# Contents

## WJEC Advanced Subsidiary GCE in Electronics
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# 2007 & 2008

# GCE ELECTRONICS

| Subject/Option Entry Codes | |
|---|---|
| *Advanced Subsidiary (AS) "Cash in" entry*<br>*Advanced Level (AL) "Cash in" entry* | *380 80*<br>*380 90* |
| Unit ET1 | 381 01 |
| Unit ET2 | 382 01 |
| Unit ET3 | 383 01 |
| Unit ET4 | 384 01 |
| Unit ET5 | 385 01 |
| Unit ET6 | 386 01 |

***When making entries, the codes listed should be prefixed with a '0' for English medium entries and with a 'W' for Welsh medium entries***

| Availability of Assessment Units | | |
|---|---|---|
| **Unit** | **January** | **June** |
| ET1 | ✓ | ✓ |
| ET2 | | ✓ |
| ET3 | | ✓ |
| ET4 | ✓ | ✓ |
| ET5 | | ✓ |
| ET6 | | ✓ |

# SUMMARY OF ASSESSMENT

Candidates for an Advanced Subsidiary qualification are required to sit units ET1, ET2 and ET3.
Candidates for an Advanced Level qualification are required to sit all six units.
This is a modular specification

| Unit | Unit Title | AS Weighting | AL Weighting |
|---|---|---|---|
| ET1 | Introduction to Digital and Analogue Systems | 35% | 17.5% |
| ET2 | Circuits and Components | 35% | 17.5% |
| ET3 | Programmable Control Systems Project | 30% | 15% |
| ET4 | Communications Systems | | 15% |
| ET5 | Systems Applications | | 20% |
| ET6 | Design Project | | 15% |

Units ET1, ET2, ET4 and ET5 are assessed externally.
Units ET3 and ET6 are assessed internally.

# ELECTRONICS

## 1 INTRODUCTION

### Criteria for Advanced Subsidiary and Advanced GCE

Both the Advanced Subsidiary and Advanced Level qualifications will be reported on a five-grade scale of A, B, C, D and E. Candidates who fail to reach the minimum standard for grade E are recorded as U (unclassified), and do not receive a certificate. The level of demand of the Advanced Subsidiary examination is that expected of candidates half way through a full Advanced Level course.

The AS assessment units will have equal weighting with the second half of the qualification (A2) when these are aggregated to produce the AL award. AS and A2 will each consist of three assessment units, referred to in this specification as ET1, ET2, ET3 for AS and ET4, ET5, ET6 for A2 respectively. This will allow candidates the opportunity to be assessed either in stages throughout the course, or for all assessments to be taken at the end of the course.

### Progression

**Prior Learning**

Candidates following an AS/L course in Electronics will normally have achieved Grade C or above in GCSE Double Award Science or an equivalent qualification. It is not necessary for candidates to have studied a course in Electronics previously.

**Progression**

This specification will provide a firm foundation for candidates wishing to study to degree or HND level in engineering related courses. It will also provide an excellent basis for students who wish to enter directly into employment and who may wish to further their career through NVQs.

The specification has been designed so that it builds on experience gained over many years when it was used as the basis for Distance and Open Learning courses. It is therefore particularly well suited for the *Learning Age* and the ideals set out in the *Competitive White Paper*.

Its modular structure and commitment to assessment of micro-technology skills through relevant coursework ensures that it supports the principle of life-long learning.

## Prohibited Combinations/Overlap with other Qualifications

There are no prohibited combinations of AS/AL Electronics with other AS/AL specifications.

Overlap exists with the following specifications:

(a) GCE Physics:

There is overlap with Section 3.8 *Electricity* of the subject criteria for Physics.

(b) GCE Design and Technology:

There are opportunities for overlap with practical work in the *Systems and Control* section.

(c) Advanced VCE in Engineering:

There is a small overlap with Mandatory Unit 7 - *Science for Engineering*.

There is some overlap with Optional Unit 15 - *Electrical/electronic principles*.

There is considerable overlap with Optional Unit 20 - *Electronics*.

The classification code for this specification is 1730.

Centres should be aware that candidates who enter for more than one GCE qualification with the same classification code will have only one grade (the highest) counted for the purpose of School and College Performance Tables.

## Rationale

The Advanced Subsidiary (AS) and Advanced Level (AL) specifications in Electronics have been designed to respond to changes in the post-16 curriculum following the Dearing report on 16-19 qualifications. These specifications comply with the criteria for AS/AL examinations published by ACCAC/QCA. The assessment will be available in English and Welsh.

This AS/AL specification will:

(a) provide a complete course in Electronics for those who do not wish to proceed further in the subject;

(b) provide a firm foundation in Electronics for those who wish to proceed to further study;

(c) complement other studies and provide support for those who are taking AS/AL in other subjects.

# 2 AIMS

The aims set out below describe the educational purposes of following a course in electronics. Most of these aims are reflected in the assessment objectives; others are not because they cannot readily be translated into measurable objectives.

The aims are not listed in order of priority.

*The AS and A Level specifications in electronics aim to encourage students to:*

- develop essential knowledge and understanding in electronics and, where appropriate, the applications of electronics, and the skills needed for the use of this in new and changing situations;
- develop an understanding of the link between theory, experiment and design;
- appreciate how electronics has developed and is used in present day society;
- sustain and develop their enjoyment of, and interest in, electronics;
- show the importance of electronics as a human endeavour which interacts with social, economic and industrial matters;
- recognise the quantitative nature of electronics and understand how mathematical expressions relate to electronic principles;
- apply modelling techniques.

*In addition the A Level specification in electronics aims to encourage students to:*

- bring together knowledge of ways in which different areas of electronics relate to each other.

**Spiritual, Moral, Ethical, Social and Cultural Issues**

This specification provides opportunities for candidates to develop an understanding of spiritual, moral, ethical, social and cultural issues as they relate to the designer, manufacturer or user.

Project work and the development of Key Skills may serve to extend understanding of these issues in order that a balanced appreciation of the conflicts and dilemmas involved in the design and manufacture of products or systems may be encouraged.

Units ET3 and ET6 encourage consideration of social, moral and ethical influences on the design, production and purpose of products.

Health and Safety issues are specifically addressed in ET6. Candidates would be expected to consider these issues when designing and making their own products.

**The European Dimension**

The approach used in constructing this specification lends itself to the establishment of links with other areas of study particularly those involving problem solving or the use of ICT.

The above approach conforms with the aspirations expressed in the 1998 Resolutions of the European Community and the Ministers of Education meeting within the Council, concerning the European dimension in education and environmental education, particularly those intended at the level of member states.

# 3 SPECIFICATION CONTENT

## 3.1 Background Scientific Knowledge

The specification builds on the knowledge, understanding and skills set out in the National Curriculum Key Stage 4 programme of study for Double Award Science.

## 3.2 Units

Knowledge of the multiples and sub-multiples, G, M, k, m, μ, n and p will be required.

## 3.3 Practical work

Practical work will play an important role throughout the course. It is assumed that candidates will be familiar with appropriate test instruments and safe operating practices as outlined in relevant DATA/ASE/CLEAPSE documents.
The following publications should be referred to:
*I.E. Wiring Regulations-Requirements for Electrical Installation BS 76711: 1992,*
*HSE-Management of Health and Safety at work: Approved Code of Practice*.

## 3.4 Mathematical Requirements

Knowledge of the following topics will be required:

| | |
|---|---|
| Arithmetic and computation | use of fractions, decimals, percentages, ratios, standard form and significant figures; |
| | use of calculators to find reciprocals, square roots, powers, sine, cosine, tangent, logarithms (to base 10 and base e) and their inverses. |

| | | |
|---|---|---|
| | Algebra | changing the subject of a formula;<br><br>solving simple equations;<br><br>substituting numerical values into equations using appropriate units;<br><br>use of the symbols: =, ≈, <, >. |
| | Graphs | translating information between graphical, numerical and algebraic forms;<br><br>drawing and interpreting graphs involving logarithmic and linear scales and units;<br><br>understanding of straight-line graph formula and its application to experimental results. |

**3.5 Use of IT**

The use of IT should pervade the course, as suggested in the Key Skills specification. Opportunities should be available for modelling systems, circuit simulation, and the use of graphic interfaces for programming tasks in ET3. Project reports might also use ICTs in many ways.

## ET1: Introduction to Digital and Analogue Systems

| AREA OF STUDY | | AMPLIFICATION |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **1.1** | **Logic gates** | |
| 1.1.1 | Types of logic gates | identify and use NOT, AND, NAND, OR, NOR, EXOR, EXNOR gates;<br>construct and recognise truth tables for these gates and simple combinations of them, with up to 4 inputs; |
| 1.1.2 | Logic families | use data provided on supply voltage requirements, voltage bands for logic levels and propagation times of the different families to select suitable devices for an application; |
| 1.1.3 | Simple digital inputs | use mechanical switches with resistors and pulse generators to provide inputs for logic systems;<br>explain the consequences of floating inputs and the use of pull-up and pull-down resistors; |
| 1.1.4 | Simple digital outputs | use a LED and resistor to indicate the output state of a logic system;<br>understand that a logic gate output can be configured to either source or sink current; |
| 1.1.5 | NAND gate logic | use combinations of NAND gates to perform other logic functions;<br>implement a logic system using only NAND gates;<br>recognise redundant gates in such a system; |
| **1.2** | **Logic system design** | |
| 1.2.1 | Specification | translate a specification into a truth table;<br>design and test a system, with up to 4 inputs from a specification; |
| 1.2.2 | System simplification using Boolean algebra | generate the Boolean expression for a system from a truth table;<br>generate the Boolean expression for a system from a logic diagram;<br>apply the rules of Boolean algebra, including De Morgan's theorem to simplify a logic system; |
| 1.2.3 | System simplification using Karnaugh mapping | draw a Karnaugh map for a logic system with up to 4 inputs and use it to minimise the number of gates required; |
| 1.2.4 | System simplification using multiplexers | design and analyse a system with up to 4 inputs using a multiplexer as a programmable logic system; |

| **AREA OF STUDY** | | **AMPLIFICATION** |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **1.3** | **Sequential logic systems** | |
| 1.3.1 | Bistables | design a Set-Reset latch based on NAND gates;<br>use a truth table sequence to describe the action of such bistables; |
| 1.3.2 | D-type flip-flops | draw a timing diagram to illustrate the significance of edge triggering;<br>draw a timing diagram to illustrate how a transition gate can be used to produce edge-triggering;<br>distinguish between the operation of the clocked data input and the set/reset inputs on a D-type flip-flop; |
| 1.3.3 | Counters | connect a D-type flip-flop to perform a divide-by-two function;<br>design 4-bit up and down counters based on D-type flip-flops;<br>design 4-bit modulo-n counters and binary coded decimal (BCD) counters;<br>draw timing diagrams for these counters;<br>describe the use of decoders and seven-segment displays;<br>convert between binary, decimal and BCD number systems<br>design systems that use a counter and combinational logic to produce a sequence of events |
| **1.4** | **Operational amplifiers** | |
| 1.4.1 | General characteristics | know the significance of inverting and non-inverting inputs, input and output impedances and voltage gain of an ideal op-amp;<br>select an appropriate amplifier from data provided;<br>describe the power supply requirements and limitations for available output voltage swing; |
| 1.4.2 | Inverting amplifier | draw and recognise the inverting amplifier circuit;<br>design an inverting amplifier using resistive negative feedback to achieve specified voltage gain;<br>use the formula<br>$\frac{V_{OUT}}{V_{IN}} = -\frac{R_F}{R_{IN}}$<br>know that the input impedance is equal to the resistance of the input resistor and is relatively independent of the op-amp characteristics;<br>use the concept of the virtual earth at the inverting input;<br>describe the use of inverting amplifiers with AC and DC signals; |

| **AREA OF STUDY** | **AMPLIFICATION** |
|---|---|
| | ***Candidates should be able to:*** |
| 1.4.3 Non-inverting amplifier | draw and recognise the non-inverting amplifier circuit;<br>design a non-inverting amplifier using resistive negative feedback to achieve specified voltage gain;<br>use the formula $\frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_F}{R_1}$<br>know that the input impedance is equal to that of the op-amp;<br>describe the use of non-inverting amplifiers with AC and DC signals |
| 1.4.4 Bandwidth | know that the bandwidth is the frequency range over which the voltage gain is greater than $1/\sqrt{2}$ of its maximum value;<br>estimate this bandwidth from a frequency response curve;<br>use the gain-bandwidth product (unity gain bandwidth) to estimate bandwidth;<br>design single stage amplifiers based on inverting or non-inverting voltage amplifiers, to achieve a specified voltage gain and bandwidth; |
| 1.4.5 Signal distortion | explain what is meant by clipping distortion, and describe how it can be reduced;<br>describe the distortion that occurs when the slew-rate of an op-amp is exceeded;<br>use the formula slew-rate (SR) = $\Delta V_0/\Delta t$ |

## ET2: Circuits and Components

| **AREA OF STUDY** | | ***AMPLIFICATION*** |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **2.1** | **Current, voltage, resistance and power** | apply Ohm's and Kirchhoff's laws;<br>calculate the combined resistance of resistors connected in series and/or parallel;<br>perform calculations on voltage dividers made of resistors;<br>apply the formula for power dissipation; |
| **2.2** | **RC networks** | explain how capacitors can be used to form the basis of timing circuits;<br>calculate the value of the time constant for *RC* circuits;<br>sketch the charge and discharge curves for voltage and current;<br>use formulae relating the voltage across a capacitor as a function of time for a capacitor being charged or discharged from a constant voltage source;<br>realise that<br>$V_C = 0.5\ V_S$ after 0.69 *RC* and<br>$V_C \approx V_S$ after 5 *RC* for charging capacitors<br>$V_C \approx 0$ after 5 *RC* for discharging capacitors;<br>understand that *RC* networks must be buffered in practice; |
| **2.3** | **Timing circuits** | |
| 2.3.1 | Monostable circuits | describe how an inverter can be used with a *RC* network to form a simple time delay circuit;<br>configure a 555 timer IC as a monostable, and calculate the time period using $T = 1.1\ RC$; |
| 2.3.2 | Astable circuits | explain the operation of a circuit based on a Schmitt inverter and estimate the operating frequency using f≈1/RC<br>configure a 555 timer IC as an astable;<br>calculate the time that the output is high and low [using $t_H = 0.7\ (R_A + R_B)\ C$ and $t_L = 0.7\ R_B C$,] and the frequency and mark-space ratio of the oscillation; |
| **2.4** | **Semiconductor diodes** | |
| 2.4.1 | Rectifier and signal diodes | sketch current-voltage characteristics for forward and reverse biased diodes;<br>realise that the forward voltage drop depends on the current flowing and is between 0.5 V and 0.9 V when the diode is conducting; |

| AREA OF STUDY | | AMPLIFICATION |
|---|---|---|
| | | ***Candidates should be able to:*** |
| 2.4.2 | Zener diodes | sketch current-voltage graphs for zener diodes, indicating the zener voltage $V_Z$ and holding current $I_{Z\ MIN;}$<br>select appropriate zener diodes given data on zener voltage and power rating; |
| 2.4.3 | Light emitting diodes | select appropriate LEDs given data on forward voltage, maximum reverse voltage, maximum forward current (including arrays and seven segment displays);<br>explain how an inverse parallel diode is used to protect the LED when used on an AC supply;<br>calculate series resistor values for DC and AC LED indicator circuits; |
| **2.5** | **Simple power supplies** | |
| 2.5.1 | AC measurement | state and apply the relationship between peak and rms value of a sinusoidal AC voltage; |
| 2.5.2 | Rectification | understand the use of diodes in half-wave and full-wave bridge rectifiers;<br>calculate the peak value of the output voltage of half-wave and full-wave rectifiers given the rms input voltage; |
| 2.5.3 | Capacitive smoothing | describe the effect of a capacitor on the output waveform from a rectifier;<br>know that the size of the ripple voltage is dependent on the method of rectification, the values of capacitance and load resistance; |
| 2.5.4 | Voltage regulation | describe how a zener diode can be used with a current limiting resistor to form a simple regulated voltage supply;<br>calculate suitable values for limiting resistors and the maximum value of current available from the voltage supply;<br>explain the effect of loading the voltage supply and sketch a graph showing the effect of loading; |

| AREA OF STUDY | | AMPLIFICATION |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **2.6** | **Signal sources** | describe the use of photo transistors, photo diodes, light dependent resistors and thermistors in voltage dividing chains to provide analogue signals;<br>sketch and interpret response curves for the above devices;<br>calculate suitable values for series resistors for use with the above devices;<br>explain the use of potentiometers to provide angular position signals;<br>use Thevenin's theorem to draw equivalent circuits and predict the effect of loading;<br>describe the use of opto-switches in rotational and displacement sensing applications;<br>explain how a Schmitt inverter can be used to provide signal conditioning with analogue signal sources and to eliminate mechanical switch bounce; |
| **2.7** | **Switching circuits** | |
| 2.7.1 | Voltage comparator | understand how the output state depends on the relative value of the two input states;<br>perform calculations on comparator switching circuits; |
| 2.7.2 | Npn and pnp bipolar transistors | describe the switching action of npn and pnp transistors;<br>perform calculations using $I_C = h_{FE} I_B$;<br>know that $V_{BE}$ depends on $I_B$ and is between 0.5 V and 0.9 V when the transistor is conducting;<br>perform calculations on transistor switching circuits;<br>estimate the value of $h_{FE}$ from data provided;<br>describe how a transistor switch can increase the output capability of a comparator circuit and compare the overall performance with that of a Darlington pair arrangement; |
| 2.7.3 | Enhancement mode n channel MOSFETs | describe the switching action of n channel MOSFETs;<br>recognise that MOSFETs have a very high input resistance;<br>perform calculations using $I_D = g_M V_{GS}$;<br>understand that $r_{DS}$ decreases from a very high value to a very low value as $V_{GS}$ is increased and is at a minimum value of $r_{DSon}$ at saturation;<br>perform calculations on MOSFET switching circuits;<br>compare the performance of MOSFET and transistor switches; |
| 2.7.4 | Interfacing | use data sheets to select suitable comparators, transistors and MOSFETs for connecting to signal sources and driving outputs such as lamps, sounders, motors, solenoids and relays;<br>state the need for diode protection for comparators, transistors and MOSFETs. |

## ET3: Programmable Control Systems Project

### Introduction

This unit focuses first on programming in a high level language using ladder logic programming, since this is prevalent in industrial control. However, many control systems, particularly in domestic systems such television remote control, car remote keys and heating controllers make use of micro-controllers such as the PIC-chip. Programming these controllers in assembly language will open the door to many powerful applications and exciting project work, whilst reinforcing the links with previous course units. This emphasis on project work is reflected in the method used to assess this unit. Further guidance on management and rationale appears in the section describing coursework in Section 6.5.1.

| **AREA OF STUDY** | | ***AMPLIFICATION*** |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **3.1** | **Control Principles** | relate a design problem to the number and nature of inputs and outputs needed by a control system;<br>apply a structured approach to programming control systems; |
| **3.2** | **Ladder Logic** | |
| 3.2.1 | Program design | design and test programs which react to information from sensors to control outputs;<br>design and test programs which produce a pre-determined sequence at the outputs; |
| 3.2.2 | Ladder functions | build programs which:<br>• incorporate digital inputs<br>• count events<br>• use a time delay<br>• produce a sequence of events<br>• monitor inputs and take decisions<br>incorporate program tools, such as switches, in combinations which perform AND, OR and latching functions; |
| **3.3** | **Microcontrollers** | |
| 3.3.1 | Program design | design and test programs which react to information from sensors to control outputs;<br>design and test programs which produce a sequence of events at the outputs which depends on the combination of inputs;<br>synthesise programs using a range of standard sub-routines; |

| **AREA OF STUDY** | **AMPLIFICATION** |
|---|---|
| | ***Candidates should be able to:*** |
| 3.3.2 Program procedures | build programs which:<br>• incorporate digital inputs,<br>• count events,<br>• use a time delay,<br>• produce a sequence of events,<br>• test bits to monitor inputs, and take decisions |

## ET4: Communications Systems

| **AREA OF STUDY** | | ***AMPLIFICATION*** |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **4.1** | **Introduction** | understand the significance of the following terms applied to communications systems:<br><br>analogue and digital signals, transmission medium, carrier, encoding/decoding modulation/demodulation, gain/attenuation, base (signal) bandwidth, broadcast bandwidth, noise/distortion, multiplexer/demultiplexer, time division multiplexing, frequency division multiplexing; |
| **4.2** | **Analogue Communications Systems** | |
| 4.2.1 | AC theory | use the formulae $X_c = 1 / 2 \pi f C$ and $X_L = 2 \pi f L$;<br>describe the phase difference between current and voltage in capacitors and inductors;<br>understand the significance of the term impedance, and that it is a function of $X_L$, $X_c$ and R in a LCR circuit;<br>plot and interpret graphs showing the frequency response of a RC network;<br>explain that resonance occurs in a parallel LC network when $X_c = X_L$ and hence calculate the resonant frequency; |
| 4.2.2 | Amplitude modulation (AM) | draw graphs to show the resulting waveform, and frequency spectrum for a sinusoidal carrier amplitude modulated by an audio signal, to a given depth of modulation; |
| 4.2.3 | AM radio receiver | draw a block diagram, and circuit diagram for a simple radio receiver, consisting of antenna, tuned circuit, detector/demodulator, audio amplifier and loudspeaker;<br>describe the function of each of these sub-systems;<br>design a tuned circuit to select a particular carrier frequency;<br>use the frequency response curves of a loaded tuned circuit to explain poor selectivity;<br>explain that a RF amplifier can be used to improve sensitivity;<br>explain that a superhet receiver offers improved selectivity and sensitivity;<br>draw a block diagram of a superhet receiver, consisting of antenna, tuned RF amplifier, mixer, local oscillator, IF filter, IF amplifier, detector/demodulator, audio amplifier and loudspeaker;<br>describe the function of each of these sub-systems; |

| AREA OF STUDY | | AMPLIFICATION |
|---|---|---|
| | | ***Candidates should be able to:*** |
| 4.2.4 | Frequency modulation (FM) | compare the merits of AM and FM; |
| 4.2.5 | Frequency shift keying (FSK) | describe the use of FSK to transmit digital data on an analogue carrier; |
| **4.3** | **Digital Communications Systems** | |
| 4.3.1 | Introduction | compare the merits of analogue and digital communication;<br>state the function of Analogue to Digital converters (ADC) and Digital to Analogue converters (DAC); |
| 4.3.2 | Communication Links | compare performance of optical fibre and cable links; |
| 4.3.3 | Regeneration | understand that the signal to noise ratio degrades down a transmission line, and that regeneration restores the original signal;<br>recognise, analyse and design inverting and non-inverting Schmitt trigger circuits to regenerate digital signals; |
| 4.3.4 | Pulse modulation | describe and illustrate the following pulse carrier modulation techniques:<br>pulse width modulation<br>pulse position modulation; |
| 4.3.5 | Shift Registers | describe the use of D-type flip-flops to form parallel-in serial-out (PISO) registers and serial-in-parallel-out (SIPO) registers;<br>draw timing diagrams. |
| 4.3.6 | Pulse code modulation (PCM) | describe and illustrate pulse amplitude modulation (PAM) techniques;<br>relate required sampling frequency to the highest frequency in the signal;<br>draw a block diagram for, and describe the operation of, a PCM communication system comprising a transmitter (low pass filter, sampling gate, ADC, PISO shift register) and receiver, (Schmitt trigger, SIPO shift register, DAC and low pass filter);<br>relate quantisation error to the number of sampling levels, and calculate it for a given system;<br>describe how time division multiplexing (TDM) can be used to improve the efficiency of a PCM communications link;<br>use given data to calculate how many channels can be incorporated into a PCM communications link, using TDM; |

| AREA OF STUDY | | AMPLIFICATION |
|---|---|---|
| | | ***Candidates should be able to:*** |
| 4.3.7 | Asynchronous transmission using RS232 | describe asynchronous character framing in terms of the start and stop bits, data bits and parity bit;<br>describe the handshaking protocol used in RS232, and the meaning and significance of the following RS232 terms – TD, RD, DTR, DSR, RTS, CTS, DCD; |
| 4.3.8 | Packet switching | discuss the relative merits of circuit switched, message switched and packet switched networks;<br>understand that transmission control protocol/internet protocol (TCP/IP), used in communications between devices on networks is an example of the use of packet switching;<br>distinguish between the three main commercial classes (A, B and C) of IP addresses;<br>understand that IP addresses are four bytes long, and are normally stated in dotted decimal notation;<br>recognise the ranges of address available to the user in each class;<br>describe how routers are used to direct data packets from source to destination by interpretation of IP addresses. |

## ET5: Systems Applications

| **AREA OF STUDY** | | ***AMPLIFICATION*** |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **5.1** | **Counting Systems** | |
| 5.1.1 | Ripple counters | understand that propagation delays limit the counting rate of ripple counters; |
| 5.1.2 | Synchronous counters | draw a block diagram showing how D-type flip-flops can be connected together to form a synchronous counter;<br>explain how simultaneous clocking of D-type flip-flops reduces total propagation delay making such counters suitable for high speed counting;<br>design a synchronous counter (up to 3 bits) to produce a given sequence including Gray code;<br>explain why unused states must be directed back into the main sequence;<br>manipulate unused (don't care) states to provide simpler solutions;<br>analyse a given synchronous counter circuit (up to 3 bits) and describe the sequence it produces; |
| **5.2** | **Signal Conversion Systems** | |
| 5.2.1 | Introduction | understand the need for signal conversion between analogue and digital form in areas such as communication systems and microprocessor systems; |
| 5.2.2 | Digital to Analogue Converters (DAC) | recognise, analyse and design summing circuits consisting of operational amplifiers;<br>describe how a summing amplifier can be used as a digital to analogue converter;<br>use the formula<br>$V_{OUT} = -R_F(V_1/R_1 + V_2/R_2 + V_3/R_3 + \ldots . )$; |
| 5.2.3 | Analogue to Digital Converters (ADC) | describe the relative advantages of flash converters and successive approximation converters;<br>describe and illustrate how several comparators can be used to form a flash converter;<br>calculate resistor values for a simple flash converter;<br>understand the factors affecting the resolution of a flash converter;<br>describe the use of a priority encoder; |
| **5.3** | **Power Supply Systems** | |
| 5.3.1 | Load and Line regulation | explain what is meant by the terms load and line regulation; |

| **AREA OF STUDY** | | **AMPLIFICATION** |
|---|---|---|
| | | ***Candidates should be able to:*** |
| 5.3.2 | Emitter follower | draw and recognise an emitter-follower arrangement; state that the input impedance ≈ $h_{FE}$ $R_E$ and $V_{OUT} \approx V_{IN} - 0 \cdot 7V$ |
| 5.3.3 | Series Regulation | describe the use of an emitter-follower as a series regulator to improve the performance of a simple zener diode power supply;<br>describe and illustrate the use of a non-inverting op-amp to stabilise the output of a regulated power supply.<br>Use the formula $V_L \approx V_Z\left(1+\frac{R_F}{R_1}\right)$; |
| 5.3.4 | Short Circuit Protection | describe the use of a transistor and resistor connected to the output of the series regulator to limit the output current;<br>perform calculations which relate the value of the resistor to the maximum permissible output current; |
| **Instrumentation Systems** | | |
| 5.4.1 | Introduction | understand that an instrumentation system can consist of sensors, signal processing, telemetry and data presentation; |
| 5.4.2 | Sensors | design sensing units containing sensors such as thermistors, thermocouples, strain gauges and gas sensors;<br>describe the advantage of using sensors in a bridge circuit compared to a simple voltage divider circuit; |
| 5.4.3 | Signal processing | describe the use of a difference amplifier as a signal processor;<br>understand the significance of common mode rejection ratio;<br>understand that some difference amplifier applications demand the use of precision components.<br>use the formula $V_{OUT} = V_{DIFF}\left(\frac{R_F}{R_1}\right)$;<br>design and analyse difference amplifier circuits based upon an op-amp;<br>design and analyse DC bridge circuits for a range of applications; |

| AREA OF STUDY | | AMPLIFICATION |
|---|---|---|
| | | ***Candidates should be able to:*** |
| 5.4.4 | Data presentation devices | describe a range of suitable data presentation devices, such as analogue/digital meters and bar graph displays to display the output of an instrumentation system; |
| **5.5** | **High Power Switching Systems** | |
| 5.5.1 | General thyristor characteristics | describe how a small gate voltage and current can latch a larger anode current;<br>select appropriate thyristors using data on minimum gate voltage, minimum gate current and holding current; |
| 5.5.2 | DC switching | describe advantages of using thyristors for switching high power loads;<br>draw a diagram showing the use of capacitor commutation for turning a thyristor off;<br>explain capacitor commutation;<br>use thyristor data to design a switching circuit; |
| 5.5.3 | Control in AC Circuits | recognise the advantage of phase control over resistive means;<br>describe how the phase control of a thyristor can be achieved using a RC network and a diac;<br>describe phase difference $\phi$ between supply voltage and capacitor voltage in RC circuits and estimate its value from CRO traces;<br>use the formula $\phi = \tan^{-1}R/X_C$ to calculate phase shift;<br>sketch waveforms for phase control; |
| **5.6** | **Audio systems** | |
| 5.6.1 | Introduction | recognise that a public address system can consist of the following sub-systems:<br>input sources, pre-amplifier, mixer, tone controls<br>power amplifier, loudspeakers; |
| 5.6.2 | Input Sources | design systems that interface an audio system to analogue input sources such as radio receivers, and digital storage devices using DACs. |
| 5.6.3 | Pre-amplifiers | describe the use of a pre-amplifier to provide maximum voltage transfer and voltage gain;<br>describe the use of multi-stage amplifiers to provide a larger bandwidth for a given gain; |
| 5.6.4 | Mixer | design a mixer circuit based on a summing amplifier; |

| **AREA OF STUDY** | **AMPLIFICATION** |
|---|---|
| | ***Candidates should be able to:*** |
| 5.6.5 Tone controls | design and analyse circuits for first order passive (*RC*) treble cut and bass cut filters;<br>describe the limitations of passive filters;<br>define and calculate break frequency;<br>draw and interpret gain/frequency graphs for filters;<br>design and analyse first order filter circuits based on an inverting amplifier including bass boost, treble boost, bass cut, and treble cut; |
| 5.6.6 Audio power amplifiers | understand that an audio power amplifier is a large-signal amplifier which can deliver sufficient power to drive a low impedance loudspeaker;<br>apply the maximum power transfer theorem;<br>describe the use of an emitter follower as a simple power amplifier, having a high input impedance and low output impedance;<br>draw circuit diagrams for, recognise and explain the operation of a push-pull output circuit consisting of a npn and pnp emitter follower;<br>describe crossover distortion;<br>understand that the power delivered to the load by a push-pull stage is a function of power supply voltage;<br>use the formula $P_L(max) = V_S^2 / 8R_L$;<br>describe the advantages of push-pull output circuits over single ended output circuits; |

## ET6: Design Project

| AREA OF STUDY | | *AMPLIFICATION* |
|---|---|---|
| | | ***Candidates should be able to:*** |
| **6.1** | **Project planning** | write a detailed specification for a solution to the problem, using appropriate technical terminology;<br>devise at least two electronic solutions which meet the specification;<br>draw a block diagram and describe the function of each block, for these two solutions;<br>give reasons for selecting one of the solutions; |
| **6.2** | **System development** | develop the chosen solution as a series of sub-systems and for each sub-system:<br>write a specification to define the desired performance of the sub-system;<br>consider, where possible, alternative circuits which meet the sub-system specification, giving reasons for selecting the preferred circuit;<br>give a circuit diagram;<br>select/calculate component values;<br>devise procedures to test the circuit ;<br>evaluate its performance against the sub-system specification;<br>modify the circuit, where necessary, to meet the specification;<br>apply appropriate safety procedures as set out in the following publications:<br>*IE Wiring Regulations-Requirements for Electrical Installation BS 76711: 1992,*<br>*HSE-Management of Health and Safety at work: Approved Code of Practice*. |
| **6.3** | **Complete system** | plan an organised layout for the complete system on either prototype board, strip-board or printed circuit board;<br>devise procedures to test the complete system in terms of the parameters given in the system specification;<br>evaluate its performance against that system specification;<br>produce a set of recommendations for further development; |
| **6.4** | **Documentation** | write a detailed report on the development of the project, including, in addition to the items listed above:<br>a record of all sources of information;<br>an operator's manual on how to use the system;<br>a photograph of the complete system;<br>a full circuit diagram for the complete system. |

# 4 KEY SKILLS

Key Skills are integral to the study of AS/AL Electronics, and a number of these Key Skills may be assessed through the course content and the related scheme of assessment as defined in the specification. In particular, candidates may demonstrate their ability to fulfil aspects of each of the following Key Skills, normally at Level 3:

- Application of Number
- Communication
- Information Technology
- Improving Own Learning and Performance
- Working with Others
- Problem Solving.

In relation to the Key Skills, candidates will be required to show their competence in the following performance indicators:

## 4.1 Application of Number

The specification will provide opportunities for candidates,

- when collecting and recording data, to –

  make and justify decisions about how an activity or task is approached;
  choose appropriate methods for obtaining the required results.

- when processing data, to –

  select appropriate data and calculations;
  carry out and check their calculations to an acceptable level of accuracy.

- when interpreting and presenting findings and conclusions, to –

  present findings effectively, to appropriate levels of accuracy;
  interpret findings, allowing for possible sources of error;
  review the choices made in the approach to the task.

## 4.2 Communication

Candidates will be required to demonstrate their competence in the following Key Skill of Communication:

1. When reading and responding to written materials candidates will be required to:

   - select and read appropriate materials for a purpose;
   - extract and collate necessary information from text and images;
   - summarise coherently information obtained from different sources.

2. When producing written materials candidates will be required to:

   - present clear and relevant information in a suitable format;
   - organise material coherently and use an appropriate style of writing;
   - check that the text is legible and ensure that the meaning is clear;
   - use standard conventions of spelling, punctuation and grammar and present arguments clearly and logically.

3. Take part in discussions and make presentations, as appropriate.

## 4.3 Information Technology

This specification will provide opportunities for candidates to demonstrate their use of IT.

1. Search for and select information for two different purposes.

   (a) Identify information needed and suitable sources.

   (b) Carry out effective searches.

   (c) Select information that is relevant to the purpose.

2. Explore and develop information, and derive new information, for two different purposes.

   (a) Enter and bring together information using formats that help development;

   (b) Explore information as needed for a purpose.

   (c) Develop information and derive new information as appropriate.

3. Present combined information for two different purposes.

   (a) Select and use appropriate layouts for presenting combined information in a consistent way.

   (b) Develop the presentation to suit the purpose and types of information.

   (c) Ensure work is accurate, clear and saved appropriately.

## 4.4 Problem solving

This specification will provide opportunities for candidates to produce evidence to demonstrate their skills in of Problem Solving in some or all of the following areas:

1. Explore a complex problem, come up with **three** options for solving it and justify the option selected for taking it forward.

2. Plan and implement at least **one** option for solving the problem, review progress and revise approach as necessary.

3. Apply agreed methods to check if the problem has been solved, describe the results and review approach to problem solving.

## 4.5 Working with Others

1. Plan complex work with others agreeing objectives, responsibilities and working arrangements.

2. Seek to establish and maintain cooperative working relationships over an extended period of time, agreeing changes to achieve agreed objectives.

3. Review work with others and agree ways of improving collaborative work in the future.

## 4.6 Improving own Learning and Performance

This specification will provide opportunities for candidates to produce evidence to demonstrate how candidates have improved their own Learning and Performance in some or all of the following areas:

1. Agree targets and plan how these will be met over an extended period of time, using support from appropriate people.

2. Take responsibility for learning by using a plan, seeking feedback and support from relevant sources, to help meet targets.

   Improve performance by:

   - studying a complex subject ;
   - learning through a complex practical activity;
   - further study or practical activity that involves independent learning.

3. Review progress on **two** occasions and establish evidence of achievements, including how there has been learning from other tasks to meet new demands.

Some suggestions about the ways evidence of achievement in Key Skills may be produced by candidates studying this specification are detailed on Page 50.

# 5 ASSESSMENT OBJECTIVES

## 5.1 Assessment objectives AO1, AO2 and AO3 are the same for AS and A Level

AO4 applies only to the A2 part of the A level specification.

***AO1*** **Knowledge with understanding**

*Candidates should be able to:*

- recognise, recall and show understanding of specific facts, terminology, principles, relationships, concepts and practical techniques;
- draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological implications and applications of electronics;
- select, organise and present relevant information clearly and logically, using specialist vocabulary where appropriate.

***AO2*** **Application of knowledge and understanding, analysis, synthesis and evaluation**

*Candidates should be able to:*

- describe, explain and interpret phenomena and effects in terms of electronic principles and concepts, presenting arguments and ideas clearly and logically, using specialist vocabulary where appropriate;
- interpret and translate, from one form to another, data presented as continuous prose or in tables, diagrams and graphs;
- carry out relevant calculations,
- apply the principles and concepts of electronics to unfamiliar situations including those which relate to ethical, social, economic, environmental and technological implications and applications of electronics;
- assess the validity of information, experiments, inferences and statements.

***AO3*** **Experiment and investigation**

*Candidates should be able to:*

- devise and plan experimental activities, selecting appropriate techniques;
- demonstrate safe and skilful practical techniques;
- make observations and measurements with appropriate precision and record these methodically;
- interpret, explain, and evaluate the results of experimental activities, using knowledge and understanding of electronics and to communicate this information clearly and logically in appropriate forms eg prose, tables, and graphs using appropriate specialist vocabulary.

***AO4*** **Synthesis of knowledge, understanding and skills**

*Candidates should be able to:*

- bring together principles and concepts from different areas of electronics and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary.
- use the skills of electronics in contexts which bring together different areas of the subject

# 6 SCHEME OF ASSESSMENT

## 6.1 Papers will be set on each of the following assessment units

| Unit | Unit Title | AS Weighting | AL Weighting |
|---|---|---|---|
| **ET1** | **Introduction to Digital and Analogue Systems** | **35%** | **17.5%** |
| **ET2** | **Circuits and Components** | **35%** | **17.5%** |
| **ET4** | **Communications Systems** | | **15%** |
| **ET5** | **Systems Applications** | | **20%** |

All examination papers will consist of questions which have varying mark allocations. These mark allocations will be indicated on each paper.
Candidates will be expected to answer all questions.

The duration of the examinations total number of marks allocated to each paper are shown in the table below.

| Unit | Unit Title | Duration | Marks |
|---|---|---|---|
| **ET1** | **Introduction to Digital and Analogue Systems** | **1½ hours** | **60** |
| **ET2** | **Circuits and Components** | **1½ hours** | **60** |
| **ET4** | **Communications Systems** | **1¼ hours** | **50** |
| **ET5** | **Systems Applications** | **1¾ hours** | **70** |

All assessments will be available in Welsh and English.

Synoptic assessment in Electronics will address candidates' understanding between different elements of the subject.

Questions set in ET5 will require knowledge of the content of ET1 and ET2 and ET4. For example problems on the topic 'synchronous counters' may well require earlier methods such as Boolean algebra and/or Karnaugh mapping.

At least 20% of the overall mark will be allocated to synoptic assessment, examined in the ET5 unit test, (15%), and in the ET6 project, (5%).

## 6.2 Relationship between the Assessment Units and the Assessment Objectives

The following table indicates approximately how each assessment objective is assessed at A level.

| Assessment Objective | Unit | | | | | |
|---|---|---|---|---|---|---|
| | **ET1** | **ET2** | **ET3** | **ET4** | **ET5** | **ET6** |
| AO1 35% | 9% | 9% | 0 | 8% | 9% | 0 |
| AO2 30% | 5% | 5% | 5% | 5% | 5% | 5% |
| AO3 15% | 0 | 0 | 7% | 0 | 0 | 7% |
| AO4 20% | 0 | 0 | 0 | 0 | 15% | 5% |

The following table indicates approximately how each assessment objective is assessed for AS.

| **Assessment Objective** | **Unit** | | |
|---|---|---|---|
| | **ET1** | **ET2** | **ET3** |
| AO1<br>50% | 17% | 17% | 16% |
| AO2<br>35% | 11% | 12% | 12% |
| AO3<br>15% | 0 | 0 | 15% |
| AO4<br>0% | 0 | 0 | 0 |

## 6.3 Availability of Units

Unit tests on ET1 and ET4 will be available in January and June. Unit tests on ET2 and ET5 will be available in June only. Internal assessment for ET3 and ET6 must be submitted for moderation by a date in May specified by the WJEC.

## 6.4 Internal Assessment of Coursework

6.4.1 The following units will be assessed internally.

| Unit | Unit Title | AS Weighting | AL Weighting |
|---|---|---|---|
| ET3 | Programmable Control Systems Project | 30% | 15% |
| ET6 | Design Project | | 15% |

6.4.2 For Unit ET3, candidates will be expected to submit no more than three programming mini-projects reports for each of the two levels of programming. The marking criteria for this unit are listed in the Coursework Mark Booklet (See Appendix 1).

6.4.3 For Unit ET6, candidates will be expected to submit a project report. The marking criteria for this unit are listed in the Coursework Mark Booklet (See Appendix 2). The following marking criteria references taken from this Coursework Mark Booklet contribute to synoptic assessment:

1b, 1c, 1d, 2c, 3b, 3d, 3e, 3f, 3h, 3i, 3k, 3l, 3n, 3o, 4b, 4c, 5c, 7c, 8b, 8c, 8f, 8g, 8h, 10b.

6.4.4 Marking criteria for units ET3 and ET6 contain objectives which address quality of written communication.

## 6.5 Guidance on the Management of Coursework

6.5.1 Unit ET3 is intended to introduce candidates to two software control techniques. The first uses ladder logic, which is a high-level language, widely used in industry. The other uses assembly language to program a PIC microcontroller. In neither case is it expected that students will be exposed to an exhaustively detailed course, but rather that they will acquire enough skill to construct simple programs to carry out control tasks.

Ladder logic should be introduced using a graphics interface such as 'ICON' or 'MEDOC'. In this way, candidates can quickly learn the action of, and how to program, the functions listed in the Unit specification. The graphics interface allows candidates to link these functions together to synthesise simple control systems and to test them 'on-screen'. It is not expected that candidates construct any external circuitry to test their programs. The assessment looks at the candidates' ability to incorporate a number of these functions into a program in an appropriate and sensible way. The mark gained depends partly on how many functions are successfully integrated into a program. The candidate can submit up to three separate programs, to make it easier to cover the range of functions, and to make the assessment more accessible to a wide ability range.

In the second section of the unit, the aim is that the candidates investigate the structure of standard sub-routines that make the PIC microcontroller carry out functions similar to those studied in the ladder logic section. However, in this case, the PIC subroutines need to be embedded in an overall program structure. It is not expected that candidates be familiar with every instruction in the instruction set, or every programming technique. Instead they should be familiar with the instructions used in these subroutines, and needed to link the subroutines together. Several manufacturers produce PIC development systems which can be used to deliver this part of the unit. The treatment should not be limited to 'on-screen' design and emulation, but should involve the actual programming of a PIC chip, and its testing remotely on a development board. As with the assessment of the ladder logic section, the candidate submits a portfolio of up to three programs to cover the range of procedures specified.

For both ladder logic and PIC programming, the coursework submission must include, for each program, a description of the design problem, a specification for the proposed solution, a listing of the program, a description of how the program works and an evaluation of the final performance against the initial specification.

6.5.2 The A2 coursework undertaken for unit ET6 should be such that it can be completed in 25 hours. Candidates should be encouraged to select projects in which they are interested and which are neither under nor over ambitious. Having decided on a design brief for the project, the candidate should undertake appropriate research so that a list of performance parameters (specification) can be given. It is expected that the specification will contain realistic numerical values against which the final performance of the work can be judged. Candidates are expected to consider alternatives and give reasons for selecting their chosen solution.

The overall system should be developed as a number of sub-systems which should be individually tested and evaluated before being incorporated into the complete system. This will ensure that the complete system grows by a gradual and incremental process, having been assessed at each stage of its development. Computer simulations may be used as a development tool in sub-system design, but should not be used as an alternative to testing an actual sub-system.

Construction of the system may be on prototype board, strip board or printed circuit board. The unit specification does not require candidates to 'hard wire' their system. Whichever method of construction is chosen the layout and mounting of components and wiring should be neat and logical, assisting the design, testing and fault finding of the system.

The system should be fully tested when the project is complete. The testing should be documented with results being displayed in tables and graphs, where appropriate. These tests will enable the candidate to assess the system and identify faults and limitations. The candidate should attempt to modify the system to correct for any limitations and then produce a final set of performance figures for the completed system. The candidate should then evaluate the final system against the initial specification and suggest further developments.

The candidate should fully document the development of the coursework project in a report. It is the evidence contained within this report upon which the coursework is marked and assessed. It should be presented in a logical order that is easy to read and understand. It should be free from repetition and should contain an acknowledgement of all sources of information and help.

Further amplification is given in Unit ET6.

6.5.3 Supervision and Authentication of Coursework

Candidates are forbidden to indulge in any unfair practice whilst preparing coursework for assessment as part of the examination. Candidates must be informed of the WJEC regulations concerning malpractice. Any candidate suspected of using unfair means must be reported to the WJEC immediately. If the WJEC is satisfied that a breach of regulations has occurred, the candidate will be liable to disqualification from the whole of the current examination. Candidates will be required to certify that they have read and understood the regulations relating to unfair practice by signing a declaration on a coursework coversheet provided by the WJEC.

Sufficient supervision must be provided so that centres can give assurance that all possible means have been taken to ensure that the assessments submitted are the work of the candidates concerned. As much coursework as possible must be conducted under the direct supervision of teachers. The teacher responsible for the supervision of candidates' work will be required to certify that the marks submitted were awarded in accordance with the specification and that they are entirely satisfied that the work submitted is that of the candidate concerned.

6.5.4 The Marking of Coursework

Marks should be awarded for the criteria listed in the Coursework Mark Booklets (See Appendix 1 for Unit ET3 coursework and Appendix 2 for Unit ET6 coursework). Standards are set by the use of marking criteria which describe the performance expected for a particular mark.

Marks should only be awarded when there is supporting evidence. Supervisors must annotate each candidate's Coursework Mark Booklet to identify the location of relevant evidence. For Unit ET6 each candidate's report must contain clear photographic evidence. A Coursework Cover Sheet is provided as an integral part of the Coursework Mark Booklet.

The centre is responsible for carrying out internal standardisation where two or more teachers have been involved in the marking of the work submitted for a single unit.

6.5.5 Moderation of coursework

Moderation of the internal assessments will take place on the basis of a detailed scrutiny of the project documentation of all candidates by a WJEC appointed moderator. Each project report together with a completed Coursework Mark Booklet (and photographic evidence in the case of Unit ET6) must be sent to the moderator. A moderation visit may be made to the centre if this is considered to be necessary to complete the moderation process. Circumstances in which visits may be needed may be those where the work submitted is unclear, confusing, problematic or where a major adjustment of the centre's marks is indicated. Visits may also be made to centres to monitor samples of any hardware produced in projects. Advanced notice of such visits will be given by the WJEC.

## 6.6 Awarding and Reporting

Candidates' results for both AS and AL will be graded on a six point scale A-E and U (unclassified). The result for each unit will be reported to the candidate.

Each assessment unit may be retaken once only. The better result will be used in the final award.

A candidates may, however, retake the whole qualification more than once.

Individual assessment unit results, prior to certification for a qualification, have shelf-life limited only by the shelf-life of the qualification.

## 6.7 Information Booklet

The booklet "Information for the use of candidates in Electronics" will be required in the examination.

Copies of this booklet may be obtained from the WJEC. The information contained in the booklet is listed in Appendix 3

## 6.8 Candidates with Particular Requirements

Details of the special arrangements and special consideration for candidates with particular requirements are contained in the Joint Council for General Qualifications document *Candidates with Special Assessment Needs: Regulations and Guidance*. Copies of this document are available from the WJEC.

# 7 GRADE DESCRIPTIONS

The following grade descriptions indicate the level of attainment characteristic of the given grade at Advanced level. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

### Grade A

Candidates recall and use knowledge of electronics from the whole specification with few significant omissions and show good understanding of the principles and concepts they use. They select appropriate information from which to construct arguments or techniques with which to solve problems. In the solution of some problems, candidates bring together fundamental principles from different content areas of the common specification and demonstrate a clear understanding of the relationships between these.

Candidates apply knowledge and principles contained within the specification in both familiar and unfamiliar contexts. In questions requiring numerical calculations, candidates demonstrate good understanding of the underlying relationships between the quantities involved and carry out all elements of extended calculations correctly, in situations where little or no guidance is given.

In experimental activities, candidates identify a problem, independently formulate a clear and effective plan, using knowledge and understanding of electronics, and use a range of relevant techniques with care and skill. They make and record measurements which are sufficient and with a precision which is appropriate to the task. They interpret and explain their results with sound use of the principles of electronics, and evaluate critically the reliability of their methods.

### Grade C

Candidates recall and use knowledge of electronics from most parts of the specification and demonstrate understanding of a significant number of the main principles and concepts within it. They select and make good use of information that is presented in familiar ways to solve problems, and make some use of the concepts and terminology of electronics in communicating their answers. In their answers to some questions, candidates demonstrate some knowledge of the links between different areas of electronics.

Candidates apply knowledge and principles contained within the specification when the context provides some guidance on the required area of work. They some understanding of the principles involved when carrying out numerical work. Candidates carry out calculations in most areas of electronics correctly when these calculations are of a familiar kind or when some guidance is provided, using correct units for most quantities.

In experimental activities, candidates formulate a clear plan. They make and record measurements with skill and care and show some awareness of the need for appropriate precision. They interpret and explain their experimental results, making some use of fundamental principles and mathematical techniques.

## Grade E

Candidates recall knowledge of electronics from parts of the specification and demonstrate some understanding of fundamental principles and concepts. Their level of knowledge and understanding may vary significantly across major areas of the specification. They select discrete items of knowledge in structured questions and make some use of the terminology of electronics in communicating answers.

Candidates apply knowledge and principles of electronics contained within the specification to material presented in a familiar or closely related context. They carry out straightforward calculations where guidance is given, usually using the correct units for physical quantities. They use some fundamental skills of electronics in contexts which bring together different areas of the subject.

In experimental activities, candidates formulate some aspects of a practical approach to a problem. They make and record some appropriate measurements, showing care and appropriate procedure in implementation. They present results appropriately and provide some descriptive interpretation of the outcomes of the investigation.

# Appendix 1: ET3 Coursework Mark Booklet

**WELSH JOINT EDUCATION COMMITTEE**
**General Certificate of Education**
**Advanced Subsidiary 2003**

**CYD-BWYLLGOR ADDYSG CYMRU**
**Tystysgrif Addysg Gyffredinol**
**Uwch Gyfrannol 2003**

# ELECTRONICS UNIT ET3

## Coursework Mark Booklet

Name of Centre: _____

Centre Number: _____

Candidate's Name: _____

Candidate Number: _____

**A.** Have you received any help or information from anyone other than your subject teacher in the production of this work?
Please answer yes/no

**B.** If the answer is yes, give the name(s) of the person(s) who helped you.

_____

_____

_____

**C.** What help did they give you?

_____

_____

_____

**Declaration by Candidate**

I have read and understood the notes relating to unfair practice in the preparation of coursework required for assessment in this examination. The attached coursework is my own unaided work apart from any help, which I have already stated.

Signed: _____ Date: _____

## Declaration by Teacher

I believe that the declaration made by this candidate is accurate.

Signed: _____ Date: _____

# SECTION A – Ladder Logic Programming Name……...……

**1. Ladder programming functions:**

| | ***The Candidate has:*** | **LLP1** | **LLP2** | **LLP3** |
|---|---|---|---|---|
| a | incorporated digital sensor(s). | | | |
| b | incorporated analogue sensor(s). | | | |
| c | used switches which perform **both** AND **and** OR functions on a single wrung | | | |
| d | used a software switch as a latch. | | | |
| e | used a software switch to trigger action elsewhere in a program. | | | |
| f | used a combination of software switches to control an action. | | | |
| g | used a counter which is reset. | | | |
| h | used two types of timer function in one program. | | | |
| i | used pulse production. | | | |
| j | used a sequencer function. | | | |

**2. Integration of techniques:**

| | ***The Candidate has used:*** | | | |
|---|---|---|---|---|
| a | at least 4 different functions (as listed above) in one program. | | | |
| b | at least 6 different functions (as listed above) in one program. | | | |

**3. Program performance:**

| | ***The initial specification and final performance:*** | | | |
|---|---|---|---|---|
| a | agree on at least two parameters. | | | |
| b | agree on at least four parameters. | | | |

**4. Project documentation:**

| | ***The Candidate has provided:*** | | | |
|---|---|---|---|---|
| a | a design brief. | | | |
| b | a specification giving two parameters. | | | |
| c | a specification giving at least four parameters. | | | |
| d | some program annotation, showing evidence of structured approach. | | | |

**5. Quality of Written Communication:**

| | ***The Candidate has provided:*** | | | |
|---|---|---|---|---|
| a | detailed annotation well presented in a structured manner. | | | |
| b | an explanation of the structure of the program, with accurate spelling and punctuation and careful use of the rules of grammar. | | | |

| | |
|---|---|
| **Total Mark (maximum 20)** | |

# SECTION B – Micro-Controller Programming

**1. Programming:**

| ***The Candidate has built program(s) that use procedures which:*** | | **Mark (1 per box)** | **See report page(s)** |
|---|---|---|---|
| a | configured the input and output terminals. | | |
| b | responded to a number of times an input pulses (counting). | | |
| c | used a time delay. | | |
| d | generated a pre-determined sequence of output events. | | |
| e | used a template. | | |

***The Candidate has used commands which:***

| | | | |
|---|---|---|---|
| f | moved data between registers. | | |
| g | branched (conditional or unconditional). | | |
| h | called a sub-routine. | | |
| i | performed a logic operation. | | |
| j | performed an arithmetic operation. | | |
| k | tested bits. | | |
| l | set and cleared bits. | | |

**2. Integration of programming procedures:**

***The Candidate has:***

| | | | |
|---|---|---|---|
| a | used effectively at least three different procedures in one program | | |

**3. Program performance:**

***The initial specification(s) and final specification:***

| | | | |
|---|---|---|---|
| a | agree on at least two parameters. | | |
| b | agree on at least four parameters. | | |

**4. Project documentation:**

***The Candidate has provided:***

| | | | |
|---|---|---|---|
| a | a design brief. | | |
| b | a specification giving two parameters. | | |
| c | a specification giving at least four parameters. | | |

**5. Quality of Written Communication:**

***The Candidate has provided:***

| | | | |
|---|---|---|---|
| a | some program annotation, showing some clarity of thought and organisation of ideas. | | |
| b | detailed program annotation, well articulated, coherent and lucid. | | |

| | |
|---|---|
| **Total Mark (maximum 20)** | |

# Appendix 2: ET6 Coursework Mark Booklet

**WELSH JOINT EDUCATION COMMITTEE** **CYD-BWYLLGOR ADDYSG CYMRU**
**GENERAL CERTIFICATE OF EDUCATION** **TYSTYSGRIF ADDYSG GYFFREDINOL**
**ADVANCED LEVEL** **SAFON UWCH**

# Coursework Mark Booklet

# GCE Electronics Unit ET6

**Centre Name** _____

**Centre Number** _____

**Candidate's name (in full)** _____

**Candidate's ID number** _____

**A.** Have you received any help or information from anyone other than your subject teacher in the production of this work?
Please answer yes/no

**B.** If the answer is yes, give the name(s) of the person(s) who helped you.

_____

_____

**C.** What help did they give you?

_____

_____

**Declaration by candidate**

I have read and understood the notes relating to unfair practice in the preparation of coursework required for assessment in this examination. The attached coursework is my own unaided work apart from any help which I have already stated.

Signed: _____ Date: _____

**Declaration by Teacher**

I believe that the declaration made by this candidate is accurate.

Signed: _____ Date: _____

**1. Project planning and research:**

| ***The candidate has:*** | | **Mark 1 per box** | **See report page(s)** |
|---|---|---|---|
| a | researched some sources of information; | | |
| b | researched an appropriate range of sources of information; | | |
| c | considered alternative system design; | | |
| d | given some reasons for design choice. | | |

**2. Initial specification:**

***The candidate has:***

| | | | |
|---|---|---|---|
| a | given a description of the design brief; | | |
| b | specified two appropriate parameters realistically; | | |
| c | given a full specification. | | |

**3. Project development:**

***The candidate has:***

| | | | |
|---|---|---|---|
| a | given some specifications for one sub-system; | | |
| b | given some specifications for most sub-systems; | | |
| c | considered alternative sub-system designs on one occasion; | | |
| d | considered alternative sub-system designs on three or more occasions; | | |
| e | given some reasons for sub-system design choice in most cases; | | |
| f | given comprehensive reasons for sub-system design choice in all cases; | | |
| g | described test procedures for one sub-system; | | |
| h | described test procedures for most sub-systems; | | |
| i | described test procedures for complete system; | | |
| j | obtained test results for one sub-system; | | |
| k | obtained test results for most sub-systems; | | |
| l | obtained test results for complete system; | | |
| m | evaluated performance of one sub-system; | | |
| n | evaluated performance of most sub-systems; | | |
| o | evaluated performance of complete system. | | |

**4. System construction:**

| ***The candidate has:*** | | **Mark 1 per box** | **See report page(s)** |
|---|---|---|---|
| a | made a reasonable attempt at an organised layout; | | |
| b | used an organised approach to layout and planning; | | |
| c | worked in a completely safe manner. | | |

**5. Evaluation of complete system:**

***The candidate has:***

| | | | |
|---|---|---|---|
| a | made some attempt to compare final performance and initial specification; | | |
| b | made sensible comments on this comparison; | | |
| c | made suggestions for further development. | | |

**6. Project reliability:**

| | | | |
|---|---|---|---|
| a | One sub-system met the specification at some time; | | |
| b | Most of the sub-systems worked at some time; | | |
| c | The complete system worked at some time; | | |
| d | The complete system worked reliably. | | |

**7. Project performance:**

***The initial specification and final performance:***

| | | | |
|---|---|---|---|
| a | agree on one parameter; | | |
| b | agree on at least three parameters; | | |
| c | agree on at least five parameters. | | |

**8. Initiative and creativity:**

| ***The candidate has:*** | | **Mark 1 per box** | **See report page(s)** |
|---|---|---|---|
| a | acted upon outline advice; | | |
| b | generally worked alone with only occasional need for guidance; | | |
| c | worked completely independently; | | |
| d | shown creativity greater than the minimum required; | | |
| e | shown creativity significantly greater than the minimum required; | | |
| f | attempted a project sufficiently enterprising to be awarded extra merit; | | |
| g | attempted a project sufficiently enterprising as to be exceptional; | | |
| h | demonstrated flair or depth of investigation to merit outstanding credit. | | |

**9. Documentation:**

***The candidate has produced a report which included:***

| | | | |
|---|---|---|---|
| a | a labelled block diagram for the complete system; | | |
| b | labelled circuit diagrams for most sub-systems; | | |
| c | a labelled circuit diagram for the complete system; | | |
| d | relevant calculations. | | |

**10. Communication:**

***The candidate has:***

| | | | |
|---|---|---|---|
| a | submitted a well-presented and structured account of the work done; | | |
| b | shown high levels of written communication in describing concepts, theories and ideas; | | |
| c | demonstrated good use of technical terminology, with accurate spelling, and punctuation, and careful use of the rules of grammar. | | |

| | | |
|---|---|---|
| **Total mark (Maximum 50)** | | |

The following criteria contribute towards synoptic assessment:

1b, 1c, 1d, 2c, 3b, 3e, 3f, 3h, 3i, 3k, 3l, 3m, 3o, 4b, 4c, 5c, 7c, 8b, 8c, 8f, 8g, 8h, 10b.

# Appendix 3: Information for the use of Candidates in Examinations

It is expected that candidates will be conversant with the equations required for this specification. The information given here is intended as an *aide memoir* only. The equations are not necessarily fully defined nor are the conditions under which they are valid given.

**Preferred Values for resistors**

The figures shown below and their decade multiples and sub-multiples are the E24 series of preferred values.

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

| | | |
|---|---|---|
| **RC networks** | $V_c = V_o (1 - e^{-t/RC})$<br>$V_c = V_o e^{-t/RC}$ | for a charging capacitor<br>for a discharging capacitor |
| **Alternating Voltages** | $V_o = V_{rms}\sqrt{2}$ | |
| | $X_c = \frac{1}{2\pi fC}$ | Capacitive reactance |
| | $X_L = 2\pi fL$ | Inductive reactance |
| | $f_0 = \frac{1}{2\pi\sqrt{LC}}$ | Resonant frequency |
| | $f_{co} = \frac{1}{2\pi RC}$ | Cut-off frequency for high pass and low pass filters |
| | $\phi = \tan^{-1}\frac{R}{X_c}$ | phase shift between $V_s$ and $V_c$ |
| **Silicon Diode** | $V_F \approx 0.7$ V | |
| **Bipolar Transistor** | $h_{FE} = \frac{I_c}{I_B}$ | Current gain |
| | $V_{BE} \approx 0.7$ V | in the on state |
| **MOSFETs** | $I_D = g_M V_{GS}$ | |

**Operational amplifier**

$$G = -\frac{R_F}{R_{IN}}$$ Inverting amplifier

$$G = 1 + \frac{R_F}{R_1}$$ Non-inverting amplifier

$$V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$$ Summing amplifier

$$\text{Slew Rate} = \frac{\Delta V_{OUT}}{\Delta t}$$ Slew rate

$$V_{OUT} = V_{DIFF}\left(\frac{R_F}{R_1}\right)$$ Difference amplifier

$$V_L \approx V_Z\left(1 + \frac{R_F}{R_1}\right)$$ Stabilised power supply

**Power Amplifier**

$$P_{MAX} = \frac{V_S^2}{8R_L}$$

**555 Monostable**

$T = 1.1\ RC$

**555 Astable**

$t_H = 0.7\ (R_A + R_B)C$

$t_L = 0.7\ R_B C$

$$f = \frac{1 \cdot 44}{(R_A + 2R_B)C}$$

**Schmitt Astable**

$$f \approx \frac{1}{RC}$$

# Appendix 4: Electrical Symbols

## Electrical Symbols

The symbols below will be used in GCSE and GCE Physics and Electronics examination papers. They are mainly in accord with the recommended symbols published by the Institution of Electrical Engineers at the time of printing of this specification. Further information about electrical symbols can be obtained from the IEE website www.iee.org.uk/schools.

It is expected that candidates will be familiar with the appropriate symbols to the extent of recognising them in circuit diagrams and drawing them.

This appendix is common to science specifications with a Physics component and Electronics specifications. It should be read alongside the specification content for information as to which symbols apply, e.g. the NPN transistor applies only to Electronics whereas the resistor applies to all specifications.

Electrical cell.
Also represents a battery of cells.

Fuse.

Junction of conductors.

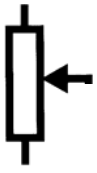
Heating element.

Resistor.

Indicator lamp.

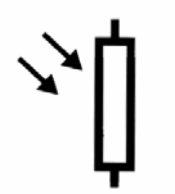
Variable resistor.

Filament lamp.



Potentiometer.

Switch.

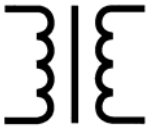


Light dependent resistor.

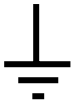
Push to make switch.

Thermistor.

Buzzer.

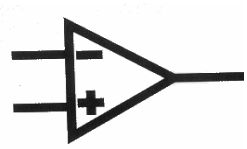


Transformer.



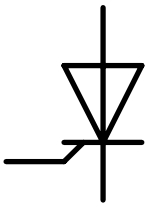
Earth.

Diode.



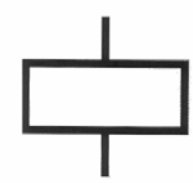
Operational amplifier.

Light emitting diode.



Thyristor.

Photo diode.

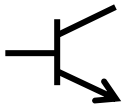


Relay coil.


Generator.

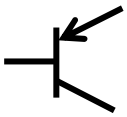

Ammeter.


Voltmeter.



NPN transistor.

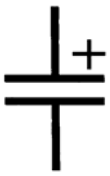

Motor.



PNP transistor

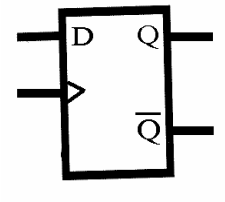
Capacitor.

Variable capacitor.

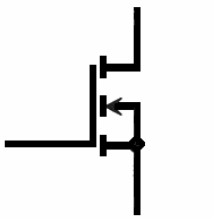


Polarised capacitor.

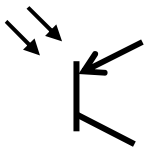
Inductor.



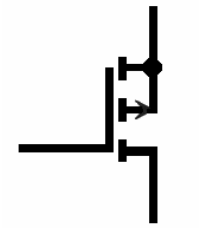

D-type flip-flop.



MOSFET n-channel



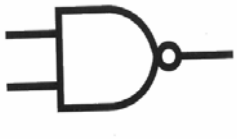
PNP phototransistor



MOSFET p-channel

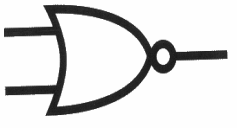
Logic Gates

AND.

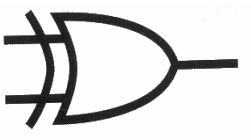


NAND.

OR.

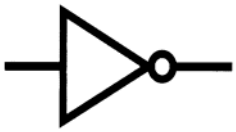


NOR.



Exclusive OR (XOR).

Exclusive NOR (XNOR)



NOT.

## THE EXEMPLIFICATION OF KEY SKILLS

The following tables give some examples of Electronics contexts in which naturally occurring key skills evidence could be accumulated.

The emphasis within the Electronics Specification is on a systems approach with its use and benefit to problem solving. This approach can also benefit the acquisition and demonstration of Key Skills. Asking students to make mini-presentations is a well-established teaching method that fosters many skills, whilst testing their real understanding of topics. Although it is often possible to assess at different levels within the same context, suggestion for a number of contexts have been made.

**Note: If producing certain types of evidence creates difficulties due to disability or other factors, the candidate may be able to use other ways to show achievement. The candidate should ask the tutor or supervisor for further information.**

## COMMUNICATION: LEVEL 1

| **C1.1 TAKE PART IN A DISCUSSION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| take part in a **one-to-one** discussion and a **group** discussion about different, straightforward subjects. | • provide information that is relevant to the subject and purpose of the discussion<br>• speak clearly in a way that suits the situation<br>• listen and respond appropriately to what others say. | Records from an assessor who observed each discussion and noted how the student met the requirements of the Unit, or an audio/video tape of the discussions. | Participation in group and class discussion about potential solutions to design problems that are introduced as part of the non-assessed learning process. Also discussion with the course tutor about coursework. |

| **C1.2 INFORMATION GATHERING** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| read and obtain information from **two** different types of documents about straightforward subjects, including at least **one** image. | • read relevant material<br>• identify accurately the main points and ideas in material<br>• use the information to suit the purpose. | A record of what the student reads and why, including a note or copy of the image. Notes, highlighted text or answers to questions about the material read. Records of how the student used the information. *Eg* in discussions for C1.1 or writing for C1.3. | Research for project work, for example in ET3 where the student might interpret a simple technical description, that could include a pin-out diagram of a micro-controller. Another instance might include simple market research results to support the need for a particular project. |

| **C1.3 WRITING** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| write **two** different types of documents about straightforward subjects. Include at least **one** image in one of the documents. | • present relevant information in a form that suits the purpose<br>• ensure text is legible<br>• make sure that spelling, punctuation and grammar are accurate so the meaning is clear. | The two different documents might include a letter, a short report or essay, with an image such as a chart or sketch. | A project report, such as one produced for ET3. Another document could be a simple set of user instructions for an artefact produced in project work, or a letter requesting work-experience, or a letter requesting information for a project. |

# COMMUNICATION: LEVEL 2

| C2.1a CONTRIBUTE TO A DISCUSSION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| contribute to a discussion about a straightforward subject. | • make clear and relevant contributions in a way that suits the purpose and situation<br>• listen and respond appropriately to what others say<br>• help to move the discussion forward. | A record from an assessor who observed the discussion and noted how the student met the requirements of the Unit, or an audio/video tape of the discussion. | Participation in group and class discussion about potential solutions to design problems that are introduced as part of the non-assessed learning process., particularly if the class/group are expected to agree upon the design solution to adopt. |

| C2.1b GIVE A SHORT TALK | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| give a short talk about a straightforward subject using an image. | • speak clearly in a way that suits the subject, purpose and situation<br>• keep to the subject and structure the talk to help listeners follow what the student says<br>• use an image to illustrate clearly the main points. | A record from an assessor who observed the talk, or an audio/video tape of the talk.<br>Notes from preparing and giving the talk.<br>A copy of the image used. | Students can be asked to give mini-presentations about topics within the specification.<br>Students can also be asked to give a brief talk about their project work. In each case, the audience could be other, or younger students. |

| C2.2 INFORMATION GATHERING | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| read and summarise information from **two** extended documents about a straightforward subject. One of the documents should include **at least one** image. | • select and read relevant material<br>• identify accurately the lines of reasoning and main points from text and images<br>• summarise the information to suit the purpose. | A record of what is read and why, including a note or copy of the image. Notes, highlighted text or answers to questions about the material read.<br>Evidence of summarising information could include the student's notes for the talk, or one of the documents written. | This information could be gathered from the preparation for a mini-presentation given by the student. Sources of information could be their own notes, text books and Internet sources. |

| C2.3 WRITING | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| write **two** different types of documents about straightforward subjects. One piece of writing should be an extended document and include **at least one** image. | • present relevant information in an appropriate form<br>• use a structure and style of writing to suit the purpose<br>• ensure the text is legible and that spelling, punctuation and grammar are accurate, so the meaning is clear. | The two different documents might include a report or an essay, with an image such as a chart, graph or diagram, a business letter or notes. | Project reports including circuit diagrams, tables of results and graphs are eligible: also letters asking for help, notes of a group discussion about project work can also be submitted. |

# COMMUNICATION: LEVEL 3

| C3.1a TAKE PART IN A DISCUSSION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| contribute to a group discussion about a complex subject. | • make clear and relevant contributions<br>• listen and respond appropriately<br>• create opportunities for others to take part. | A record from someone who has observed discussion or has made video/ audio tape of discussion. | Classroom discussion on a complex problem that has more than one clearly defined line of exploration. |

| C3.1b MAKE A PRESENTATION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| make a presentation about a complex subject, using at least **one** image to show complex points. | • speak clearly and use suitable style<br>• structure ideas and information<br>• use a range of techniques. | A record from someone who has observed discussion or has made video/ audio tape of discussion or preparatory notes with images. | Presentation of one preferred solution to a project brief. |

| C3.2 INFORMATION GATHERING | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| select and synthesise information from **two** extended documents that deal with a complex subject<br><br>**One** of these documents should include at least one image. | • select and read material that contains information needed<br>• identify accurately, and compare, the lines of reasoning and main points from texts and images<br>• synthesise the key information in a suitable form. | A record of what was read and why, including a note of the image. Notes, highlighted text or answers to questions about material read.<br>Evidence of synthesising information from notes of a presentation or a written document. | Notes or annotation of different sources relating research in response to a complex project brief. These should include different types of sources i.e. written, visual, graphical that might come from notes, text books or Internet. |

| C3.3 WRITING | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| write **two** different types of document**s** about complex subjects. **One** piece of writing should be an extended document and include at least **one** image. | • select and use appropriate style of writing<br>• organise relevant information clearly and coherently, using specialist vocabulary<br>• ensure text is legible, spelling, punctuation and grammar are accurate, and that meaning is clear. | The two different documents might include an extended essay or report, with an image such as a chart, graph or diagram and a letter or memo. | Notes taken in a classroom lesson or summary of a section of a book.<br>One document might be a technical project report. |

# APPLICATION OF NUMBER: LEVEL 1

| N1.1 INTERPRET STRAIGHTFORWARD INFORMATION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Interpret straightforward information from two different sources.<br>At least one source should be a table, chart, diagram or line graph. | • Obtain the information needed to meet the purpose of the task; and<br>• Identify suitable calculations to get the results needed. | Description of the tasks and purposes. Copies of source material.<br>A statement from an assessor who checked the accuracy of the student's measurements or observations (if this was done).<br>Records of the information obtained and the types of calculations identified to get the results needed. | Interpret experimental results that have been recorded in a table and Interpret experimental results that have been illustrated in a graph.<br>Interpretation of technical data sheets to select components and design circuits. |

| N1.2 CARRY OUT STRAIGHTFORWARD CALCULATIONS | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Carry out straightforward calculations to do with:<br>a. amounts and sizes;<br>b. scales and proportion;<br>c. handling statistics. | • Carry out calculations to the levels of accuracy the student has been given; and<br>• Check the results make sense. | Records of the calculations (for a, b and c) and how the student checked them. | There are many opportunities to carry out calculations. The candidate could also comment whether the calculation result makes sense e.g. order of magnitude.<br>Statistics might include the randomness of a digital dice. |

| N1.3 INTERPRET THE RESULTS OF CALCULATIONS | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Interpret the results of the calculations and present her/his findings. The student must use one chart and one diagram. | • Choose suitable ways to present findings;<br>• Present findings clearly; and<br>• Describe how the results of the calculations meet the purpose of the task. | Descriptions of the findings and how the results of the calculations met the purpose of the tasks.<br>At least one chart and one diagram presenting the findings. | Experimental work and project-testing should provide many opportunities. |

## APPLICATION OF NUMBER: LEVEL 2

Candidates must carry through at least **one** substantial activity that includes a number of straightforward **related tasks** for N2.1, N2.2 and N2.3.

| **N2.1 INTERPRET INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Interpret information from two different sources, including material containing a graph. | • Choose how to obtain the information needed to meet the purpose of the activity;<br>• Obtain the relevant information; and<br>• Select appropriate methods to get the results needed. | A description of the substantial activity.<br>Copies of source material, including the graph, and/or a statement from someone who has checked the accuracy of the student's measurements and observations.<br>Records of the information obtained and the methods selected for getting the results needed. | Students will need to design fair tests that will produce results that can be used to evaluate a sub-system or a project.<br>Project work might include some market research. |

| **N2.2 CARRY OUT CALCULATIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Carry out calculations to do with:<br>a. amounts and sizes;<br>b. scales and proportion;<br>c. handling statistics;<br>d. using formulae. | • Carry out calculations, clearly showing methods and levels of accuracy; and<br>• Check methods to identify and correct any errors, and making sure the results make sense. | Records of calculations (for a, b, c and d), showing methods used and levels of accuracy. Notes on how the student checked methods and results. | There are many opportunities for performing calculations within Electronics. |

| **N2.3 INTERPRETING THE RESULTS OF CALCULATIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Interpret the results of calculations and present findings. The student must use at least one graph, one chart and one diagram. | • Select effective ways of presenting findings;<br>• Present findings clearly, describing methods; and<br>• Explain how the results of the calculations meet the purpose of the study. | Descriptions of findings and methods. Notes on how the results from the calculations met the purpose of the activity. At least one graph, one chart and one diagram presenting the findings. | Practical experimental work, mini-project and major project activities. |

## APPLICATION OF NUMBER: LEVEL 3

Candidates must plan and carry through at least **one** substantial and complex activity that includes a number of **related** tasks for N3.1, N3.2 and N3.3.

| **N3.1 INTERPRET INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Plan and interpret information from two different sources, including a large data set. | • Plan how to obtain the information required to meet the purpose of the activity;<br>• Obtain the relevant information; and<br>• Choose appropriate methods for obtaining the results needed and justify the choice. | A description of the activity and tasks. Copies of source material, including a note of the large data set. A statement from someone who has checked the accuracy of any measurements or observations. Records and a justification of methods selected. | Experiment which involves the collection and analysis of a large data set, such as testing the randomness of a digital dice, or a survey to determine market information about a product being designed. |

| **N3.2 CARRY OUT MULTI-STAGE CALCULATIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Carry out multi-stage calculations to do with:<br>a. amounts and sizes;<br>b. scales and proportion;<br>c. handling statistics;<br>d. rearranging and using formulae. | • Carry out calculations to appropriate levels of accuracy, clearly showing methods; and<br>• Check methods and results to help ensure errors are found and corrected. | Records of calculations (for a, b, c and d). Showing methods used and levels of accuracy. Notes on the large data set and how the methods and results were checked. | A project-led approach to teaching might involve choice of voltage–gain from gain-bandwidth product by estimation, and calculation of component values from formulae.<br>Market research information of experimental results might be used for statistical analysis. |

| **N3.3 INTERPRETING THE RESULTS OF CALCULATIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Interpret the results of calculations, present findings and justify methods. The student must use at least one graph, one chart and one diagram. | • Select appropriate methods of presentation and justify choice;<br>• Present findings effectively; and<br>• Explain how the results of the calculations relate to the purpose of the activity. | Report justifying methods and explanation of how results relate to the activity. At least one graph, one chart and one diagram. | There are many opportunities in a project-led course for the presentation of project outcomes. Project work for ET3 and ET6 could also be used. |

# INFORMATION TECHNOLOGY: LEVEL 1

| **IT 1.1 FIND, STORE AND DEVELOP INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| find, explore and develop information for **two** different purposes. | • find and select relevant information<br>• enter and bring in information, using formats that help development<br>• explore and develop information to meet the student's purpose. | Print-outs and copies of the information the student selects to use.<br>A record from an assessor who observed the student using IT when exploring and developing information or working drafts with notes of how the student met the requirements of the Unit. | Use the Internet for research for a project or a topic.<br>Use a circuit-simulation program to develop circuits.<br>Use a micro-controller simulator to develop control programs for PLCs or PICs. |

| **IT 1.2 PRESENT INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| present information for **two** different purposes. The student's work must include **at least one** example of text, **one** example of images, and **one** example of numbers. | • use appropriate layouts for presenting information in a consistent way<br>• develop the presentation so it is accurate, clear and meets the purpose<br>• save information so it can be found easily. | Working drafts showing how the student developed the presentation or records from an assessor who saw the student's screen displays.<br>Print-outs or prints of a static or dynamic screen display of the students final work, including examples of text, images and numbers.<br>Records of how the student saved information. | Project reports that use text, screen shots or photographs and tables of results. |

# INFORMATION TECHNOLOGY: LEVEL 2

| IT 2.1 SEARCH FOR AND SELECT INFORMATION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| search for and select information for **two** different purposes. | • identify the information needed and suitable sources<br>• carry out effective searches<br>• select information that is relevant to the student's purpose. | Print-outs of the relevant information with notes of sources and how the student made searches, or a record from an assessor who observed the student using IT when searching for information. | Using the Internet to research suitable product descriptions/specifications, the student would specify the information needed, suggest key words, and present a selection of URLs stating why some were rejected.<br>When using an electronic (CD) catalogue to select components such as microcontontroller; a description of the search process and the reasons for homing in on specific information. |

| IT 2.2 EXPLORE AND DEVELOP INFORMATION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| explore and develop information, and derive new information, for **two** different purposes. | • enter and bring together information using formats that help developments<br>• explore information as needed for the purpose<br>• develop information and derive new information as appropriate. | Print-outs, or a record from an assessor who observed the student using IT, with notes to show how the student explored and developed information and derived new information. | Use of spreadsheet or mathematical program to enter experimental results and develop a graph for analysis. Use a circuit or program simulation software to enter and explore information to develop circuits or programs. Enter key words in a search engine or directory to search the Internet and use the results to derive new key words to develop the search. |

| IT 2.3 PRESENT COMBINED INFORMATION | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| present combined information for **two** different purposes.<br>The student's work must include at least **one** example of text, **one** example of images and **one** example of numbers. | • select and use appropriate layouts for presenting combined information in a consistent way<br>• develop the presentation to suit the purpose and the types of information<br>• ensure the work is accurate, clear and saved appropriately. | Working drafts, or a record from an assessor who observed the screen displays, with notes to show how the student developed content and presentation.<br>Print-outs, or prints of static or dynamic screen displays, of the final work, including examples of text, images and numbers.<br>Records of how the information was saved. | Experimental reports could include text, scanned photographs or images from a digital camera, tables of results, graphs, screen images from a circuit or program simulator.<br>Reports that use Internet pages could include screen shots. |

## INFORMATION TECHNOLOGY: LEVEL 3

Candidates must plan and carry through at least **one** substantial activity that includes a number of related tasks for IT3.1, IT3.2 and IT3.3.

| **IT 3.1 SEARCH AND SELECT INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| compare and use different sources to search for, and select, information required for **two** different purposes. | • plan how to obtain and use information<br>• choose appropriate techniques for searches<br>• make selections based on judgements. | Print-outs with notes of sources and how searches made and selected information<br><br>A record from someone who observed use of IT to search for and explore information. | Search for technical data, written/visual sources on the Internet, a database or CD ROM such as an electronic catalogue. The information could be entirely technical or it might demonstrate conflicting viewpoints from school-based, or other market research for a project. |

| **IT 3.2 DEVELOP INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| explore, develop and exchange information and derive new information to meet **two** different purposes. | • bring together information in consistent form<br>• create and use appropriate structures<br>• use methods for exchanging information. | Print-outs or record of someone who observed use of IT showing how information has been exchanged, explored and developed.<br><br>Notes of automated routines | Following search for appropriate data on Internet or CD ROM, the information could be developed and enhanced, to present, for example, market statistics or information in a alternative form such as a graph.<br>Circuit and processor simulation programs develop and derive new information (new circuits or programs) that could be presented.<br>Emailing draft reports to peers/teachers is one method exchanging information. |

| **IT 3.3 PRESENT INFORMATION** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| present information from different sources for **two** different purposes and audiences. **One** example of text, **one** of images and **one** of numbers. | • develop structures and content<br>• present information effectively<br>• ensure work is accurate. | Working drafts or a record from an assessor who observed screen displays, showing how developed for presentation.<br><br>Print-outs or a static or dynamic screen display of final work, including text, images and numbers. | Information obtained through the use of IT, such as simulation packages, the Internet, could be presented in project reports using word processing, graphics and IT packages. Analysis and presentation of experimental results perhaps using a spreadsheet or graphing program. |

# WIDER KEY SKILLS

## PROBLEM SOLVING: LEVEL 1

Candidates must provide at least **two** examples of meeting the standard for PS1.1, PS1.2 and PS1.3.

| **PS 1.1 CONFIRM PROBLEMS AND IDENTIFY OPTIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| confirm understanding of the given problem and identify at least **two** options for solving it, with help from an appropriate person. | • check that the problem is understood, and how to succeed in solving it<br>• identify different ways of tackling the problem<br>• decide, with help, which options are most likely to be successful. | Descriptions of the two problems and how they have been solved.<br>Descriptions of ways for solving the two problems and the options most likely to be successful.<br>Records of help given. | Project work (ET3 and ET6) |

| **PS 1.2 PLAN AND TRY OUT OPTIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| plan and try out at least **one** option for solving the problem, using given evidence and support. | • confirm with an appropriate person the option to be tried for solving the problem<br>• plan how to carry out this option<br>• follow through the plan, making use of advice and support given by others. | Statements on how the student confirmed the options to be tried out.<br>A plan for trying out each option.<br>Records of what was done in following the plan, with notes on the advice and support given. | Project work (ET3 and ET6). |

| **PS 1.3 CHECK AND DESCRIBE RESULTS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| check if the problem has been solved and describe the results, including ways to improve the approach. | • check whether the problem has been solved successfully<br>• describe clearly the results of tackling the problem<br>• identify ways of improving the approach to problem solving. | Records of the methods given and they were used.<br>Descriptions of the results of tackling the problems and ways to improve the approach to problem solving. | Project work (ET3 and ET6). |

## PROBLEM SOLVING: LEVEL 2

Candidates must provide at least **two** examples of meeting the standard for PS2.1, PS2.2 and PS2.3.

| **PS 2.1 IDENTIFY PROBLEMS AND OPTIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| identify the problem and come up with **two** options for solving it. | • identify the problem, accurately describing its main features and how to show success in solving it<br>• come up with different ways of tackling the problem<br>• decide which options have a realistic chance of success, using help from others when appropriate. | Descriptions of the two problems and how the student is going to show they have been solved successfully.<br>Descriptions of ways for solving the two problems.<br>Records of how the student decided which options were most realistic, including the help obtained. | Project work (ET3 and ET6). |

| **PS 2.2 PLAN AND TRY OUT OPTIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| plan and try out at least **one** option for solving the problem, obtaining support and making changes to the plan when necessary. | • confirm with an appropriate person the option to be tried for solving the problem, and plan how to carry it out<br>• follow the plan, organising the relevant tasks and making changes to the plan when necessary<br>• obtain and effectively use support needed. | Statements on how the options were confirmed and tried out.<br>A plan for trying out each option.<br>Records of what was done, including any changes made to the plan.<br>Notes of the support obtained and how this was used effectively. | Project work (ET3 and ET6). |

| **PS 2.3 CHECK AND DESCRIBE RESULTS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| check if the problem has been solved by applying given methods, describe the results and explain the approach to problem solving. | • apply accurately the methods given to check whether the problem has been solved successfully<br>• describe clearly the results, and explain the decisions taken at each stage of tackling the problem<br>• identify the strengths and weaknesses of the approach to problem solving and describe what would be done differently if a similar problem were met. | Records of the methods used, the results of the checks carried out and explanations of the decisions taken.<br>Descriptions of the strengths and weaknesses of the approach to the problem solving activities, and what would be done differently in future. | Project work (ET3 and ET6). |

## PROBLEM SOLVING: LEVEL 3

Candidates must provide at least **one** substantial example of meeting the standard of PS3.1, PS3.2 and PS3.3.

| **PS 3.1 EXPLORE PROBLEMS AND OPTIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| explore a complex problem, come up with **three** options for solving it and justify the options selected for taking it forward. | • explore the problem, accurately analysing its features, and agree with others on how to show success in solving it<br>• select and use a variety of methods to come up with different ways of tackling the problem<br>• compare the main features of each possible option, including risk factors, and justify the option selected to take it forward. | Description of the problem, the analysis of its features and methods used for exploring it<br>Statements endorsed by appropriate people of how problem was going to be solved<br>Descriptions of the **three** options for solving the problem, with notes on the methods used for coming up with these and comparisons of their main features<br>A note to justify the chosen option. | Project work (ET3 and ET6). |

| **PS 3.2 PLAN AND IMPLEMENT OPTIONS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| plan and implement at least **one** option for solving a problem, review progress and revise approach as necessary**.** | • plan how to carry out the chosen option and obtain agreement to go ahead from an appropriate person<br>• implement plan, effectively using support and feedback from others<br>• review progress towards solving the problem and revise approach as necessary. | A plan, with notes of changes made, and endorsed statement of how agreement to go ahead with chosen option was obtained<br>Records of how plan is implemented, including how support and feedback was used and how progress was reviewed. | Project work (ET3 and ET6). |

| **PS 3.3 CHECK AND REVIEW APPROACH** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| apply agreed methods to check if the problem has been solved, describe the results and review approach to problem solving. | • agree, with an appropriate person, methods to check if the problem has been solved<br>• apply these methods accurately, draw conclusions and fully describe the results<br>• review approach problem solving, including whether alternative methods and options might have proved more effective. | Description of the methods used, the results and conclusions<br>Records of review, including notes of any alternative methods and options which might be predicted to have been more effective. | Project work (ET3 and ET6). |

## WORKING WITH OTHERS: LEVEL 1

Students must provide at least **one** example of meeting the standard for WO1.1, WO1.2 and WO1.3

- **one** example must show work in one-to-one situations
- **one** example must show work in group situations

| **WO 1.1 CONFIRM WHAT TO DO** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| confirm what needs to be done to achieve given objectives, including responsibilities and working arrangements. | • check understanding of the objectives the student has been given for working together<br>• identify what needs to be done to achieve them and suggest ways the student could help<br>• make sure that the student is clear about her/ his responsibilities and working arrangements. | Records from someone who observed the student's discussions with others or audio/video tapes.<br>Notes of the objectives, responsibilities and working arrangements. | Mini projects that are used as part of the learning strategy to introduce topics in the specification. For example, mini-projects might include the design of logic systems to meet a specification, with one student producing the Karnough map and logic statement, whilst another converts to NAND and minimises. Responsibilities of team members could be negotiated.<br>It is important that this work is not confused with the assessed project work, which must be individual-candidate-based. |

| **WO 1.2 WORK TOWARDS OBJECTIVES** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| work with others towards achieving the given objectives, carrying out tasks to meet responsibilities. | • carry out tasks to meet responsibilities<br>• work safely, and accurately follow the working methods the student has been given<br>• ask for help and offer support to others, when appropriate. | Records of how the student carried out tasks to meet responsibilities. Notes of the help given and the support the student offered others.<br>These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs with notes. | Mini projects that are used as part of the learning strategy to introduce topics in the specification. For example, mini-projects might include the design of logic systems to meet a specification, with one student producing the Karnough map and logic statement, whilst another converts to NAND and minimises. Notes would be kept of help given top other team members. It is important that this work is not confused with the assessed project work, which must be individual-candidate-based. |

| **WO 1.3 IDENTIFY PROGRESS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| identify progress and ways of improving work with others to help achieve given objectives. | • identify what has gone well and less well in working with others<br>• report any difficulties in meeting responsibilities and what was done about them<br>• suggest ways of improving work with others to help achieve objectives. | Statements (written or recorded). Records of answers to questions about any difficulties and what the student did about them.<br>Notes of ways to improve work with others. | Evaluation of team-based mini projects that are used as part of the learning strategy to introduce topics in the specification. |

## WORKING WITH OTHERS: LEVEL 2

Students must provide at least **two** examples of meeting the standard WO2.1, WO2.2 and WO3.3

- **one** example must show working in one-to-one situations
- **one** example must show working in group situations

| **WO 2.1 PLAN WORK** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| plan straightforward work identifying objectives and clarifying responsibilities and confirm working arrangements. | • identify the objectives of working together and what needs to be done to achieve these objectives<br>• exchange relevant information to clarify responsibilities<br>• confirm working arrangements with those involved. | Records from someone who observed the student's discussions with others or audio/video tapes.<br>Note of the information provided, with details of the identified objectives, responsibilities and working arrangements of those involved. | Extended team-based mini projects could are used as part of the learning strategy to learn or revise topics in the specification., or to prepare for project work. These projects might use IT to minimise the time taken. Different team member could be responsible different sub-systems. |

| **WO 2.2 WORK TOWARDS OBJECTIVES** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| work co-operatively with others towards achieving the identified objectives, organising tasks to meet responsibilities. | • organise own tasks so the student can be effective in meeting responsibilities;<br>• carry out tasks accurately and safely, using appropriate working methods<br>• support co-operative ways of working, seeking advice from an appropriate person when needed. | Records of how the student organised and carried out tasks, supported co-operative work and sought advice. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs with notes. | Team-based mini-projects to summarise topics or reinforce links between topics. |

| **WO 2.3 EXCHANGE INFORMATION ON PROGRESS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| exchange information on progress and agree ways of improving work with others to help achieve objectives. | • provide information on what has gone well and less well in working with others, including the quality of work<br>• listen and respond appropriately to progress reports from others<br>• agree ways of improving work with others to help achieve objectives. | Statements on progress (written or recorded) including details about the quality of work and how the student responded to other reports on progress.<br>Notes of what the student agreed to do to improve work with others and help achieve objectives. | Team meetings for team-based mini-projects that are used as part of the learning strategy. |

## WORKING WITH OTHERS: LEVEL 3

Students must provide at least **one** substantial example of meeting the standard for WO3.1, WO3.2 and WO3.3 in both one-to-one and group situations.

| **WO 3.1 PLAN WORK** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| plan complex work with others, agreeing objectives, responsibilities and working arrangements. | • agree realistic objectives for working together and what needs to be done to achieve them<br>• exchange information, based on appropriate evidence to help agree responsibilities<br>• agree suitable working arrangements with those involved. | Reports which describe how the student planned work with others, including objectives, responsibilities, and working arrangements. Records from someone who observed the discussions with others or audio/video tape. | Mini projects that are used as part of the learning strategy to introduce or review topics in the specification. |

| **WO 3.2 WORK TOWARDS OBJECTIVES** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| seek to establish & maintain cooperative working relationships over an extended period of time, agreeing changes to achieve agreed objectives. | • organise and carry out tasks to show effectiveness and efficiency in meeting responsibilities and produce the quality of work required<br>• seek to establish and maintain cooperative working relationships, agreeing ways to overcome any difficulties<br>• exchange accurate information on progress of work, agreeing changes where necessary to achieve objectives. | Records of how the student organized and carried out tasks and maintained cooperative working relationships, including a progress report. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs, or products made, with notes. | Mini projects that are used as part of the learning strategy to introduce or review topics in the specification. Exchange of information regarding sub-system input/output information and negotiating changes where necessary.<br>If an assessed project has been defined for an external market (eg an artifact for a family member), customer negotiations could be included. It could be appropriate for the teacher to act the part of a commissioning customer. |

| **WO 3.3 REVIEW WORK** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| review work with others and agree ways of improving collaborative work in the future. | • agree the extent to which work with others has been successful and the objectives have been met<br>• identify factors that have influenced the outcomes<br>• agree ways of improving work with others in the future. | Statements (written or recorded) from both the student and others on the extent to which the agreed objectives were achieved. Reports produced with others on ways to improve future collaborate work. | Team meetings for team-based mini-projects that are used as part of the learning strategy.<br>If an assessed project has been defined for an external market (eg an artifact for a family member), customer negotiations could be included. It could be appropriate for the teacher to act the part of a commissioning customer. |

## IMPROVING OWN LEARNING AND PERFORMANCE: LEVEL 1

The candidate must provide at least **two** examples of meeting the standards for LP1.1, LP1.2 and LP1.3.

| **LP 1.1 CONFIRM TARGETS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| confirm understanding of targets and how these will be met, with the person setting them. | • make sure targets clearly show what is wanted to be achieved<br>• identify action points and deadlines for each target<br>• make sure the dates for reviewing progress and how to get support needed are known. | Records of discussions which show the student checked her/his understanding of targets and knew how to get the support.<br><br>Two action plans with action points, deadlines and dates for reviewing progress. | Project work.<br>General curriculum work if using Open Learning and more traditional learning support. |

| **LP 1.2 FOLLOW A PLAN** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| follow plans, using support given by others to help meet targets.<br>Improved performance by<br>• studying a straightforward subject<br>• learning through a straightforward practical activity. | • work through the action points to complete tasks on time<br>• use support given by others to help in the meeting of targets<br>• use different ways of learning suggested by supervisor and make changes suggested by the person supervising the student, when needed. | A log of study-based and activity-based learning, with notes of the support given.<br>Records from those who have seen the work and which shows the tasks were completed on time and how any suggested changes were made. | A Project report could include notes regarding progress tutorials.<br>Research for mini-presentations also provides opportunities.<br>Many Centres use Open-Learning materials and this, in itself provides a more obvious context for this assessment, although more traditional learner support is also relevant. This applies to both study-based and practical assignments. |

| **LP 1.3 REVIEW PROGRESS AND ACHIEVEMENTS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| review achievements and progress in meeting targets, with an appropriate person. | • say what it is thought has gone well and less well, what was learned and ways learning took place<br>• identify targets met and evidence of achievements<br>• check that the student understood how to improve. | Records of<br>• what was said about the student's progress<br>• her/his achievements<br>• what to do to improve<br>Examples of work which show the student learned from studying two subjects and two practical learning activities to show targets met. | Progress reviews with teacher.<br>Project report, with notes regarding progress tutorials is also relevant. |

## IMPROVING OWN LEARNING AND PERFORMANCE: LEVEL 2

The candidate must provide at least **two** examples of meeting the standard for LP2.1, LP2.2 and LP2.3.

| **LP 2.1 SET TARGETS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Help set short-term targets with an appropriate person and plan how these will be met. | • provide accurate information to help set realistic targets for achieving what is to be done<br>• identify clear action points for each target<br>• plan how time will be used effectively to meet targets, including use of support and a date for reviewing progress. | Records information provided to help set targets.<br>Two action plans with action points, timetable and notes of support needed. | Project work provides an ideal context to demonstrate the ability to set clear, effective short-term targets.<br>This applies to assessed individual projects and non-assessed team-based mini-projects. |

| **LP 2.2 USE A PLAN** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| Take responsibility for some decisions about learning, using a plan and support from others to help meet targets.<br>Improve performance by<br>• studying a straightforward subject<br>• learning through a straightforward practical activity. | • use action points to help manage time well and complete tasks<br>• identify when support is needed and use this effectively to help the meeting of targets<br>• select and use different ways of learning to improve performance. | A log of learning, with notes of:<br>• when the student asked for support and it was used<br>• when and how the student worked without close supervision<br>• any changes made to the plan.<br>Records from those who saw the work which show the student managed her/his time well and completed tasks. | The assessed project work provides opportunities to provide evidence that the candidate can manage time, identify when help is needed and work in different ways. |

| **LP 2.3 REVIEW PROGRESS AND ACHIEVEMENTS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| review progress with an appropriate person and provide examples of evidence of achievements, including how learning was used from one task to meet the demands of a new one. | • identify what and how was learnt, including what has gone well and what has gone less well<br>• identify targets met, and examples of evidence of achievements<br>• identify ways of improving own performance. | Records of information provided on progress and ways of improving performance.<br>Examples of work which show what was learned from two study-based and two activity-based learning activities.<br>Notes on personal action plans to show targets met. | The use of tutorials to review progress could include notes taken regarding targets. This applies to both study-based and practical assignments.<br>Project report, with notes regarding progress tutorials is also relevant. |

## IMPROVING OWN LEARNING AND PERFORMANCE: LEVEL 3

Candidates must provide at least **one** substantial example of meeting the standard for LP3.1, LP3.2 and LP3.3.

| **LP 3.1 AGREE TARGETS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| agree targets and plan how these will be met over an extended period of time, using support from appropriate people. | • seek information on the ways to achieve what they want and identify factors that might affect plans<br>• use this information to agree realistic targets with appropriate people<br>• plan how time will be effectively managed and use support to meet targets, including alternative action for overcoming possible difficulties. | Records to show how the student obtained and used information to agree targets<br>An action plan for an extended period of time (eg. about three months) including alternative courses of action and a note of supported needed. | The preparation of a schedule of deadlines when planning project work. This could apply to assessed work negotiated with teacher or other students in team-based non-assessed projects. |

| **LP 3.2 USE A PLAN** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| • take responsibility for learning by using plan, seeking feedback and support from relevant sources, to help meet targets<br>• improve performance by:<br>  • studying a complex subject<br>  • learning through a complex practical activity<br>  • further study or practical activity involving independent learning. | • manage time effectively to complete tasks, revising plan if necessary<br>• seek and actively use feedback and support from relevant sources to meet targets<br>• select and use different ways of learning to improve performance, adapting approaches to meet new demands. | A log of learning, with notes of:<br>• how the student learned in different ways and adapted his/her approach<br>• when the student sought feedback and support and how he/she used it<br>• any revisions made to the plan<br>Records from those who have seen the work managed effectively and tasks were completed. | Team-based presentations and project work help students to explore their own level of understanding of curriculum topics, and to manage time.<br>If Open Learning is used, it may need support from tutorials, peers, or other, and could be recorded for this section. Other learner support using tutorials is also relevant.<br>Production of a project report, with notes regarding progress. |

| **LP 3.3 REVIEW PROGRESS AND ACHIEVEMENTS** | | | |
|---|---|---|---|
| **Candidates must:** | **Evidence must show candidates can:** | **Examples of evidence:** | **Suggested context**: |
| review progress on **two** occasions and establish evidence of achievement, including how learning from other tasks has been used to meet new demands. | • provide information on the quality of learning and performance, including factors that have affected the outcome<br>• identify targets met, seek relevant sources to establish evidence of achievements<br>• exchange views with appropriate people to agree ways to further improve performance. | Records of information provided by the student on his/her learning and performance, including how he/she used learning from other tasks to meet new demands<br>Examples of work which show what the student learned from studying complex subjects, through practical activity and independent learning<br>Records of discussions which show how the student sought evidence of his/her achievements and exchanged views on ways to improve performance<br>Note on action plan to show targets that have been met. | Progress reviews or tutorials.<br>Team-based presentations and mini-projects could have progress-review meetings.<br>Candidates can keep a portfolio of all tasks that have been assessed during the course, accompanied by a log that shows evidence of performance improvement in the form of comments both verbal and written, made by the teacher and others. |