GCE A LEVEL EXAMINERS' REPORTS

ELECTRONICS
A LEVEL

SUMMER 2022

Grade boundary information for this subject is available on the WJEC public website at:
https://www.wjecservices.co.uk/MarkToUMS/default.aspx?l=en

Online Results Analysis

WJEC provides information to examination centres via the WJEC secure website. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre.

Annual Statistical Report

The annual Statistical Report (issued in the second half of the Autumn Term) gives overall outcomes of all examinations administered by WJEC.

ELECTRONICS

GCE A LEVEL

Summer 2022

COMPONENT 1: PRINCIPLES OF ELECTRONICS

General Comments

The general standard of responses was high. There was a wide range of marks with a mean of 80.6. Questions were accessible with two questions (1 and 2) attempted by all candidates and all others by close to 100%. The exception is question 7 which was attempted by 92.9%. Question 3 was the most accessible (FF 0.89) and questions 8, 11 and 12 were the least accessible (FF 0.48, 0.44 and 0.48 respectively). Generally, the accessibility was in line with the 2019 paper.

Some responses required recall of a circuit or a graph which caused difficulty for some. Learning of such is essential to enable candidates to access these marks.

Circuit diagrams were often drawn freehand often making them difficult to read; use of a pencil and ruler should be encouraged.

Calculations were often correct and well laid out. But on occasions the wrong formula was chosen, or incorrect data selected to substitute into the equation. Calculations benefit from a clear logical layout.

Comments on individual questions/sections

Q.1 (a) (i) Most candidates knew the truth table for the 3-input NAND. There were a small number however who were confused by being a 3-input gate.

(ii) NAND replacement was generally well answered. A minority lost marks for missing out the top NOT gate or mixing up the equivalent NAND circuit for the OR and AND gates.

(iii) This was mostly well answered with cancellations clearly shown. Some candidates cancelled gates in parallel sections rather than gates in series. An even smaller number did not attempt this part.

(iv) Many answers focused on the number of gates rather than the number of ICs required and were awarded zero marks.

(b) (i) Whilst a majority of scripts answered this correctly a significant minority were unable to identify the set and reset properties of the set and reset inputs.

(ii) Mostly correctly answered using the disallowed state answer. Very few identified the alternative answer that Q can change at any time.

(iii) The good answers to this part gave a clear application, however, many answers simply named a latch without giving the application for it.

Q.2 **(a)** **(i)&(ii)** A very high proportion of candidates knew these identities.

(b) There were many correct and well set out answers for this question. The commonest error was to forget the brackets around the OR function $(\overline{\mathrm{A}} + \mathrm{B})$ which then derailed the simplification.

(c) Most answers to this were correct. However, most of those not achieving full marks made the error of not wrapping the top and bottom of the Karnaugh map thus missing out on a group of 4.

Q.3 **(a)** Most scored full marks on this part. Many others achieved close to full marks with error carried forward (ecf) applied to M, N and Q.

(b) Like part (a) most scored full marks. The expectation was for the Boolean expression to be derived from the truth table. A few gave a Boolean expression derived from the circuit; this was awarded full marks where correct.

Q.4 **(a)** **(i)** A few candidates misunderstood their calculation thinking that the number of revolutions was the final answer.

(ii) Most candidates gave a correct answer.

(iii) Nearly all candidates achieved full marks. A small number used the voltage across the LED rather than the voltage across R.

(iv) There were some good explanations demonstrating a clear understanding of this circuit. However, a large number of candidates were unable to give an answer worth more than 1 mark. Typical errors were thinking that the photodiode increases resistance in the light and that an increasing collector current increases V_{OUT}. Other misconceptions were describing the transistor as voltage controlled rather than current controlled.

(b) Whilst many candidates correctly identified the Schmitt invertor role as that of digitising the signal from the encoder, many focused incorrectly on the inverting property.

Q.5 **(a)** **(i)** This was a simple case of reading from the graph. A few candidates mis-read 0.6 as being 0.7V

(ii) Nearly all candidates scored full marks. Then commonest error, though rare, was to give a negative gain.

(iii) A majority of candidates drew clear and ruled diagrams of the correct circuit. There were a surprising number who were unable to draw a non-inverting amplifier correctly and others who would benefit from using a ruler.

(b) **(i)&(ii)** Candidates had no problem calculating the gain in the table. However, whilst many produced very good and accurate graphs, a significant number plotted one or two points inaccurately or in some cases not at all. Candidates should be encouraged to use x or + symbols for plotting rather than unclear dots. Lines were of mixed quality with some wobbly, point to point or discontinuous.

(iii) Good answers compared the maximum gain with the required gain stating whether it was in tolerance and then calculated the bandwidth again stating whether it met the requirement. Many candidates were unable to calculate the bandwidth.

Q.6 **(a)** **(i)** Most candidates recognized the type of filter. High pass and bass cut were both accepted.

(ii) This calculation was generally well done. Where errors were made it was usually with powers of ten.

(b) **(i)** A significant number of candidates were unable to carry out this straight-forward calculation either not knowing the formula or making powers of ten errors.

(ii) Many candidates struggled with this calculation. Common errors included using a standard voltage divider formula without Z, having X_C on top of the formula or using C instead of X_C.

(iii) The straight-forward method here was missed by many.

(c) Whilst most candidates were able to draw the correct shape graph (both the curve and the straight two-line approximation were accepted) for the type of filter, many candidates displayed confusion with the labelling, mixing up the appropriate labelling between the two methods.

Q.7 Whilst some candidates clearly knew this circuit others struggled to complete all elements of it. The commonest problems were with the number of op-amps and the number of resistors. Where the statement "all relevant values" is used in a question, candidates are expected to provide resistor values, and this was not the case in some responses.

Q.8 **(a)** A straightforward question that candidates struggled with. The mark was for both location and orientation of the diode being correct.

(b) **(i)** Candidates were expected to know that when the transistor is saturated V_{CE} is zero. This assumption then allows the calculation of the collector current from the solenoid rated values. Then use h_{FE} to calculate the base current. Whilst the majority of candidates were successful in this calculation some struggled with the two-step calculation.

(ii) Common errors in this calculation were to forget to subtract 0.7 from V1 there was error carried forward from this. Also, few candidates realised that to ensure saturation the E24 value below their calculated value was required.

(c) This question required the use of the values provided in the question to draw the graph. Many candidates were unable to draw this standard graph some reversing the cut off and saturation regions. Error was carried forward to the drawing of the linear region for an incorrect saturation value.

(d) **(i)** This relied on using the graph to find V_{CE}.

(ii) Another multi-stage calculation which is at the top of the range of difficulty. There were however some excellent answers and many clearly laid out and easy to follow; this should be encouraged.

Q.9 **(a)** **(i)** The first step of determining the time period from the graph was well done. The second step of using their value to find the frequency sometimes led to powers of ten errors.

(ii) This straight-forward selection of formula, substitution and calculation proved more challenging than expected for some candidates. Some were unable to identify the formula on the data sheet and others unable to read the amplitude from the graph correctly.

(b) **(i)** A straight forward reading off the graph provided the answer. The commonest error was omitting the kHz.

(ii) A straight-forward reading off the graph and subtraction provided the answer. The commonest error was omitting the kHz.

(c) **(i)** There were few candidates who provided both parts to this answer thus only scoring one mark. The commonest omission was not mentioning that signals are sent at the same time many candidates clearly incorrectly stating that the signals are divided up with a portion of each sent one after the other, a clear confusion with TDM.

(ii) The calculation was successfully attempted by many candidates. Incorrect responses used the wrong value for the frequency range or the wrong bandwidth. The second mark was for identifying that the calculated value for the number of stations is always rounded down.

(d) **(i)** The first mark here was for describing the link between the audio signal and the carrier wave. Many candidates were able to do this. However, some responses gave vague descriptions of frequency change in the carrier without specifying the link between that and the audio signal modulating it. Many responses referred to the constant amplitude in the carrier wave, whilst true this is not a change in the modulated wave. Only a small minority of candidates identified that the frequency in the audio signal modulated the carrier waves rate of change of frequency.

(ii) Precise wording was required for a correct response to this question, a correct answer being that FM is less susceptible to noise in transmission. Many candidates described it as FM not being affected by noise. The second part was often correctly given even when the first part had been incorrect.

(iii) **I.** The modulation index was correctly calculated by a large number of candidates. Some candidates were unable to select the correct values for the equation.

II. The bandwidth was correctly calculated by a large number of candidates. Some candidates were unable to select the correct values for the equation.

Q.10 **(a)** Many candidates were able to complete the circuit mostly with correct values for the resistors. A number of candidates had the connections to the op-amp the wrong way round which would not fulfil the specification.

(b) **(i)** Many candidates were able to identify the correct equation and many of those substituted the correct values although rearranging the formula was a challenge. Use of 24V or failing to subtract 3 were common numerical errors.

(ii) More candidates scored full marks on this part than the previous part. It was not uncommon for candidates to write the formula correctly and then forget to square the current.

Q.11 **(a)** **(QER)** Candidates who achieved marks in the top band calculated the gain and bandwidth correctly and confirmed that they met the first and third parameters of the specification. They were able to identify that the input impedance of the amplifier was 10kΩ and that this did not meet the requirement for parameter two. They then explained how the input impedance could be changed by using 12kΩ for R_{IN} but that R_F would need to be changed to 600kΩ to maintain the gain of the amplifier. They also analysed the output for the maximum input voltage either by calculating V_{OUT} and concluding that it would be greater than saturation and therefore produce clipping distortion or they calculated the maximum value of V_{IN} to avoid clipping distortion and concluded that it would be less than the maximum input voltage required by the specification. To rectify this they suggested that the power supply should be increased.

Lower tiers answers were poorly structured and/or missed some of these points of analysis. There were also some common misconceptions such as confusing the input impedance of the op-amp with the input impedance of the amplifier and taking the gain-bandwidth product as the gain of the amplifier. Where these occurred, credit was given to any correct analysis in the response unless the errors contradicted a correct answer.

(b) **(i)** Most candidates were able to calculate the time taken, with the commonest difficulties being unable to identify the correct formula or to rearrange the formula to make Δt the subject of the equation. The graph was often inverted so that V_{OUT} increased to +10V rather than decreasing to -10V.

(ii) This part was less well answered than part (i), however, it was pleasing to see some students who were unable to attempt part (i) attempted successfully part (ii); this should be encouraged as later question parts are usually accessible independent of earlier parts. The commonest issues were failing to convert slew rate into seconds (0.5 x 106) and using the input voltage rather than the output voltage for V_P.

Q.12 **(a)** There were a few responses that clearly demonstrated the candidates lacked an understanding of the term attenuation. For those that understood the term the first part to this answer was generally well explained. Very few candidates pointed out that the frequency is unaffected by attenuation.

(b) Many candidates worked through this calculation in a clear and logical manner. Where marks were lost it was on the logarithmic rearrangement and calculation. More candidates were able to determine the power loss along the link and the overall loss thereof.

(c) This was better answered than the previous part. Common errors were not to subtract the noise from the combined output voltage for which candidates were penalised one mark and using the power equation rather than the voltage equation.

Summary of key points

- Candidates must ensure that they know which formula to use.
- Candidates should be encouraged to attempt all parts of questions and not to be put off if they are unable to answer the first part.
- Candidates need to read the questions carefully to ensure that they are answering the question that has been set. They should also take care in reading over their answer to ensure that it says what they think it says.
- Candidates need to be reminded that circuit diagrams should be drawn with the aid of a ruler.

ELECTRONICS

GCE A LEVEL

Summer 2022

COMPONENT 2: APPLICATION OF ELECTRONICS

General Comments

The general standard of answers was high. Often, mistakes happened because candidates did not read the question carefully or did not take on board the information provided. There are often clues, such as the number of lines provided and marks, as to what is expected in the answer.

Drawing signal diagrams freehand invites errors. Using a pencil makes it easier to make corrections. Karnaugh maps offer, for most, an easier, visual, route to simplifying Boolean expressions than using the rules of algebra. However, they must be drawn and processed correctly.

Comments on individual questions/sections

Q.1 Overall, a well-answered question, with many candidates scoring full marks.

(a) Most candidates made this task more difficult by drawing the signal freehand without a ruler. Most scored the mark for showing the correct mark:space ratio but many did not realise that there should be three.

(b) (i) The Data Booklet provided a formula for T_{ON} / T_{OFF} in terms of resistor values. Using this formula leads quickly to an answer of 11kΩ for resistor R_1. Many got this answer. Those who did not often tried to use other formulae, involving the value of capacitor C, which was not given.

(ii) Answers that showed the LED and resistor connected across the power rails were given no credit. A resistor in series with a LED connected between pin 3 of the 555 and 0V scored two marks only if the LED symbol and orientation were correct.

(iii) Most scored full marks on this part. Those who did not either used the wrong voltage in the Ohm’s law formula or could not expand the multiplier ‘milli’ correctly.

(c) (i) The switch and resistor in series had to connect at its mid-point to pin 2 of the 555, use correct symbols and have the correct orientation. This final factor was the most common source of lost marks.

(ii) The necessary formula was provided in the Data Booklet. Some candidates used others and lost marks. Some failed to expand the multipliers correctly.

Q.2 (a) This was usually answered correctly. The common mistake was to ignore the main sequence and progress from the ‘000’ state in S_4 to the first unused state ‘011’. ‘Error-carried-forward’ was then applied for the remainder of the question.

(b) A mixed response, some identified the correct clock period. Others realised that valve B opened for two steps in each cycle. A few scored full marks.

(c) A few candidates tried to generate answers using Boolean algebra, with varying degrees of success. Most used Karnaugh maps. However, the performance on these was not good. Often, these used binary numbering from one cell to the next instead of gray code.

Grouping cells and then identifying the groups was a problem for some.

(d) This question required understanding of stuck states. Some confused unused and stuck states.

(e) This followed on from the expressions obtained in part (c). Most answered this completely correctly. Some, however, confused the circuit with that of counters and connected the Q bar outputs back to the D-inputs. Others failed to use the Q bar outputs to generate the required signals, using NOT gates instead.

(f) This question produced mixed success. Many identified the correct Boolean expression in (i). Many scored a mark for realising that this could be generated by one additional gate. A few scored full marks.

Q.3 **(a)** At this point in the question, port B has not been defined as input or output. Some answers assumed that it was already configured as an output. Most recognised the role of the TRIS register.

(b) **(i)** It was important that candidates recognised that the microcontroller used 8-bit numbers. A few had nine bits and a few had the wrong literal. Accurate syntax was required for the second instruction.

(ii) Again, correct syntax was essential. A few candidates tried to clear TRISB.

(c) **(i)** The important factor was to recognise that the change would lengthen the delay. Some candidates implied this without stating it explicitly and were awarded the mark.

(ii) Some candidates translated the meaning of each instruction in order. This risked overlooking the effect of the combined group of commands. The mark scheme identifies the four important statements needed to specify this effect.

(d) **(i)** There were very few correct answers. Few stated that the stack stores the return address, showing where the processor left the program to execute the interrupt service routine. Some realised that its purpose is to enable the processor to return to that point once the ISR is completed.

(ii) A common mistake was to insert the mnemonics to identify the bits of the INTCON register rather than add the binary numbers that would configure it to do the required task.

(e) Some failed to "...describe..." but instead stated an advantage, such as "cheaper". Without further justification, this earned no marks.

Q.4 **(a)** Answers were often disappointing. Few candidates could identify the power amplifier.

(b) Again, often disappointing, many candidates scored only one mark.

(c) **(i)** Some used the inverting amplifier gain formula and so gained reduced credit.

(ii) Overall, most obtained the correct answer though some lost the '-' sign along the way.

(d) **(i)** Not many correct answers to this. Some realised that 6V was the correct answer but failed to justify why in part (ii).

(ii) Only a handfull of candidates scored this mark. Many were close to the answer but too vague.

(e) A two-part question, indicated by the instruction"...Explain...". Many recognised the need to block any DC component in the signal but few knew why. The best answers talked about distortion or saturation of the output.

Q.5 **(QER)** Overall, the performance on this QER question was good. Most answers covered a range of aspects.
The important factors are outlined in the mark scheme. Most worked out the voltage gain. Many used the break frequency formula, but not necessarily with the correct resistor.
The biggest issue was that this was not the circuit diagram for a bass boost filter. The best answers identified this issue, showed how to correct it and worked out voltage gain and break frequency for the corrected circuit.
Very few commented that the resistors should have values greater than 1kΩ.

Q.6 **(a)** Again, attempting to draw these signals freehand, as most candidates did, made the task much more difficult. The answers should have shown no change in pulse height but a consistent change in width (for PWM) or position (for PPM.)

(b) **(i)** Very few candidates knew the answer to this question.

(ii) This was also genarally poorly answered. Many forgot to halve the sampling frequency in part II. Only part III was well-known.

(iii) On the other hand, there were many correct answers to this part. Some made the wrong decision about whether to round up or round down the fractional answer they obtained, to give a resolution better than 0.01V.

(c) **(i)** The question asked candidates to interpret the Schmitt transfer characteristic curve, and many could not do so. Common mistakes included the effect at the threshold voltages and the value of the output saturation voltages (i.e. reading the graph.)

(ii) This proved to be too difficult for most candidates. Many produced correct diagrams showing voltages at the output and non-inverting input but were unable to use them to deduce the correct answer. Few seemed to use the idea of common current flow (and direction) through the 22kΩ resistor and resistor R. There was confusion over which threshold went with which output voltage.

Q.7 **(a)** **(i)** Not well-answered, many seemed to believe that multi-mode fibres contained a bundle of optical fibres.

(ii) Equally poorly answered, some misunderstood the question and compared optical fibre communication to other forms of communication. Some believe that multi-mode fibres, having a bundle of fibres, transmit a number of signals simultaneously.

(b) **(i)** Most answered this correctly.

(ii) Most answers were correct. Some first subtracted the wavelengths and then converted the answer to a frequency which they believed to be the bandwidth.

(iii) Usually well-answered, some had the problem identified earlier. Faced with a fractional answer to the number of channels - to round up or to round down? There were some obviously unrealistic answers, extremely high or extremely low. These were offered without comment.

(c) **(i)** Most struggled with this task. There were a variety of approaches, but few were successful. Some earned intermediate marks.

(ii) **I.** A wide variety of circuits were offered here. Some used positive feedback. Some included a second resistor, though the instructions did not mention it. Some added a second power rail. A minority were completely correct.

II. A number of candidates seemed to stumble on the answer as if by accident. They calculated the voltage across the 30kΩ resistor apparently without realising that the result was the answer to the question.

Q.8 **(a)** Most answers were correct. Some wanted to use 'voltage' as the answer to either or both parts.

(b) **(i)** Many seemed to struggle with this circuit diagram. There were incorrect symbols for zener diodes, zener diodes that were forward-biased, op-amps with input connections the wrong way round, transistors with symbols that missed off the emitter arrow and then there were circuits that were just wrong.

(ii) Many produced correct and reasoned answers to this lengthy calculation. Common errors included using the wrong voltage to calculate the resistor in series with the zener diode, incorrect interpretation of multipliers and failure to consider E24 series values.

(iii) Although many offered the correct answer to part I, few justified it correctly. A tiny minority mentioned ripple current.

Q.9 **(a)** **(i)** Usually correctly answered, some talked about "sufficient current" without specifying that it referred to anode current or mentioned gate voltage.

(ii) Here was another case where the candidate needed to describe a sequence of events - voltages at X and Y before the switch was pressed and then after, the role of the capacitor and the effect of these changes on the thyristor. Many succeeded.

(b) **(i)** Once again, a two-part question. Many correctly identified the advantage of the triac as two-way conduction. Why this is significant was identified correctly less often.

(ii) The common problem in the first graph, (V_T) was positioning the label 'X' on the vertical edge of the graph, where the voltage is changing. This was marked wrong. Most candidates scored full marks on the load voltage graph.

(c) **(i)** This was usually answered correctly. The mistake that some made was to use capacitance in the formula instead of capacitive reactance.

(ii) Many realised that reducing R would reduce the phase angle, but few realised why this would make the lamp brighter.

Summary of key points

- Read the question carefully, paying particular attention to the verb it contains:

- "Describe…" / "Explain…" / "State…" etc. have different implications for the expected answer. Look at how many lines are provided for the answer.

- Use a pencil and ruler for all diagrams.

- Explaining complex concepts requires careful planning. Think through the steps needed in your explanation before committing it to paper.

- Learn how to expand multipliers.

ELECTRONICS

GCE A LEVEL

Summer 2022

COMPONENT 3: SYSTEM DESIGN AND REALISATION TASKS – NEA

General Comments

Centres are to be congratulated for their effort in presenting candidates' work for moderation, including the online recording of centre marks.

The assessment of the work was within tolerance in the vast majority of centres but in a small number of centres adjustments to marks were required.

Candidates should focus on a problem to analyse to enable them to write a design specification based on a specific identified problem.

The majority of centres provided excellent photographic evidence, but annotation of candidate's work was quite limited. A large number of centres failed to provide any annotation. Annotation on the scripts along with an indication on the task form of which level descriptors were or were not achieved greatly aid the moderation process.

A common weakness in both tasks was in the Evaluation section. To gain the full range of marks for the evaluation candidates must make valid, critical and objective evaluation of the performance of the complete system. The evaluation should compare the system against the design specification.

A common problem was that the consequence of not having many measurable parameters in the specifications resulted in some simplistic evaluations.

Suggestions for improvement must be relevant and should state why incorporating such an improvement would be beneficial.

Comments on individual questions/sections

Task 1

With the Summer 2022 adaptations assembler programs should have been downloaded to either the candidates own circuit board or a pre-prepared/development circuit board for testing. Several centres gave full credit to candidates who did not download their programs. A number of centres submitted microcontroller projects containing light chaser sequences resulting in all candidates within the centre producing very similar programs. It is expected that the tasks are for individual identified problems by the candidates, this would be expected to produce specification parameters that are different, and with programs that have variations in structure and commands used.

For the microcontroller task at A level, candidates are required to program the microcontroller using assembly language, other programming languages are not acceptable. A small number of centres allowed candidates to produce hybrid programs that included both assembler and Basic commands. (This is possible within PICAXE but not within the MPLAB environment)

Some candidates who used the PICAXE programming environment produced programs which called delay sub-routines such as 'wait100ms'. The delay sub-routines were not listed in the template provided. All standard sub-routines are listed in the ‘Assembly Language Template’ provided on the Eduqas website. Any sub-routines called and equate statements used should be included in the task 1 template. It is important that candidates realise that these sub-routines and equate statements actually exist.

Task 2

With the Summer 2022 adaptations if physical circuits were not completed an organised physical layout for the circuit was required to gain the layout marks. A planning diagram for the breadboard, stripboard or printed circuit board was required to gain these marks.

The specification requires candidates to select their own focus for the tasks based on
An individually identified problem and this is expected to produce a wide range of tasks within a centre.
In many centres’ candidates produced a very good range of tasks with some of the work being outstanding and demonstrating considerable innovation.

A significant number of candidates struggled to provide meaningful parameters and simply quoted power supply values, current consumption or simply a list of sub-systems and/or components. A list of sub-systems and/or components to be used is not part of a specification. These may be part of the design solution to a problem but not part of the specification. A full specification should include a range of both qualitative and quantitative terms based on their analysis of the problem and contain detailed realistic electronic parameters.

A common trend was for candidates to provide extensive photograph evidence showing voltmeter reading at various stages of system development. Although this is useful it should be considered as a supplement to tabulated results rather than an alternative.
Even when tabulated test results were provided there was often very little analysis of the results.

To access the full range of marks for system realisation the use of appropriate instruments is expected. For example, measuring the mark/space ratio of an astable circuit with an oscilloscope.

Summary of key points

- Candidates should focus on a problem to analyse to enable them to write a design specification based on a specific identified problem. Good analysis of a problem should enable candidates to provide meaningful parameters with clear justification, including measurable parameters and numerical data.

- For task 1, candidates are required to program the microcontroller using assembly language. Other programming languages are not acceptable, this includes hybrid programs that are part assembler and part Basic commands.

- Test results should be tabulated, and the results should be analysed against intended performance of the sub-system/system.

- Evaluation must make valid, critical and an objective evaluation of performance against the design specification.

WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk