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ELE2 Further Electronics

Report on the Examination

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General Comments

This module examination tested the Further Electronics module, ELE2, of the AS Electronics specification as well as the basic knowledge acquired from the Foundation module, ELE1. The examination reflected the style of previous papers, with questions being set in the context of real applications where ever possible, so recognising the importance of electronics in the real world.

As usual, approximately 40% of the marks were available to those candidates who had learnt the basic descriptions and calculations detailed in the subject specification. Overall candidates seem to have been better prepared this year than in the past, with fewer producing poor attempts at the examination. At the other end of the scale, there were more candidates producing very high quality responses to questions.

While the presentation and handwriting of some candidates was excellent, a significant number of candidates produced scripts which were difficult to read. Candidates communicate with examiners via their handwriting, and all too often responses were verging on being illegible. Candidates need to be reminded that examiners must be able to read responses if they are to gain any credit. Candidates should also consider crossing out errors with a single line and not producing a scribbled mess over which they attempt to write a modified answer.

The marks scored by candidates ranged from 4 to 68 out of 72, with all of the marks being scored in the examination; no marks being unachievable to all candidates. Again this year it was noticed that the candidates from complete centres were unable to gain significant marks on particular questions, implying that some centres do not cover the complete range of the specification. It should be noted that each year it can be expected that all sections of the specification will be examined and that it is very unwise for any sections to be omitted.

This report should be read in conjunction with the question paper and the mark scheme.

Question 1

This was intended to be a familiar introduction to the paper, providing candidates with an opportunity to relate some standard bookwork and settle into the examination. While many candidates were able to provide good responses, a larger than expected number were unable to answer successfully.

In section (a), a significant number of candidates were unable to successfully complete the circuit diagram of the modulo-12 counter, often producing a shift register instead. It was also not uncommon for candidates to consider flip-flop **D** to be the least significant bit.

For section (b)(i), while there were some excellent responses, too many candidates simply rewrote the Boolean expression in words instead of answering the question and explaining the origin of the terms. It was pleasing to see, in part (ii), many competent attempts to simplify the expression, with both Boolean algebra and Karnaugh maps being used correctly.

Question 2

Once candidates had overcome their initial problems with section (a), there were many good responses.

In section (a), many of the candidates were able to state the voltage at the inverting input of the op-amp as 6V correctly, but the required explanations were usually poor, incorrect or omitted. A popular incorrect answer was 0V; candidates becoming confused with the concept of a virtual earth as a result of not understanding the circuit diagram.

Section (b) provided few problems to most candidates, though it was normal for the minus sign to be omitted.

The calculation for section (c) was well attempted, and error carried forward marking was used for all sensible answers from section (b).

The majority of candidates realised that a variable resistor needed in section (d), but many decided that it should replace one of the 10 kΩ resistors in the voltage divider rather than either R_1 or R_2. There were also a few candidates who decided that a mechanical solution was required and so discussed removing turns of wire from the coil, replacing the magnet with a weaker one, etc. Since these solutions would not make the sensitivity of the system adjustable, they were not given credit.

Many candidates were able to give a credit worthy response to section (e). The reactance formula and associated calculation seemed to be familiar to candidates, and apart from the usual problems caused by powers of 10, many completely correct solutions were received.

Question 3

This question was based on a common subsystem which has occurred on many of the past papers. It was therefore disappointing to see that too many candidates still have not learnt how this functions.

The pull-up resistor, in section (a), on the motion sensor lulled many students into feeling, incorrectly, that the output of the motion sensor would have to go to logic 0 to enable the system. The explanations that followed were often very confused, since, although they knew that the NAND gate required a logic 1 input, they could not rationalise this with their earlier statement.

Most candidates gained some marks for section (b) but often explanations were vague and incomplete.

Section (c) produced a good response from many candidates, though there were still problems and issues with powers of 10 in the calculation.

In section (d) many candidates focussed their answers on the bank of NOT gates driving the piezo sounder, rather than the NAND gate astable circuit itself. NAND gate 2, in the astable circuit, was the crux of this answer and a significant number of candidates were able to answer the question succinctly.

Question 4

This was one of the more demanding question on the paper since it required candidates to have a thorough understanding of both the op-amp circuit and the MOSFET source follower.

Section (a) produced a wide variety of explanations, the most creditworthy ones of which correctly identified that if the output was not saturated then the two inputs to the op-amp must be almost the same voltage because of the large open loop voltage gain of the op-amp.

For section (b), candidates were required to use Ohm's law to calculate the value for R. While there were many correct responses, a significant number of candidates believed that there were 6, 7 or 12V across R, despite being told that the voltage was 5V in section (a).

Many candidates did not recognise the circuit arrangement of the MOSFET as a source follower, in section (c)(i), often believing it to be a switch instead. A very popular, but incorrect response for part (ii) was that the MOSFET was needed to provide voltage amplification for the op-amp. Candidates were expected to know that the open loop voltage gain of the op-amp is very large but that it can only supply a small output current and so needs the MOSFET to supply the required current for the battery.

A few candidates realised for section (d), that the battery is effectively in the negative feedback loop of the op-amp and so as the voltage across the battery varies during the charging, the voltage across the resistor R would also try to vary. As it does so, the op-amp would adjust its output voltage in order to make the MOSFET produce a constant current, so keeping the voltage across R also constant.

Question 5

Some sections of this question were demanding and it was unfortunate that many candidates failed to gain the straightforward marks which were available.

It had been hoped that section (a) would yield more correct responses than were received, but the circuit arrangement of a unity gain inverting amplifier was not as universally well known as had been expected. As a result, not all of the candidates were able to gain these four very accessible marks.

For section (b)(i), there were still some candidates who could not correctly mark the virtual earth point on the inverting input of the op-amp. Part (ii) required candidates to manipulate an algebraic expression. It was pleasing to see that a significant number of candidates gained some credit for this part even though some did revert to replacing *v* with numbers.

Section (c)(i) foxed many candidates, though it was pleasing to see so many candidates attempt this part with some success. Correct responses for part (ii) were largely limited to those candidates who went on to score high marks, so providing discrimination at the higher end of the mark range.

Question 6

The subsystem for section (a)(i) should have been familiar to all candidates, but unfortunately many became confused and drew quite respectable binary counters instead of a shift register. The reset circuit in part (ii) caused some candidates difficulties, but there were a respectable number of correct circuits drawn.

It had been expected that section (b) would provide all candidates with accessible marks. Unfortunately this did not prove to be the case, and a significant number of candidates did not correctly shade the seven segment display diagrams or identify the hexadecimal values for 12, 13 and 15.

Question 7

The overall response to this question was encouraging, with many candidates making valiant attempts at all of the sections.

The responses to section (a)(i) were encouraging with most candidates gaining credit. Part (ii) was not so well answered; it would appear that gain-bandwidth product is not taught in some centres.

In section (b)(i), most candidates correctly made the assumption that the reactance of C_1 was negligible and so the input impedance of the circuit was 1 MΩ. Unfortunately a few candidates opted for 10 kΩ, having become confused by the feedback resistors of the op-amp circuit. Part (ii) was attempted by almost all candidates with varying degrees of success. Those candidates who realised that the op-amp circuit was a non-inverting amplifier and so used the correct formula gained three straightforward marks. A variety of invalid assumptions were given by candidates, though a pleasing number did correctly make the assumption that the voltage gain of the source followers was unity.

Most candidates for section (c)(i) gave credit worthy responses in explaining cross-over distortion. Part (ii) caused more difficulty, since although the question stated that there was a quiescent current through the MOSFETs of 50mA and the MOSFETs were included within the negative feedback loop of the op-amp. Many candidates did not take this as an indication that there would be very little cross-over distortion.

Most candidates attempted section (d)(i) with varying success. A common error was to use 4 A, the maximum current that the power supply could supply as given in the stem of the question, rather than the maximum current that the 4 Ω speaker would allow to flow from the power supply. There were also those who wrote a selection of numbers and then produced the answer of 28 W. For part (ii) many candidates realised that there would be energy lost in the MOSFETs as well as the op-amp output not actually reaching the power supply voltage and the MOSFETs requiring a turn on gate to source voltage.

Almost all candidates, for section (e), can now identify the important design features of heatsinks.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the **Results statistics** page of the AQA Website.