ELECTRONICS

ADVANCED SUPPLEMENTARY LEVEL

AIMS

The general aims of the subject are :

1. to foster an interest in and an enjoyment of electronics as a practical and intellectual discipline;
2. to develop knowledge and understanding of the physical basis of electronics;
3. to provide a foundation for the further study of engineering, computer science, medicine and other applied sciences;
4. to prepare candidates for careers in electronic and electrical engineering.

OBJECTIVES

The objectives of the examination are to test candidates' ability to :

1. understand, describe and explain behaviour and the characteristics of devices and components and their observation or measurement;
2. describe and analyse the behaviour of circuits in terms of their constituent devices and components and larger systems in terms of smaller sub-systems as specified in the syllabus;
3. communicate and manipulate electronics ideas in a variety of methods, including numerically, graphically and diagrammatically;
4. apply a knowledge and understanding of the syllabus content to analyse unfamiliar situations and to solve simple design problems;
5. design, construct, test and operate a simple electronic system and report on the processes involved.

THE EXAMINATION

1. The examination will consist of one written paper and a course project. The allocation of marks and the duration are as follows :

Paper 1	80%	3 hours
Paper 2 (Project)	20%	20 hours workshop time

2. Paper 1 consists of two sections, A and B. Section A (32%) will contain a number of short questions, all of which are to be attempted. Section B (48%) will consist of six long questions from which candidates are required to answer four.

3. Paper 2 is a course project taking approximately 20 hours of workshop time to be completed in the school workshop. Each candidate is required to choose a project from a list issued by the Hong Kong Examinations and Assessment

Authority during the year before the examination. The project should involve planning, specification, selection of procedures, construction, evaluation and the preparation of a report. The projects will be marked internally by school teachers and will be moderated by the chief examiner.

4. Knowledge of the Hong Kong Certificate of Education Electronics and Electricity syllabus, though not a prerequisite, would be an advantage.

THE SYLLABUS

This is not a teaching syllabus. Subject materials need not be taught in the order given.

1. Electrical Principles

	Topics	*Explanatory Notes*
1.1	Current, charge, e.m.f. and potential difference; alternating current and voltage; amplitude, frequency and phase difference; real and apparent power.	Relationship between peak, average and r.m.s. for sinusoidal signals is required, but *not* its derivation.
1.2	Ohm's Law. Resistance, resistivity, conductivity, internal resistance. Resistors in series and parallel.	Circuit calculations including the application of Kirchhoffs laws. Colour coding. Temperature coefficient of resistance.
	Variable resistors and potential dividers. Power rating and tolerance.	Types of resistors and their applications.
1.3	The use of ammeters, voltmeters and ohmmeters. Oscilloscope. The use of an oscilloscope to measure voltage, current, time and relative phase difference.	The use of digital and analogue meters. The effect of meter resistance on circuits. Measuring p.d. across known series resistor as a means of measuring current.
1.4	Capacitance. Capacitor and its working voltage. Tolerance. Capacitors in series and in parallel. The time constant, *RC*.	Parallel plate capacitor. The polarity of electrolytic capacitors. Types of capacitors and their applications.
1.5	Inductor and inductance	Self and mutual inductance. Change of flux.

1.6	Ideal transformers. The relationship between turns ratio, voltage and current ratios.	Power and r.f. transformers and their applications.
1.7	Semiconductor. The diode. I/V characteristic.	p-type, n-type, p-n junction, forward bias, reverse bias.
1.8	Half-wave and full-wave rectification and the bridge rectifier. Capacitor smoothing. The zener diode.	The effect of load current and smoothing capacitance on ripple voltage, treated qualitatively.

2. **Analogue Electronics**

	Topics	*Explanatory Notes*
2.1	The Bipolar Transistor.	
	Biasing requirement. Saturation and cutoff. Current amplification.	Transfer and output characteristics.
	Common emitter configuration. d.c. and a.c. analysis. Voltage amplification, current amplification, power amplification. The use of transistor as a switch.	Superimpose small a.c. signal variation on d.c. level graphically.
2.2	Amplifiers.	
	Magnitude and phase relationship between input and output signals.	Measuring voltage gain with a signal generator and an oscilloscope.
	Bandwidth.	Define by the frequencies at which the power drops to half.
	Input and output impedance. Condition for maximum power transfer.	Matching and mismatching of source and load impedance.
2.3	Feedback.	
	Oscillation due to positive feedback.	Comparison between positive feedback and negative feedback.
	Negative feedback.	Advantages of using negative feedback.

	Feedback formula.	$A_f = \dfrac{A}{1 + A\beta}$
2.4	Operational Amplifiers.	
	Properties of an ideal operational amplifier. The inverting amplifier and non-inverting amplifier.	Derivation of voltage gain and input impedance.
	Voltage follower.	Situations in which buffering is required.
	The voltage comparator.	The comparator as a circuit in which analogue techniques are used to produce an output having only two states. Generation of a rectangular wave from a sine wave.
	Use of Wien bridge oscillator to illustrate positive feedback as a means of oscillation and negative feedback as voltage stabilisation.	Demonstration of the frequency response of the Wien bridge (derivation of formulae not required). At the frequency of oscillation, the output is in phase with the input and equal to one-third of the input.

3. **Digital Electronics**

	Topics	*Explanatory Notes*
3.1	Digital Logic.	
	Boolean variables and logical operations.	Use of voltage levels to represent Boolean variables.
	Logic gates: AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.	Use of NAND gates to form the other gates.
	Truth tables and Boolean expressions. De Morgan's theorem. Minimisation of Boolean expressions and derivation of the sum of products form.	Use of Boolean algebra and Karnaugh maps (not more than 4 variables).

	Bit, byte, word. Octal and hexadecimal numbers. Addition of unsigned binary numbers.	Familiarity with binary (8421) numbers.
3.2	Combinational Circuits.	
	Implementation of Boolean expressions.	Use of logic gates for minimised form and NAND gates for sum of products form.
	Logic operations with binary data.	AND, OR and EX-OR only.
	Actions of BCD to decimal converter, half adder and full adder.	Truth table treatment only.
	Seven-segment display.	Use with BCD driver to decimal converter.
3.3	Multivibrators.	
	Astable multivibrators and applications.	Formed with NOR gates and RC circuits. Typical uses.
	Monostable multivibrators and applications. Necessity for debouncing switches.	Formed with NAND gates and RC circuits. Typical uses.
	Bistable multivibrators.	Formed with logic gates.
	Schmitt trigger.	Implementation with a pair of NAND gates and a feedback loop.
3.4	Sequential Circuits.	
	SR latch and D latch. Clocked and unclocked forms.	Timing diagrams and transition tables expected but no discussion of theory.
	Rising-edge D-type flip-flop, falling-edge JK flip-flop, T-type flip-flop.	Timing diagrams for toggling action only. Master-slave flip-flop not required.
	Register and the storage of binary data, the concept of memory. Shift registers.	The register should be treated as an array of independent flip-flops used to latch data.

	Counting circuits. Frequency division. Principles of the digital clock.	Emphasis on action and use of the four-bit binary asynchronous counter.

4. **Simple Electronic Systems**

	Topics	*Explanatory Notes*
4.1	A simple communication system. Functional block diagram only.	Transducer, carrier generator, modulator, demodulator, transmitter, receiver, transmission medium, channel selection and multiplexing.
	Modulation and modulated waveforms.	Examples of AM, FM and PCM.
4.2	Simple computer systems. Functional block diagram only.	
	Hardware.	CPU, RAM, ROM, data, control and address buses, input and output.
	Software.	Concept of programming. Simple flowcharting (process box and decision box only).
	Computer control systems.	Simple applications. Functions of A/D and D/A converters.