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Electronics ELEC6

(Specification 2430)

Unit 6: Practical System Synthesis

Report on the Examination

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ELEC6 – Coursework Component

This is the third year that this revised coursework specification has been used for A2 and it was pleasing to see that for many of the established centres, the scheme presented few problems, with the requirements being correctly interpreted and the work of their candidates being accurately and consistently assessed.

The coursework assessment scheme used for ELEC6 is more demanding than that for ELEC3 and while it still requires candidates to produce a report describing how they designed and constructed an electronic system to overcome a problem or satisfy a need, several of the criteria now require higher level skills in order to access their marks

A programme of standardisation meetings took place in January with representatives from over sixty centres attending. Details of future standardisation events will be available from the Subject Manager at AQA.

The administration issues documented in the AS report equally apply to the A2 coursework and so will not be repeated here.

The A2 subject specification states that coursework should be based on at least three active devices and should be commensurate with the content of ELEC4 and ELEC5 and of a more demanding nature than AS coursework. As with the AS coursework, an active device is anything that can provide power amplification at a frequency greater than 40kHz. It should be noted that the assessment scheme does not award additional credit for those candidates who produce very complex projects. This is intentional, as it is the process of producing, testing and evaluating an artefact that is being assessed. The artefact produced is just the vehicle used for making the assessment. Supervisors are required to approve the projects of their candidates and, when doing so, they should consider whether the projects are of the correct standard and contain at least three active devices. Supervisors should also consider whether individual candidates have the ability to successfully complete the work. A candidate should not proceed with any project that does not have the approval of the centre supervisor.

Issues noted in previous reports have continued this year and are again brought to the attention of all centres. It is essential that all centres are able to ensure that they can provide clear photographic evidence of the existence of the hardware for a candidate's coursework. It is very difficult to justify any marks at all for candidates when there is no evidence of hardware, even when a report is written, since the report is essentially the description of the work involved with the production of the electronic system. It is also essential that any software devised and used by candidates is fully annotated. Candidates can use everything from machine code through to Python for their control systems so long as the code is fully documented.

Different sections of the marking scheme caused difficulties for different centres. The following sections describe the coursework process and how the criteria link to this, together with some of the common issues noted this year. They should be read and noted in conjunction with the subject specification and the coursework Support Booklet.

For Aa marks, candidates are expected to independently select and then give a clear description of the problem that they are going to solve using an electronic system at the beginning of the report. It is expected that the description will be a short paragraph but will not contain details of either the circuitry or the components that are going to be used, as this would pre-empt the research. Some descriptions were extremely brief this year and as such it is difficult to justify the award of two marks in these cases. Centres are reminded that group projects are prohibited and that all of the candidates should do projects that are completely unrelated.

Having identified the problem to solve, the candidates are then expected to undertake research to help them determine the parameters for their electronic system. Details of research from at least two books, catalogues or the Internet are required for marks for Ab and must be specific, including page references, URLs and also a brief summary of the information obtained from each source.

Candidates are also required to undertake practical research to help determine their system parameters. For the Ac marks, candidates should give details of at least two investigations/experiments that they have carried out together with their conclusions. Photographs of the investigations can provide useful evidence. Trying a circuit for the first time either practically or virtually is not sufficient to qualify as such an investigation. For some candidates, their evidence for Ac looked very similar for their evidence for Bc and so was not credited.

Having completed their research candidates, should be ready to design their electronic system. The marks for Ad are gained by the candidates giving specific operating parameters for their system. In order to gain both marks, they will need to give at least three numerical and realistic parameters for their system. It is expected that these will include the range for the supply voltage with which the system is expected to operate, together with a realistic estimate of the operating current. It should not then be too demanding for candidates to identify at least one other parameter, though moderators were surprised this year by just how many candidates failed to do this and so lost at least one mark. It is expected that if a project is to operate at a certain light level, temperature, time period etc, then these values will be parameters given in the specification. It is also expected that if a circuit is to operate in a car then its operating voltage range should include that of the car battery.

With the operating parameters for their system defined, candidates are now required to justify their decisions for the marks for Ae. This is one of the more demanding assessment criteria included in the A2 course and caused many candidates unnecessary difficulty. The justification should be in the form of a statement for each of the system parameters defined. E.g. "*I have chosen an operating supply voltage of 7 – 10V so that my system will work from a PP3 battery. A new PP3 battery was found to have a terminal voltage of 9.6V and the voltage decreased as the battery became discharged. I chose 7V for the lower limit because the 7805 voltage regulator needs at least 2V across it to function correctly.*"

It is unlikely that there is a unique solution to any electronic system design and so candidates, for the Af marks, are required to consider and give details of realistic alternatives within their system. For example, a system that requires a timing period of 10 minutes could be constructed from a microcontroller, monostable or a counter circuit. Candidates would be required to give circuit details of both possibilities for the Af marks. All too often this year, candidates either gave insufficient details or described alternative problems rather than focussing on their chosen system.

Having identified the alternatives, then for the Ag marks, candidates are required to make a reasoned decision as to which of the alternatives they are going to use. Where possible, these decisions should be made on the basis of electronic functionality, i.e. lower power consumption, more accurate timing etc, rather than lack of availability. Insufficient knowledge is not considered as an adequate reason, since the alternative should not be considered if the candidate has inadequate knowledge.

With the system designed, the construction should then start. Candidates should, from the outset, be aware that their systems must contain at least three active devices. Failure to do so will exclude them from all of the subsystem marks (Ba, Bb and Bc) and is likely to lead to a disappointing report.

It is expected that candidates will be able to provide circuit details of at least one subsystem with minimal guidance from their course notes and begin construction on protoboards. It is found that when supervisors insist candidates hard wire (solder) circuits, their circuits often do not work and their overall coursework mark is depressed. It is expected that most candidates will be able to score at least one mark from Ba.

With a subsystem built, it now needs to be tested. The Bb marks are for this testing and for giving details of at least two measurements from a subsystem. Many candidates only gave one measurement and so forfeited a mark. These marks can be gained on any subsystem, but there must be two measurements from a single subsystem to gain both of the Bb marks. This often caused problems for candidates using templates, since once they had used their '*Bb space*' inappropriately there was no further opportunity to record the measurements from other subsystems.

After all of the subsystems have been constructed and tested, candidates now need to connect them together to form the complete system. Frequently this will involve the candidate having to change one or more of the subsystems to solve incompatibility issues between the subsystems. The Bc marks are gained by the candidate describing how these issues are solved and are likely to include having to add buffers to provide additional current, blocking capacitors to remove offset voltages etc.

The Bd marks are for giving a full and detailed description of how the system works. It was common to see candidates attempting to do this without having produced a full circuit diagram of their system. Such circuit diagrams should contain details of the component values and types. Any program code used in the project *must* be fully listed with each line/section annotated to explain its purpose.

One of the most demanding parts of building an electronic system is translating the circuit diagram into a well organised and effective component layout on the protoboards. To gain the Be marks, candidates need to demonstrate their ability and this is most easily achieved with clearly labelled diagrams or photographs of their protoboards. Effective component layout is usually key to a successful system and so supervisors may choose to guide weaker candidates but then only award a single mark in this category.

Candidates are expected to consider and document the risks they are *likely* to encounter when undertaking practical work and identify ways of reducing these risks to a safe level. They should do this also for the components and the equipment that they use as well as their colleagues. Such documentation, together with at least two subsystems constructed, are required for the award of both marks for Bf. The documentation of the safety considerations was often omitted this year by candidates and supervisors are advised that a witness statement is not an acceptable substitute.

In order to find faults within a system, it is important that it is constructed neatly with wires being no longer than are needed to join the various parts of the circuit together. This is reflected in the marks for Bg and any system that contains long, looping wires or where modifications are difficult to make, is not considered to be neat.

At A2 it is expected that candidates will construct their complete systems and that the systems will work to a large extent. The Bh marks therefore reflect this and two marks should only be awarded if the system fully works *and* the candidate received only 'minimal guidance'. It is interesting to note that some supervisors awarded two marks for Bh despite their candidates describing the help and assistance given to them in their reports!

With the system completed a test plan should be devised which focuses on how the system parameters are going to be measured, including the equipment that is going to be used. In order for the time spent testing to be productive, it is essential that the testing plan is developed *before* any testing takes place. The criteria for Ca are used to make an assessment of this plan. This still seems to cause some candidates and centres difficulties, with marks being awarded for these criteria when there is no evidence that a plan was devised prior to the commencement of testing or when the plan mainly refers to subsystem tests. Centres are reminded that subsystem tests/measurements do not gain any credit in this section.

At A2 it is assumed that basic testing will be carried out by the candidate and so this is not rewarded. Marks for Cb should be awarded when the candidates has completed all of the basic testing, e.g. how long the buzzer sounds for, the temperature which activates the system etc and the candidate then investigates how, for example, the time period of the buzzer varies with supply voltage. To gain two marks for Cb, it is necessary to make and record detailed numerical measurements on the system parameters. Recording every conceivable voltage is not assessing the system parameters and so is unlikely to gain these marks. Many centres marked this criterion generously.

An increasing number of centres are using computer based oscilloscopes which enable candidates to paste into their reports the traces obtained from their measurements. While this is to be commended, it is important that candidates then interpret these pictures and not leave it for their readers to determine the measurements.

The marks for Cc are awarded for the candidate justifying the *accuracy* of their system measurements. This requires candidates to find out how accurate their multimeters really are either by looking up the manufacturers' data sheets or by calibration. Most multimeters are accurate to 1% and so candidates' measurements should reflect this. Of more importance are the measurements made from oscilloscopes. For this, candidates should ensure that the variable controls for y sensitivity and time base speed are set to the calibrate position and the test probes are touched onto the calibrate terminal of the oscilloscope in order to ensure that measurements are as accurate as possible. It is unlikely that measurements taken from an oscilloscope will be accurate to more than 5% and so measurements should reflect this in the number of significant figures quoted.

With the system tested and measurements carefully recorded, candidates should then assess their system to see if it is fit for purpose and solves the original problem. This will involve reference to both the measurements made on the system and also the parameters for the system, and is judged by the criteria for Cd. It is difficult to justify any marks for this criteria if the original system parameters are weak and there is little testing of the system.

It is likely that the performance of the system, once working, will not match the original parameters and so the criteria for Ce assess the limitations and possible solutions identified by candidates. Frequently these marks are inappropriately awarded by supervisors who give credit to candidates describing how they made their system work or how they identify improvements to their system which change the original specification. Marks should only be awarded when clear limitations in the performance of the working system are identified together with possible solutions.

There will be occasions when a candidate constructs a system that works fully to the original specification and so there are no limitations. In such cases supervisors should award both marks for Ce (and also Cf) so long as full marks have been awarded for Ad, Cb and Cc, i.e. the system has been fully specified and tested.

Having suggested modifications to the system to make it work more closely to the specification, candidates should now carry out the modifications and then re-test the system. The marks for Cf are used to judge the evidence for this and were often incorrectly awarded for a candidate making a non-working system function.

With the system retested, the candidate now needs to formally evaluate the performance of the complete system. To gain marks for Da, the evaluation must be numeric and should consist of a table showing the design parameters and the equivalent system measurements. If the initial specification is weak and/or the system is not fully tested, it is difficult to justify any marks for this criterion.

Marks for Db should be awarded to reward those candidates whose system meets or exceeds their design specification and solves the original problem.

Marks for Da and Db were often very generously awarded by centres again this year.

The criteria for Dc embrace the whole of the report including quality of written communication, photographic evidence, annotated program code and a complete circuit diagram including component values and types. Inadequacy in any of these areas will result in the loss of at least one of the available marks.
Supervisors are expected to comment on errors in the circuit diagrams produced by their candidates. Several instances this year were found where a circuit diagram could not possibly lead to a functioning circuit and yet had been ticked by the supervisor.

To reduce plagiarism, it is important that candidates produce a summary of all of the sources of information and help that they have received during their coursework. This is assessed through the criteria for Dc and should be located at the end of the report. It is expected that full details of sources will be given by candidates, particularly web sites, where a full URL is required. It is also expected that candidates will give a one line statement of the information gained from each source.

Mark Ranges and Award of Grades

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