GCE A LEVEL MARKING SCHEME

SUMMER 2019

A LEVEL
ELECTRONICS - COMPONENT 1
A490U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

EDUQAS ELECTRONICS - A LEVEL COMPONENT 1

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response question).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

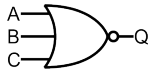
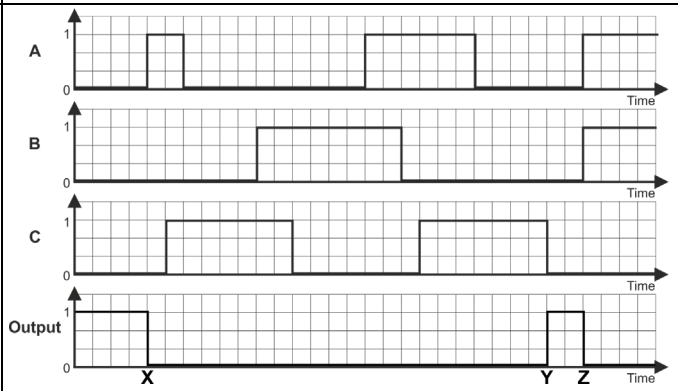
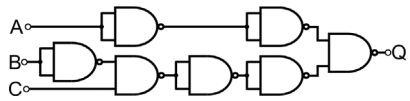
Extended response question

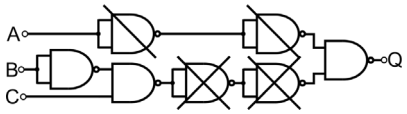
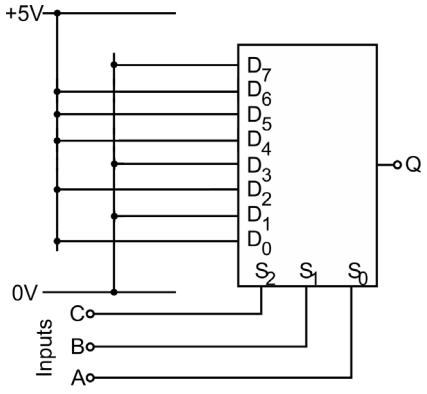
A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

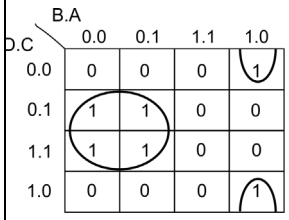
Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

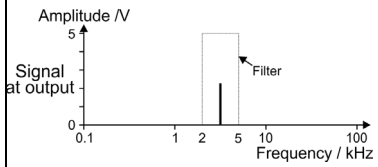
cao = correct answer only
ecf = error carried forward

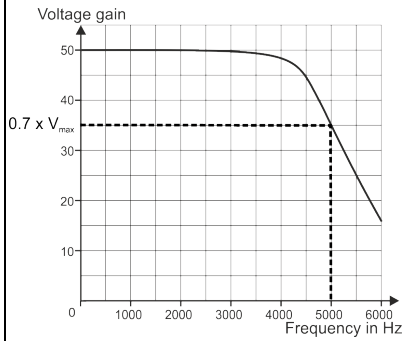
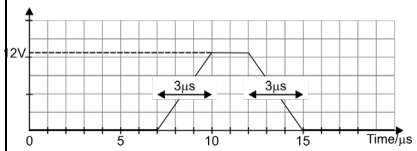
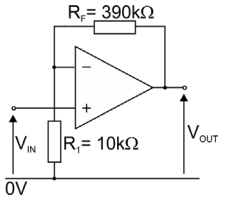
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
1.	*(a)*	i	$Q = \overline{A + B}$ [1]	1			1	
		ii	 Correct symbol [1]	1			1	1
		iii	 Correct transitions at **X**, **Y** and **Z** - one mark each (and no others) [3]	1	2		3	3
	(b)	i	C B A X Y Z Q 0 0 0 1 1 0 1 0 0 1 1 0 0 0 0 1 0 0 1 0 1 0 1 1 0 0 0 0 1 0 0 1 1 1 1 1 0 1 1 0 1 1 1 1 0 0 1 0 1 1 1 1 0 0 0 0 X column correct (= $\overline{B}$) [1] Y column correct (= $\overline{A}$) [1] Z column correct (= C.X) [1] Q column correct (= Y+Z) [1]	2	2		4	4
		ii	 NOT gate replacement (both) [1] AND gate replacement [1] OR gate replacement [1]	3			3	

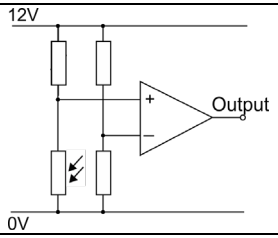
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		iii	 Any redundant pair [1] Both redundant pairs (and no others) [1]	1	1		2	
			 Correct select inputs [1] Correct data inputs [2] (inverted - one mark only)			3	3	
			Question 1 total	**9**	**5**	**3**	**17**	**8**

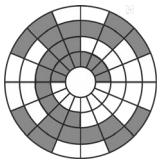
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
2.	*(a)*		**Q** = A. ($\overline{A}$ + B) = A.$\overline{A}$ + A.B = A.B Remove bracket [1] Answer [1]	1	1		2	2
	(b)		Q = $\overline{A}$.$\overline{B}$.$\overline{C}$ + $\overline{A}$.B.$\overline{C}$ + A.$\overline{B}$.C One mark per term [3]	1	2		3	3
	(c)		 Correct map [1] Biggest groups identified on map [1] Answer Q = $\overline{C}$.B.$\overline{A}$ + C.$\overline{B}$ [1]	1	2		3	3
	(d)		**Indicative content:** **When neither switch is closed -** the output of the NAND gate is logic 1 and so the LED will be on continuously. The AND and EX-OR gates both output logic 0. This part of the specification is met. **When either switch, but not both, is closed** - the output of the AND gate is still logic 0. The output of the NAND gate is still logic 1. The EX-OR output is logic 1. The LED is on continuously. This part of the specification is not met. **When both switches are closed** - the NAND gate and the EX-OR gate both output logic 0. The three-input AND gate output pulses at 2Hz, as does the OR gate output. The LED pulses at this frequency. This part of the specification is met.			6	6	6

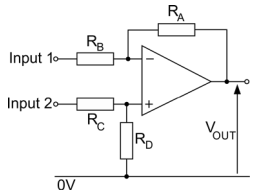
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
			Improvements - • The NAND gate should be replaced with a NOR gate. • The 2Hz pulse generator should be disconnected from the 3 input AND gate. It should be replaced by a 1Hz pulse generator (or the output of a divide-by-two subsystem whose input is connected to the 2Hz pulse generator.) **5-6 marks** A detailed analysis, including improvements, is given for all factors identified above. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** A general account is given of two of the three situations. There is an attempt to suggest improvements. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** The performance of the system is discussed in qualitative terms only. The verdict is correct for at least one of the three elements of the specification. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.* **0 marks** No attempt made or no response worthy of credit.					
			Question 2 total	**3**	**5**	**6**	**14**	**14**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3.	*(a)*	i	A passive filter has a maximum voltage gain of 1. [1] An active filter can have a gain greater or less than 1. [1] (or equivalent)	2			2	
		ii	 One frequency component remaining with correct Frequency and [1] Correct amplitude [1]		2		2	1
	(b)	i	 Straight line [1] positive gradient [1]	1	1		2	1
		ii	I Reactance = 318.3Ω [1] Use of formula [1] II Reactance of inductor = answer to I [1]	1	2		3	2
		iii	I $R_D = 0.1 \times 10^{-3} / 3 \times 1 \times 10^{-9}$ $= 33k\Omega$ [1] Use of formula [1] II $Q = 2 \times \pi \times f_0 \times L / r_L$ $=104.7$ (Accept 105) [1] Use of formula [1] III Bandwidth = $f_0 / Q = 0.5 \times 10^6 / 104.7$ $= 4775.5$Hz (Accept 4761.9Hz) [1] Use of formula [1] (Allow ecf from II)		6		6	6
			Question 5 total	**4**	**11**	**0**	**15**	**10**

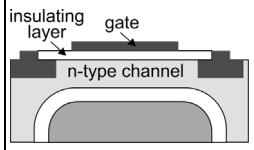
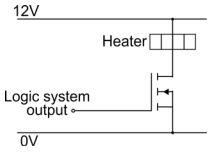
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4.	*(a)*		 Use of 0.7 and [1] Evidence of use of graph [1] Bandwidth = 5kHz [1]		3		3	2
	(b)	i	Input impedance = 12kΩ [1]	1			1	
		ii	Voltage gain = 30 [1] = 12 / 30 [1] = 0.4V [1]	1	2		3	1
		iii	 Correct max.output voltage (12V) [1] Correct timing (3µs) [1] Correct synchronisation [1] (Inverted output max 2 marks)	1	2		3	2
	(c)		 Non-inverting amp circuit [1] R_F:R_1 = 39:1 [1] All resistors > 1kΩ [1]			3	3	3
			Question 4 total	**3**	**7**	**3**	**13**	**8**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
5.	*(a)*		'Open loop' means that no proportion of the output signal is fed back to the amplifier input. (or equivalent.) [1]	1			1	
	(b)	i	 Light sensor as voltage divider [1] Correct orientation [1] (LDR connected to 0V)	1	1		2	
		ii	Switches when input voltage exceeds +8V [1] Use of voltage divider formula and comparator equation [1] (Allow ecf from (i))		2		2	2
		iii	High input impedance means that only a tiny current is drawn from the light-sensing sub-system. As a result, the signal from the light sensor is not appreciably affected. (or equivalent.) [1]	1			1	
	(c)	i	Outputs **Y** and **Z** will be in positive saturation. [1]		1		1	
		ii	**B** = 1, **A** = 0 Both correct [1] (Allow ecf from (i))		1		1	1
		iii	Flash converter completes most conversions faster than the digital ramp converter. (or equivalent) [1]	1			1	
	(d)	i	2^8 = 256 comparators [1]		1		1	1
		ii	Resolution = 100 x 10^{-3} / 2^8 Answer = 0.39mV [1] Use of formula [1] (Allow ecf from (i))	1	1		2	1
			Question 3 total	**5**	**7**	**0**	**12**	**5**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6.	*(a)*		Problem - false readings giving wrong orientation of the disc.[1] Cause - misalignment of photodiodes with segments [1]	1	1		2	
	(b)	i	Only one 'bit' changes state in rotating from one segment to the next. [1]	1			1	
		ii	 Completely correct [3] 13 segments correct - 2 marks only 10 segments correct - 1 mark only		3		3	
	(c)	i	Address: P Q R; Data bit: 7 6 5 4 3 2 1 0; LED lit 0 0 0 1 0 0 0 0 0 0 0 **N** 0 0 1 0 1 0 0 0 0 0 0 **NW** 0 1 0 0 0 1 0 0 0 0 0 **SE** 0 1 1 0 0 0 1 0 0 0 0 **S** 1 0 0 0 0 0 0 1 0 0 0 **NE** 1 0 1 0 0 0 0 0 1 0 0 **W** 1 1 0 0 0 0 0 0 0 1 0 **E** 1 1 1 0 0 0 0 0 0 0 1 **SW** Completely correct [3] 5 LEDs correct - 2 marks only 4 LEDs correct - 1 marks only		3		3	
		ii	5 ring disc - 2^5 segments so 32 directions [1]		1		1	1
			Question 6 total	**2**	**8**	**0**	**10**	**1**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
7.	*(a)*	i	Bridge circuit [1]	1			1	
		ii	Current through 2kΩ resistors = 12 / (2+2) = 3mA Voltage across lower 2kΩ resistor = voltage at P = 6V [1] Use of above or voltage divider formula [1] Current through variable resistor = 12 / (1.75+2) = 3.2mA Voltage across variable resistor = voltage at Q = 6.4V [1] Use of above or voltage divider formula [1] V_{OUT} = 6.4 - 6.0 = 0.4V [1]	1	4		5	4
	(b)	i	The leads act as aerials and pick up noise signals. Generally, the longer the lead, the greater the amplitude of the noise signal. Or equivalent answer. [1]	1			1	
		ii	The leads connecting the sub-systems are probably of similar length and so pick up similar sized noise signals. [1] The circuit amplifies only the difference between the voltage at **P** and that at **Q**. [1] The noise signals appear equally on both and so are not amplified.	2			2	
		ii	Voltage gain = 9 / 0.3 = 30 [1] R_A/R_B = 30 [1] R_A = R_D and R_B = R_C AND all resistors > 1kΩ [1]  Inverting input circuit correct [1] Non-inverting input correct [1]			5	5	3
			Question 7 total	**5**	**4**	**5**	**14**	**7**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8.	*(a)*	i	Noise - additional signal from an external source. [1] Distortion - modification to signal frequency spectrum because of internal system non-linearity. [1] (or equivalents)	2			2	
		ii	Nearby electric motor, e.g. vacuum cleaner. [1] (or equivalent)		1		1	
		iii	S:N = $10\log_{10}$ (5 / 0.001) = 37dB [1] Use of formula [1]		2		2	2
	(b)		Attenuation - signal amplitude decreases as it passes down the cable due to energy losses such as generation of heat. (or equivalent) [1]	1			1	
	(c)		No. of voice channels = $1.5 \times 10^6 / 3 \times 10^3$ = 500 [1] Use of formula [1]		2		2	2
	(d)	i	TDM - signals are broken into small sections. Each signal source sends one section in turn. [1] (or equivalent)	1			1	
		ii	Advantage of multiplexing - fewer cables needed, so cheaper, to transmit a given volume of data. [1] (or equivalent)	1			1	
			Question 8 total	**5**	**5**	**0**	**10**	**4**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9.	*(a)*		 n-type channel labelled correctly [1] insulating layer labelled correctly [1] gate terminal labelled correctly [1]	3			3	
	(b)		Bipolar transistor - a small change in input (base) current causes a much larger change in output (collector) current (or equivalent) [1] MOSFET - a small change in gate voltage produces a large change in drain current. (or equivalent) [1]	2			2	
	(c)	i	Total current = 750mA (or evidence) [1] R = V / I = 9.5 / 750 [1] = 12.7Ω [1] so choose 13Ω [1]	2	2		4	3
		ii	Base current = collector current / h_{FE} = 750/100 = 7.5 mA [1] The logic gate cannot source sufficient current. [1] The transistor will not switch on fully. [1] (or equivalent)		2	1	3	1
	(d)	i	The MOSFET has a huge input impedance and so draws a tiny current. The resulting heating of the MOSFET is minimal. The device does not need a current-limiting resistor. [1]	1			1	
		ii	 Use of correct circuit symbol [1] Correct connections (x3) [1]	2			2	

Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
		iii	I When heater fully on, drain current = 5A gm = 5 / 10 - 3 = 0.7S II MOSFET dissipates power = I_D^2 x R_{DSON} (Use of formula) Use of 5A (allow ecf from I) = 5W	[1] [1] [1] [1] [1]	2	3		5	3
			Question 9 total		**12**	**7**	**1**	**20**	**7**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
10.	*(a)*		Light has greater frequency and so higher data transfer capacity [1] Contained in an optical fibre, no information can 'leak' and so the system is more secure. [1] or equivalent	2			2	
	(b)		Electrical noise adds 'spikes' to signal. These cause temporary changes to the amplitude. In amplitude modulation, the signal is carried as an amplitude variation and so the noise can be seen as part of the signal.[1] In frequency modulation, the amplitude of the carrier is irrelevant and so electrical noise does not affect the signal.[1]	1	1		2	
	(c)	i	Carrier frequency = 1 / 1 x 10^{-6} = 1MHz (+/- 0.1MHz) [1] Use of formula [1]		2		2	2
		ii	Carrier wavelength = 3 x 10^{8}/ 1 x 10^{6} (ecf from (i)) Use of formula [1] = 300m [1]		2		2	2
		iii	Depth of modulation = [(7 - 3) / (7 + 3)] x 100% Use of formula [1] = 40% [1]		2		2	2
		iv	Inability to recover original signal (or equivalent) [1]	1			1	
	(d)	i	The modulation index is $\frac{\left(\frac{(200.1 - 199.9)\times 10^{6}}{2}\right)}{10 \times 10^{3}} = 10$ [1] Use of formula [1]		2		2	2
		ii	Bandwidth = 2[(1+10) x 10 x 10^{3}] = 220kHz [1] Use of formula [1]		2		2	2
			Question 10 total	**4**	**11**	**0**	**15**	**10**

ELECTRONICS A COMPONENT 1

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	9	5	3	17	8
2	3	5	6	14	14
3	4	11	0	15	10
4	3	7	3	13	8
5	5	7	0	12	5
6	2	8	0	10	1
7	5	4	5	14	7
8	5	5	0	10	4
9	12	7	1	20	7
10	4	11	0	15	10
TOTAL	**52**	**70**	**18**	**140**	**73**