RECOGNISING ACHIEVEMENT

GCE

Electronics

Advanced GCE **A2 H465**

Advanced Subsidiary GCE **AS H065**

Report on the Units

June 2010

HX65/R/10

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This report on the Examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

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REPORTS ON THE UNITS

F611 Simple Systems

The paper produced a good spread of marks with some candidates at almost every possible total mark. There was no evidence that the candidates lacked time with all questions attempted by most candidates; where questions where not attempted by some candidates these tended to be weaker candidates not attempting the more challenging questions.

Question 1 was about a simple system. The question started with a simple power calculation that almost all candidates could do. A significant number of candidates had difficulty clearly describing the need for a driver in this circuit but most could choose a suitable MOSFET for the driver and explain their choice with a few wrongly choosing the closest value to the required current and failing to appreciate the notion of maximum ratings. Many candidates had problems showing how to connect up a MOSFET as a driver with significant problems drawing the correct MOSFET symbol. Candidates were better at showing how to connect a resistor and switch as an input but had difficulty explaining the function of the pull up resistor. Almost all candidates could complete the calculation of monostable period but very few could draw a completely accurate timing diagram to show how it operated; many used their electronics knowledge to predict that G was the complement of H.

Question 2 was about logic gates. Almost all candidates could name the gates, draw symbols and complete truth tables, there were a few questionable symbols with candidates either hedging their bets or not drawing clearly which gained no marks. Boolean algebra is predictably more challenging for candidates. The Boolean expressions were completed well for the OR gate with some candidates writing $\overline{A} \cdot B + A \cdot \overline{B} + A \cdot B$ who were also awarded the marks. The expression for the NAND gate was less well done and the Boolean manipulation was a problem for most candidates.

Question 3 was about a comparator system. The question started with the calculation of a resistor for an LED, most candidates did not achieve full marks due to a failure to correctly calculate the pd across the resistor. The explanation of the terms digital and analogue produced a range of answers with some candidates showing misunderstandings here but also many good clear answers. Almost everyone could identify the Zener diode but few could accurately draw the graph of current as a function of voltage and about half failed to spot that it would give 3.6V at A. Most candidates knew that LDR resistance fell with increased illumination and could calculate the voltage from a potential divider by one of a number of techniques. The better candidates could explain the state of the LED showing understanding of the comparator. Most candidates had problems calculating the value of the LDR's resistance at the turn-on voltage of the circuit although a number appreciated that the voltages at B and A should be the same.

Question 4 was about a larger logic system. Most candidates could accurately draw a truth table from a complex Boolean expression. Once again, manipulation of the Boolean expression proved challenging for most candidates. Many candidates could draw a working circuit to reproduce the function described by the truth table with evidence of recall of NAND gate equivalences and a significant number cancelling NOT gates to minimise the number of gates.

Question 5 was about a spike generator. All but the weakest candidates showed the ability to read and calculate values for waves from an oscilloscope trace. Most candidates could show how to connect an oscilloscope and calculate the time constant of the RC circuit but failed to recognise the spike generator or be able to draw the trace it produced. The existence of the clamping diodes in a gate and their effect on the trace was only well understood by a small minority of the best candidates.

F612 Signal Processors

General Comments

Centres are to be congratulated on the work they have done in preparing their candidates for this paper. Almost every question was attempted by every candidate, and although they did not always earn the marks, they clearly felt that they could answer the question. Candidates were particularly good at designing sub-systems, such as amplifiers and filters, and doing calculations.

However, many candidates still find it difficult to earn enough marks in questions which require extended prose answers. They ought to write down one distinct point for each mark. Instead, they appear to start writing and stop when they come to the end of the answer line, even though they may still have more to say. It might be useful for candidates to practice planning their answers before rushing in to write them down.

Weak candidates still find it difficult to distinguish between the words behaviour and function. In describing the former, they should be using attributes of signals (such as current, voltage and frequency) at appropriate points in a circuit, whereas for the latter they should be invoking transfer characteristics of devices.

Comments on Individual Questions

1 Candidates need to be encouraged to explain the function of a sub-system using words that are not in its name. Writing that an ADC converts analogue signals into digital ones earns no marks for part (a), but saying that it creates binary words in response to the voltage at its input does. As last year, too many weak candidates are unable to identify the msb of a binary word or convert hexadecimal into binary. Although candidates were better at describing the effect of a flowchart than last year, a majority still insist on making up their own flowchart symbols instead of using only the ones listed on the data sheet. This meant that very few candidates earned all of the marks for part (e), often by failing to put 60 into a register before copying it to the output port.

2 Half of all candidates earned no marks at all for part (a), usually because they failed to realise that an explanation cannot rely on using words (such as gain) which are part of what they are required to explain. They fared worse in part (b). Part (c) involved calculations, so proved to be easier, although few made the assumption that the op-amp inputs draw little current in their calculation for (c)(ii).

3 The majority of candidates knew why crystal oscillators are better than relaxation oscillators for clocks - a popular incorrect answer suggested that RC networks only operate at lower frequencies. Many candidates omitted to draw the connections between the counters for part (b), and very few correctly identified the output which had a frequency of 2 Hz. It was good to see that the majority of candidates could correctly connect the flip-flops to make a counter. Although most candidates could name the two missing sub-systems, too many omitted to describe their function precisely enough to earn the marks.

4 Most candidates earned high marks for this question, suggesting that they had a good understanding of audio systems. Although the vast majority of candidates correctly placed the input and output devices for part (a), only the strongest placed the volume control before the power amplifier. It was good to find that many candidates could produce correct circuits for the bass cut filter of part (b) and justify component values with calculations. The non-inverting amplifier of part (c) proved to be more of a challenge for the weak candidates (feedback to the non-inverting input was a popular incorrect answer), as was the circuit for the volume control.

5 This question was about latches. Although most candidates found parts (a) and (b) straightforward, only a minority earned marks by explaining the bistable nature of the circuit for part (c). This was not unexpected. However, many candidates lost marks in part (d) because of they confused the behaviour of latches and flip-flops and didn't provide enough detail. All of the inputs and outputs were given unique labels to help candidates provide precise answers, but too often weak candidates would ignore them and produce confusing and ambiguous answers as a result.

6 It was good to find that the majority of candidates could correctly calculate the frequency of a relaxation oscillator, although weak candidates tended to use the incorrect formula for the period, discover that the answer was close to one and stop there, converting units from s to Hz along the way. Similarly, in part (b) few candidates were unable to connect an AND gate to reset the counter, but a minority had difficulty in working out the binary for five. Part (c) required candidates to use the summing amplifier formula - only the strongest could manage this, probably because they also had to realise that the inputs were held at 5 V or 0 V when 1 or 0. On the other hand, part (d) showed that most candidates can design an inverting amplifier successfully and justify the component values.

F613 Build and Investigate Electronic Circuits

For this second year of the new AS coursework, moderators report far fewer changes to the raw marks submitted by centres and, for those centres who did have a change, the adjustments were small. One of the main goals behind the introduction of the new AS coursework was to make candidates aware of the importance of subsystems and their use in the production of larger circuits. Moreover, the importance of understanding circuit behaviour, predicting outputs for given inputs, designing useful testing programmes, building neat circuits, taking good test data, and analysing that data with reference back to the predictions. It must be remembered that for the digital and analogue circuits there is no circuit design whatsoever to be done by the candidates – the circuit is to be given to them. There is evidence that some candidates are still designing these circuits from scratch which is not required. The only circuit design element at this level is with the microcontroller circuit.

The raw marking this year was more accurate than last year but the following points are restated as they are the common sources of problems encountered by moderators.

- To score highly for criterion 1a, candidates must give a possible use of the circuit, describe its operation fully, and make detailed predictions of its behaviour. A relatively common problem with those candidates who attempted a filter circuit is that they did not describe the use of the capacitor, thus, could not achieve 4/4 for this criterion.
- For criterion 1b, testing plans must be detailed and thorough. For example, when testing active filters, the amplitude of the test signal should be quoted and shown that saturation will not occur.
- For criterion 2, an example set of marked circuit builds are available on the OCR website.
- Criterion 3c does cause some trouble. To score highly, candidates must analyse fully the test results and refer back to the predicted behaviour – this is a more challenging criterion and often causes some trouble
- Criterion 4a is not just about correct circuit diagrams. For high marks, other useful diagrams should also be included. These would typically be labelled diagrams to further explain the test programme or to show predicted circuit behaviour.

Finally, it is a requirement that the mark awarded for each criterion be shown on the scripts. A simple red line with the relevant criterion marked is sufficient. This helps both the marking of the reports and the moderation process.

F614 Electronic Control Systems

All but the very weakest candidates attempted all of the questions on this paper. The responses showed that candidates were generally familiar with of themes in the specification. Noticeable weaknesses were apparent in proportional feedback and in the detail of the machine cycle. Candidates generally found calculations easier than descriptions, explanations or drawing graphs.

Question 1 was about processing binary words. Almost all candidates realised that six D-type flip-flops were needed and about half of them wired them up correctly; a few candidates included circuitry for output enable which was not required but lost no marks. The work on binary arithmetic was pleasing showing that candidates had spent time studying this. Almost all candidates could convert decimal to binary and there were very few problems with binary addition. The questions on two's complement and its role in subtraction was a good discriminator with stronger candidates providing good answers but weaker candidates showing confusion with these ideas.

Question 2 tested candidates' knowledge of microcontrollers. Almost all of the candidates could accurately label the parts of a microcontroller. The descriptions of the data bus and explanation of the data bus sometimes lacked precision. There were some good answers to the question about the general purpose register but many candidates showed gaps in their understanding, most understood that it was some form of memory but failed to correctly locate it in the CPU, often locating it in memory and most could not give good answers about its use. There were some very full answers to the question about the machine cycle with candidates giving great detail and showing a good understanding but about half the candidates failed to appreciate what a machine cycle was and so gained no marks.

Question 3 was about power supplies. Candidates could recognise and name the rectifier at the start of the question and could show the rectifying effect on the graph but many candidates failed to show the ~1.4 V reduction in amplitude due to the two diode losses and few showed V_B at 0 V whilst V_A was between -1.4 V and 1.4 V. Candidates had few problems adding a smoothing capacitor to the power supply and most could draw the graph of the smoothed output. The regulator circuit was well completed with the Zener diode but many candidates failed to calculate the voltage across the MOSFET when calculating the power dissipated in it. Most candidates failed to appreciate the negative feedback in the regulator and wrongly treated the circuit as a comparator to turn off the supply when the battery was charged.

Question 4 showed a MOSFET circuit to mix two signals. Candidates showed familiarity with MOSFETs and could complete all of the calculations accurately, with the weaker candidates struggling with (c)(ii) which was more involved. Most candidates could predict and explain what would happen to the output of the circuit as voltage at the gate was reduced. Most candidates found the final part of the question difficult but many candidates produced good solutions by calculating and plotting V_{out} at a number of times and joining the points.

Question 5 was about a microcontroller system and the program to operate it. Most candidates showed familiarity with masking and with about half the candidates gaining full marks for (a). There were some good answers to (b) but very many candidates did little more than paraphrase the functions in the datasheet and did not refer to the circuit in Fig 5.1 or what each part of the subroutine was for. Many candidates were clearly familiar with producing time delays and could write good subroutines and could express 250 in hexadecimal, but a number of candidates failed to use the rcall function when invoking the wait1ms subroutine. Only about half the candidates could correctly write down the binary for (d)(i), many candidates failed turn on the green LED but most could represent their binary answer in hexadecimal.

Question 6 was about a proportional servo control system. About a third of candidates failed to recognise the difference amplifier and calculate the output voltage. Most candidates could not accurately draw an amplifier with a gain of |2| suggesting that some of the knowledge from AS had not been retained or revised. Many candidates found drawing graphs of the voltages in the circuit challenging although many appreciated that the voltage at D was twice the voltage at E.

Question 7 was about building memory circuits. Candidates knew what volatile meant in this context but did not appreciate the role of the tristate in allowing the data lines to be bidirectional and connect to several cells. Most candidates failed to appreciate that four memory cells were needed in (c) and only drew two memory cells although most could correctly use the demultiplexers to operate one memory location at a time. There were some good designs for demultiplexers from logic gates but most candidates found this question challenging and a few candidates ignored the instruction in the question and used analogue switches instead of logic gates in their design.

F615 Communication Systems

General Comments

The range of marks earned on this, the first of its kind for the new A2 specification, went from 104 to 6 out of a total of 110, providing plenty of discrimination. The inclusion of stretch-and-challenge questions aimed at A* candidates would have made things harder for weak candidates, but there was no evidence in the scripts that candidates did not have enough time to answer all of the questions.

Several questions required candidates to describe the function of a sub-system. Weak candidates often lost marks by attempting to answer these questions solely in terms of the words in the sub-system's name. For example, saying that a DAC converts a digital signal into an analogue one earns no marks, whereas saying that it uses a binary word to create a voltage does.

Questions which require candidates to explain something with several lines of writing often fail to deliver full marks. This is possibly because candidates don't plan their answers carefully enough, but rush straight in and write until they get to the end of the lines provided and then stop. If there are four marks available, candidates should aim to mention four different points if they want full marks. Five points would be even better.

Too many weak candidates seem to believe that a horizontal line in a circuit diagram which represents a 0 V supply rail does not need to be labelled as such.

Comments on Individual Questions:

1 Almost every candidate was able to correctly draw a resistor ladder to provide reference voltages for the circuit. Candidates who drew a circuit using a zener diode or clamping diodes could earn some credit for (b), but full marks were reserved for circuits which met the specification exactly. Only about a third of the candidates earned the marks for (c)(i), right across the whole ability range. Many candidates attempted, without success, to use Boolean algebra to prove the expression, instead of inspecting the truth table and explaining why the expression was valid. However, it was good to find that the majority of candidates could draw a correct circuit with NAND gates, even if only a minority could justify it with Boolean algebra. Centres might consider training their candidates to write pertinent algebra at the output of every logic gate in a circuit as a way of justifying their arrangement. Only a minority of candidates went back to inspect the truth table and decide that B = Y was the simplest expression. Finally, too many candidates neglected to state a value for the terms that they had to define, with many weak candidates not knowing their meaning at all.

2 As a whole, this question provided excellent discrimination. Weak candidates earned few of the marks and strong ones earned most of them. Parts (a) and (b) proved to be straightforward, with only a few candidates drawing bands instead of spikes for the sidebands of the amplitude-frequency graph. Part (c) required candidates to explain how a circuit performs its function, always a difficult thing to do. Some did not help themselves by giving in-depth explanations of the level shifter and neglecting to say much about the MOSFET and op-amp. Too many candidates failed to appreciate that the op-amp was configured as an amplifier rather than as a comparator. Part (d) proved to be straightforward for many candidates. It was good to see many responses with correct voltage-time graphs and associated explanations.

3 Although almost every candidate managed the calculation of part (a), many only earned some of the marks for (b)(i) because they couldn't recall the relative bandwidths of AM and FM signals. Very few candidates earned all four marks for their explanation of the high SNR of FM, usually by not providing enough detail. Part (c)(ii) was intended as a stretch-and-challenge question, and so it proved in practice. Part (d) proved to be more straightforward, with most candidates attempting to put three filters in series, and a minority placing a buffer amplifier between each pair. Explanations often dwelt on the need for the filters to have slightly different resonant frequencies, completely ignoring the function of the buffer amplifiers.

4 This question required students to demonstrate their understanding of asynchronous transfer of digital information. For part (a), weak candidates who ignored the example provided in the question stem often earned no marks at all. The calculation of part (b) proved to be difficult for the many candidates who calculated the bandwidth required for the digital signal rather than the bandwidth of the signal being encoded and transmitted. However, it was good to find that the majority of candidates could explain the purpose of a start bit, and most knew how to calculate bandwidth. Many lost a mark by not putting a start and stop bit at either end of the data word. Few candidates earned maximum marks for part (c). Although many could describe the contents of a packet, some lost marks by assuming that the signal being sent was the same as in part (b) and only a minority supplied explanations of time-multiplexing which clearly involved asynchronous (not synchronous) transmission.

5 It was good to find that the majority of candidates were able to earn high marks for their drawings of the filter and shift register. However, it was disappointing to find that a quarter of the candidates failed to spot the virtual earth in the summing amplifier, and that the majority felt that they could explain the function of the SI and CK inputs by naming them serial input and clock respectively. Part (b) was another stretch-and-challenge, with only the strongest candidates earning all of the marks.

6 The majority of candidates managed to earn many marks on this question. Their bandwidth calculation often omitted to halve the bit rate to find the frequency, and their accounts of how a picture was placed on the screen too often failed to describe a raster scan, implying that all of the pixels in a line or frame were refreshed simultaneously.

7 This question provided an easy end to the paper for many candidates. Only a small minority discussed the method of modulation instead of how the modulated carrier was transported, but many candidates failed to mention explicitly that signals went down wires as current or voltage. Quite a few candidates failed to distinguish between noise and interference, and weak candidates failed to provide enough detail in their reasons why optical fibre was the least affected by noise and interference.

F616 Design Build and Investigate Electronic Circuits

For this first session of the new A2 coursework, moderators report that a number of centres had a change to the raw marks submitted.. Compared to the old specification, this new coursework does contain some new criteria which centres have to come to terms with. The main general reason for the changes was the lack of evidence within the reports. The following should clarify what moderators looked for in the reports (only common problems have been highlighted).

Introduction

1 a) Relevant research usually would consist of either a circuit diagram, circuit behaviour, or some relevant data specific to the chosen circuit. A simple reference to the research does not count as a marking point for 1a (it would count for 4a though). Moderators look for evidence within the report that candidates have gained some useful piece of information from the research.

1 b) For high marks, there must be some numeric data offered for the specification.

1 c) Many candidates seemed to forget the work done at AS level and did not describe the proposed test plan. Instead, many described how the testing had been done, rather than designing a thorough test programme – labelled diagrams are also useful here.

Circuit

2 b) To score high marks here, subsystems must be described at component level.

2 c) See the OCR website for marked examples of circuit builds.

2 d) Sometimes, high marks had been awarded for this section yet there was no evidence within the report that the subsystems actually worked.

2 e) To score highly here, candidates must describe the problems they faced and how they were solved.

Testing

3 a) To score highly, all subsystems and the final circuit should be tested and the evidence provided.

3 b) Presentation of test results should be the most *appropriate* – for example, the most appropriate way of showing the test results of a filter would be to use a table of results and then plot the response – not simply to offer numerous photos of scope traces showing the output signal at various frequencies. These traces can help but are not the best way of presenting the test results.

3 c) In general, this criterion was badly done, yet sometimes marked generously. Candidates need to analyse fully the test results of subsystems and the final circuit. Comparison to the circuit specification is vital.

3 d) Without evidence, marks cannot be awarded for this section.

Report

4 a) A correct circuit diagram must contain component values. ICs must not be shown as pin out diagrams – this makes for untidy circuit diagrams.

4 d) In the sources of assistance, it should be quoted what help was obtained from the particular sources.

Other Matters

In marking the reports, it is a requirement that each criterion achieved is shown on the report – this does aid the marking and helps the moderator identify any potential problems.
Many of the circuits attempted were very good and appropriate for this level

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