ELECTRONICS AND ELECTRICITY

INTRODUCTION

The science of Electronics and Electricity makes a very important contribution to our everyday existence. Electricity is concerned with the generation, transmission and utilization of electrical energy. Electronics is concerned with its applications in communications, computers, control engineering and various consumer products.

AIMS

The general aims of the syllabus are as follows :

1. to broaden the general education of candidates with particular reference to the 'Electronic Age' in which they live;
2. to provide a foundation for the further study of engineering, computer science, medicine and other applied sciences;
3. to prepare candidates for careers in electronic and electrical engineering.

OBJECTIVES

The objectives of this examination are to evaluate the candidates' ability to

1. understand the basic principles, technological language, concepts and facts relating to electronics and electricity,
2. use various procedures, methods and techniques to solve problems associated with electronics and electricity,
3. generate, select, develop and realize solutions to problem associated with project work,
4. demonstrate certain practical skills in bench work, electrical winding, identifying faults, electrical repairing, soldering, printed circuit-board making, and electronic component assembling,
5. use electrical and electronic equipment, instruments, and hand tools properly,
6. demonstrate effective communication skills in various presentations.

THE EXAMINATION

The examination will consist of two written papers and a project work. The allocation of marks and the duration are as follows :

Paper 1	45%	1 hr 30 min
Paper 2 (M.C.)	25%	1 hr
Paper 3 (Project work)	30%	

Paper 1 consists of two sections, A and B. Section A (15%) will contain six short questions, all of which are to be attempted. Section B (30%) will contain five long questions from which candidates are required to answer four.

Paper 2 consists of multiple-choice questions, all of which are to be attempted.

Paper 3 is a project work. Each candidate is required to complete a project in the school workshop. This should take about 20 hours of class time in the final year of study. Candidates will be required to choose a project from a list issued in the year before the examination. In order to make the approach to the project as flexible as possible, the components employed in the project construction need not be limited to those devices covered in the syllabus. However, candidates are expected to demonstrate in the project report that they have knowledge of the devices used. This may be either an understanding of the working principles of the device or the knowledge of its field of application. Candidates will be required to submit the project together with the project report.

THE SYLLABUS

1.	**Basic Electricity**	
1.1	Charge and Current	Ions and electrons. The units of charge and current. $Q = It$.
1.2	Voltage	Potential difference and electromotive force.
1.3	Electric Circuit	Ohm's Law. V/I characteristics of some ohmic and non-ohmic components. $R = \frac{V}{I}$.
1.4	Resistance and Resistors	Conductors and insulators. Resistivity, $R = \rho \frac{\ell}{A}$. Resistors in series and in parallel : $R_T = R_1 + R_2 + ... + R_n$, $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ... + \frac{1}{R_n}$. Internal resistance of cells. Applications of resistors : carbon film, metal film, and wire wound. Fixed and variable. Colour coding and power rating. Temperature coefficient of resistance : $R_\theta = R_o\ (1 + \alpha\theta)$.
1.5	Power and Energy	Power = IV. Energy = power × time. Watt and kilowatt-hour. Heating effect of a current.

1.6	Electromagnetism	Flux density $B = \frac{\phi}{A}$, magnetomotive force mmf = NI, magnetic field strength (magnetising force) $H = \frac{mmf}{\ell}$, permeability, $\mu = \mu_o \mu_r$, and $\mu = \frac{B}{H}$. Magnetic properties of steel and iron. Laws of electromagnetic induction : e.m.f. induced in a conductor = $B\ell v \sin\theta$. Force on a current-carrying conductor in a magnetic field = $BI\ell \sin\theta$.
1.7	Inductance and Inductors	Lenz's Law. Self and mutual inductance (calculations not required). Energy stored in an inductor = $\frac{1}{2} LI^2$.
1.8	Capacitance and Capacitors	Electric charge and capacitance, Q = CV. $C = \varepsilon \frac{A}{d}$. Energy stored = ½ CV^2. Capacitors in series and in parallel : $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + ... + \frac{1}{C_n}$, $C_T = C_1 + C_2 + ... + C_n$. Applications of various types of capacitors : electrolytic, ceramic, mica, tantalum, PVC and air. Fixed, pre-set, and variable. The working voltage, and breakdown voltage.
1.9	R-C and R-L Circuits	Voltage-Time and Current-Time graphs in R-C and R-L circuits. The time constants : T = CR, $T = \frac{L}{R}$.
1.10	Alternating Current	The generation of alternating current. Frequency, period, the average, r.m.s. and peak values for sinusoidal waves. $f = \frac{1}{T}$, $E_{r.m.s.} = \frac{E_{max}}{\sqrt{2}}$, $E_{av} = \frac{2E_{max}}{\pi}$.

1.11	A.C. Circuits	Series combination of R, L and C in circuits : inductive reactance (X_L) = $2\pi f L$, capacitive reactance (X_C) = $\frac{1}{2\pi fC}$, impedance, phasor diagrams. Power factor, real and apparent power. Power factor correction (calculations not required). Resonance in a series circuit, $f_r = \frac{1}{2\pi\sqrt{LC}}$. Resonance in a loss-free parallel circuit, $f_r = \frac{1}{2\pi\sqrt{LC}}$.

2. **Basic Electronics**

2.1	Semiconductors	Semiconductors, p-type and n-type. P-N junctions. Junction diodes. Junction transistors : common base, common collector and common emitter configurations and compare their impedances and gains.
2.2	Rectification	Principles of operation of the half-wave rectifier and full-wave rectifier (calculations not required). Capacitor smoothing. The zener diode as a voltage stabilizer.
2.3	Amplification	Simple biasing methods of a transistor amplifier (common emitter mode only). The use of capacitors in amplifiers. DC load-line, operating point in output characteristics. Power gain = current gain × voltage gain. Power gain in dB. The input and output waveforms of class A, class B and class C amplifiers. Principle of feedback (block diagrams only), $A_f = \frac{A}{1-\beta A}$. Impedance matching.

3.	**Electronic Devices**	
	Functions and applications of electronic devices	Practical applications of light dependant resistors (LDR), photo-diodes and photo transistors, light emitting diodes (LED), liquid crystal display (LCD), silicon control rectifiers (SCR), diacs, triacs, operational amplifiers, thermistors, Piezo-electric crystals, loudspeakers, relays and microphones (both the moving coil and condenser type).
4.	**Logic Functions**	
4.1	Logic circuits	The Boolean expression, truth tables, symbols and applications of the AND, OR, NAND, NOR and NOT (inverter) gates. Combination of logic gates (not more than 4 gates).
4.2	Multivibrators	The functions and applications of the bistable, monostable and astable multivibrators (block diagrams only).
5.	**Radio Systems**	
	Radio transmission and reception	The radio waves, AM and FM. Simple block diagrams of the radio transmission and receiving systems. The block diagram of a superheterodyne receiver. AM detection.
6.	**Instrumentation**	
6.1	Cathode-ray tube	Construction and principles of operation of the cathode ray tube, thermionic emission and deflection systems.
6.2	Testing instruments	Electrical testing : selection and use of ammeters, voltmeters, wattmeters, multimeters, megger, oscilloscopes and signal generators to test and measure circuit components. Wheatstone bridge. Connection of a shunt or multiplier to a moving-coil instrument so that it can be used as an ammeter or voltmeter.

7.	**Electrical Machines**	
7.1	Generators and motors	The basic operating principles of d.c. and a.c. generators. The basic operating principle of d.c. motors. Practical applications of series, shunt, compound, universal and a.c. motors.
7.2	Transformers	Transformer principle, turns, voltage and current ratios, $\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$. Applications of transformer. Auto-transformer.
8.	**Local Power Supply System**	
8.1	Generation, transmission and distribution	A brief description using schematic diagrams of the generation, transmission and distribution of electrical power in Hong Kong (including the 3-phase supply system).
8.2	Protective devices	The fuses, the earth-leakage circuit breaker and miniature circuit breaker.
9.	**Electrical Safety**	Hazards of electricity. Basic safety precautions. First-aid for electric-shock.

Common Circuit Symbol List of HKCE Electronics & Electricity