.</p> <p>Treatment of main components (towers, insulators and conductors) and functions.</p> <p>Detailed treatment of components not required.</p> <p>Operating voltage levels for transmission lines (132 kV and 330 kV) and the need for high voltage system should be emphasized.</p> <p>Layout diagram and main components of electricity distribution.</p> <p>Functions of substation components (transformers, feeders etc.)</p>

<p>15. MAINTENANCE AND REPAIR OF VARIOUS ELECTRICAL APPLIANCES</p> <p>Maintenance</p> <p>Maintenance and repair of electrical appliances</p>	<p>Types (predictive, preventive and corrective)</p> <p>Common faults that occur in electrical appliances (blender, electric iron, electric kettle, toaster, fluorescent lamps etc) such as short circuit, open circuit, earth fault etc.</p>
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