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General Certificate of Education

Electronics 1431/2431

ELEC4 Programmable Control Systems

Report on the Examination

2010 examination - June series

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General Comments

This module examination tested the Programmable Control Systems module of the A2 Electronics specification as well as the basic knowledge acquired from the AS modules. It is the first examination of the new specification for ELEC4 following its revision. During that revision some topics were removed completely from the overall specification (e.g. Basic programming via a PC) while other topics were added and revised (e.g. Assembler code programming of a microcontroller, Robotic Systems, H-bridge controllers, stepper motors etc) so as to modernise the specification.

The examination reflected the style of the previous specification papers, with questions being set in the context of real applications where ever possible, so recognising the importance of electronics in the real world. When constructing the examination, 50% of the marks were based on standard bookwork which should have been readily available to all candidates who had studied the course and undertaken some revision. All sections of the specification were examined and it is expected that this will continue in future years.

This year the papers were marked via an online viewing system and so the presentation and handwriting of candidates was even more important. While the presentation and handwriting of some candidates was excellent, a significant number of candidates produced scripts which were problematic for examiners. Candidates communicate with examiners via their handwriting, and all too often their 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.

All of the marks were gained overall by candidates with no marks being inaccessible. Marks ranged from 9 to 73 out of 80 with the mean mark being 42. As in previous examinations, candidates gained credit for all responses that contained correct electronics.

Question 1

Section (a), parts (i) and (ii) provided no problems for most candidates though it was worrying that some candidates did not make any attempts to answer these questions.

Section (b) produced many correct responses but there are some concerns over the number of candidates who believed that the decoder took information from both the counter and DAC - combined it together and then formed a hexadecimal number for the 7 segment display.

Section (c) also presented most candidates with little difficulty though it is worrying that some candidates thought that the output decreased with time, presumably as a result of only remembering the summing amplifier part of the DAC.

Section (d) produced many good, concise explanations, though unfortunately some candidates expended significant energy focusing on the events around when the counter was reset instead of explaining how the whole system functioned as an ADC.

Question 2

For section (a), many candidates gained both marks though a significant number of candidates scored no marks at all. Some candidates did not make any attempt to answer this section. Candidates who were unable to work out the correct response perhaps should have taken some clue from the order of the connections within the diagram.

Many candidates gained both marks for section (b) by identifying that the system was closed loop because it had feedback.

For section (c), there were some very clear succinct responses to this question, which scored full marks. Unfortunately many candidates chose to not read the question and so just described how the system worked in general, which usually resulted in few marks being scored. Error carried forward marking was used for those candidates who gave incorrect answers for section (a).

Question 3

There were many correct responses for section (a) with candidates correctly applying the parallel resistor and the voltage divider formulae. Some candidates forgot that the 20k resistor is effectively in parallel with the 10k resistor and so calculated answers of 7.5V which was then claimed to be near 6V.

For section (b), many candidates gained full marks for this section, and achieved the answer of 9V in a variety of valid ways, ranging from another full calculation to reasoning that the switching levels would be symmetrical around 7.5V and so subtracting 6 from 15V.

Many candidates had no difficulty with section (c). There were a significant number of candidates who believed that the extractor switched on when the output from the humidity sensor reached the upper switching level. There were also a significant number of candidates who incorrectly extended the graph to estimate the humidity level.

Question 4

Responses to section (a), part (i) were disappointing with few candidates able to explain the use of the term 'multiplexed' in the context of a display. Most candidates did not know that the 7 segment displays were switched on and off sequentially to display the numbers individually. For part (ii), while there were some good responses to this question, a significant number of answers were disappointing with a popular incorrect advantage being that a multiplexed display used less power, rather than fewer components. Incorrect disadvantages often focused on poor reliability rather than issues of the display being dimmer or being more complex to set up initially.

Section (b) produced many good answers, with candidates readily able to identify advantages and disadvantages of LED displays compared to LCDs. However, a surprisingly large number of incorrect answers stated that LED displays have a lower power consumption than LCDs.

Responses to section (c) were disappointing, with candidates usually providing irrelevant reasons for why the displays must be common cathode. The fact that there was only one common connection shown in the circuit for the segments of each display escaped most candidates.

Responses to section (d), part (i), were very disappointing, with very few completely correct answers being seen. Many candidates were able to calculate a suitable resistor value had the display been static. However, it is a multiplexed display, where each display is only switched on for 25% of the time. This means that the four times the static current can pass through each segment resulting in a resistor of a quarter of the static value being needed. This last step was omitted by almost all candidates.

The answers received to section (d), part (ii) were disappointing. Most candidates failed to realise that each segment could dissipate 76mW and so the maximum dissipation for the whole seven segment display is 7 times this (or 8 times if the decimal point is included). Each segment has a forward voltage of 1.9V and so the maximum current is either 280 or 320mA.

Section (e) was well answered by the majority of candidates, with only a small number of responses failing to gain credit. Common errors included the numbers being listed for the displays to be scanned from right to left and also giving the 'inverse' of the number, i.e. 7, 11, 13 and 14 instead of 8, 4, 2 and 1.

Question 5

While most candidates managed to gain some marks with section (a), descriptions of suitable sensors and their operation were often poor. Statements such as Infrared and ultrasonic were common responses for the possible devices to use as sensors, and unless a description of the operation was included, they gained no credit. PIRs were also not accepted as sensors as they would not detect obstacles that are at the same temperature as the surroundings.

Section (b) was well answered by the majority of candidates. There were clear descriptions of the command sequence for the motors in order for the robot to navigate past the obstacle. A few candidates did get confused with their left and right hand side, but usually managed to gain some marks.

For section (c) it was pleasing to see that many candidates knew about rechargeable batteries and their relative merits. Responses to this section varied from concise and comprehensive details of two types of rechargeable batteries through to no attempt. Unfortunately some students failed to read the question correctly and included solar cells as a rechargeable battery. Credit was not given for this even if its poor efficiency in the dark was mentioned.

Question 6

Many correct answers were seen for section (a) though it is disappointing that not all candidates were able to gain this mark for such a straight forward question.

Responses to section (b) were disappointing, with few candidates gaining full marks. Many candidates gave vague statements instead of focusing on the benefits of MOSFETs in this application, e.g. high Rgs and low Rds. Many candidates still seem unfamiliar with MOSFETs and their use.

For section (c), the majority of candidates knew that the diodes were to protect the MOSFETs from the large reverse voltage produced by the motor, though there was still a worrying number who thought that the diodes were there to protect the motor.

From the answers received to section (d), it would appear that many candidates had no experience of H-bridge circuits. While a few completely correct answers were received, most candidates did not notice that the top two MOSFETs of the bridge were p-type with the result that credit was not gained for these answers. Far more candidates were successfully able to identify the logic levels needed to stop the motor. Credit was not given to those candidates who enabled all of the MOSFETs, for while this would have stopped the motor, it may have been permanent as the power supply would be short circuited.

Question 7

Section (a) required candidates to describe one architectural difference between a microcontroller and microprocessor. Many candidates just described the microcontroller architecture without comparing it to a microprocessor, and so only scored one of the two available marks. Candidates also confused microprocessors with Artificial Neural Networks, believing that they had distributed memory and many simple processors.

For many candidates section (b), part (i) presented few problems, with many answers receiving full marks. However, it would appear that a few candidates were not familiar with setting the bit direction on a port and so struggled to provide an answer. For part (ii), since most scientific calculators contain a function to convert binary numbers to hexadecimal, it was worrying to see how many candidates were able to write down the correct binary value but then fail to convert this correctly to hexadecimal as required by the question. While many candidates gained both marks for part (iii), many lost marks by making errors with the assembler instruction. The assembler instructions are given in the data sheet and it is a pity that more candidates did not consult these, rather than relying on their memory.

For section (c), part (i), few succinct and fully correct responses were seen for this question. Candidates often failed to explain that a subroutine is separate to the main program, instead usually stating that a subroutine is part of the main routine. Part (ii) was, overall, well answered by the majority of the candidates. However, some sections caused more problems than others:

- 'start:' was rarely explained as a label or name for the subroutine, with many candidates believing it to be an instruction telling the subroutine to begin.
- 'movrw PORTA' was thought by many candidates to mean 'move the contents of W and R into PORTA'
- 'movw 2' was often thought to mean 'move the contents of w to register 2'
- 'RET' was often thought to mean 'return to the start of the subroutine'.

Some candidates had clearly not done any assembler programming at all. Some candidates had used the data sheet to give incorrect answers such as 'move w to r in PORTA' for 'MOVWR PORTA'.

Mark Ranges and Award of Grades

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