GCE AS MARKING SCHEME

SUMMER 2022

A LEVEL
ELECTRONICS – COMPONENT 2
A490U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2022 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 A LEVEL ELECTRONICS – COMPONENT 2

SUMMER 2022 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.

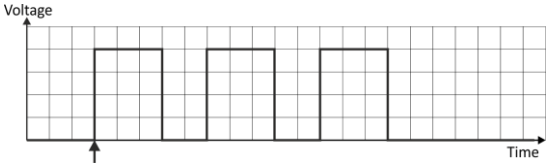
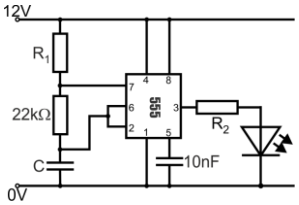
Extended response question

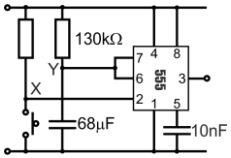
A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide 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

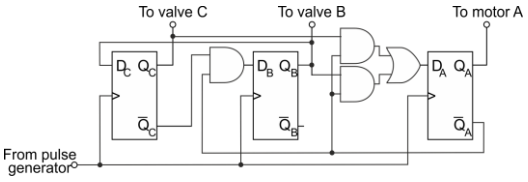
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
1.	(a)		 3 pulses [1] Timing (3:2) [1]		2		2	2
	(b)	(i)	From $T_{ON} / T_{OFF} = (R_1 + R_2) / R_2$ $R_1 = (1.5 \times 22 \times 10^3) - 22x10^3 = 11k\Omega$ Select formula and substitute values [1] Re-arrange formula [1] Answer [1]	1	2		3	2
		(ii)	 R_2 in series with LED [1] Correct orientation for LED [1]	2			2	
		(iii)	Voltage drop across resistor = 12 - 3.2 = 8.8V [1] From $R = V/I$, $R_2 = 8.8 / 30x10^{-3} = 293\Omega$ Interpretation of multiplier [1] Answer [1]	1	2		3	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(c)	(i)	 Switch unit (any orientation) [1] Correct orientation [1]		2		2	2
		(ii)	T = 1.1 RC = 9.7s Select formula [1] Substitute values [1] Answer [1]	1	2		3	2
			Question 1 total	**5**	**10**	**0**	**15**	**10**

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="5">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th></tr>
<tr><td>2.</td><td>(a)</td><td></td><td>
<table>
<tr><th></th><th>C</th><th>B</th><th>A</th><th>D_C</th><th>D_B</th><th>D_A</th></tr>
<tr><td>S_0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>S_1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>S_2</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>S_3</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>S_4</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
</table>
Completely correct [2]
One mistake only - 1 mark
</td><td></td><td>2</td><td></td><td>2</td><td>2</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Duration of each state = 1 / 0.2 = 5s [1]
Valve B is on in two states, so on for 10s per cycle [1]
(Allow ecf from (a)(i))</td><td></td><td>2</td><td></td><td>2</td><td>2</td></tr>
<tr><td></td><td>(c)</td><td></td><td>D_C = B [1]
Derivation from Boolean algebra or Karnaugh map [1]
D_B = $\mathbf{\overline{C} . \overline{A}}$ [1]
Derivation from Boolean algebra or Karnaugh map [1]
D_A = $\mathbf{C.\overline{A} + B.\overline{A}}$ One mark per term [2]
Derivation from Boolean algebra or Karnaugh map [1]
(or equivalent answers. Allow ecf from (a)(i))</td><td>1</td><td>6</td><td></td><td>7</td><td>4</td></tr>
<tr><td></td><td>(d)</td><td></td><td>There are no stuck states [1]
All unused states lead into the main sequence. [1]
(or equivalent answer.)</td><td>1</td><td>1</td><td></td><td>2</td><td></td></tr>
</table>

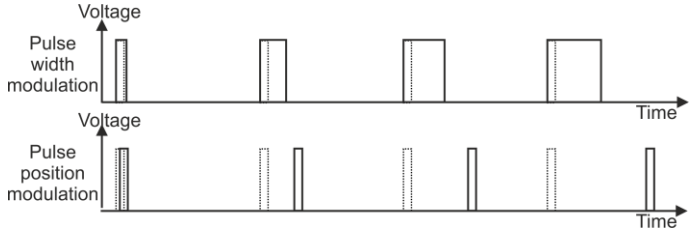
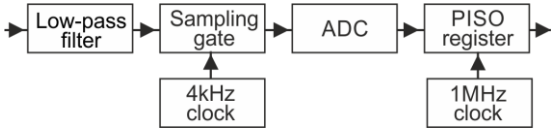
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(e)		 Signals to data inputs correct - 1 mark each x 3 inputs [3] Clock connections correct [1] Use of $\overline{Q}$ outputs to provide NOT function, throughout. [1] (or equivalent. Allow ecf from (c))	1	3	1	5	3
	(f)	(i)	$X = \overline{C} . \overline{B} . A$ [1]			1	1	
		(ii)	One gate needed [1]		1		1	
			Question 2 total	**3**	**15**	**2**	**20**	**11**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3.	(a)		PORTB transfers data between the outside world and the microcontroller. [1] TRISB controls the direction in which that data flows [1]	2			2	
	(b)	(i)	movlw b'xx1100xx' (x = don't care') [1] movwf PORTB [1]	1	1		2	1
		(ii)	clrf PORTB [1] bsf PORTB,4 [1] bsf PORTB,5 [1] (or reverse order)		3		3	1
	(c)	(i)	d'120' increases the length of the delay [1] (or equivalent answer.)		1		1	
		(ii)	The contents of the 'count' register are decremented with the result retained in the file register. [1] The result is checked. [1] Until it reaches zero, the program then jumps back to the label 'repeat'. [1] When it reaches zero, the subroutine ends. [1]		3	1	4	
	(d)	(i)	On interrupt, the current instruction is completed, the address of the subsequent instruction is stored on the stack and the main program execution is then suspended. [1] When the ISR is finished, the processor retrieves the address of the next instruction from the stack and continues with the main program. [1] (or equivalent answer.)	2			2	

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(ii)	<table><tr><td>b 7</td><td>b 6</td><td>b 5</td><td>b 4</td><td>b 3</td><td>b 2</td><td>b 1</td><td>b 0</td></tr><tr><td>1</td><td>x</td><td>x</td><td>1</td><td>x</td><td>x</td><td>0</td><td>x</td></tr></table> (x = don't care') Bits 7, 4 and 1 correct - 1 mark each [3]		3		3	
	(e)		Benefits such as: • ability to modify delays without changing hardware; • ability to change sequence without changing hardware. (or equivalent answer.) 1 mark per advantage [1]		1		1	
			Question 3 total	**5**	**12**	**1**	**18**	**2**

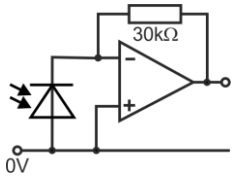
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4.	(a)	(i)	Pre-amplifier = A or B [1]	1			1	
		(ii)	Power amplifier = E [1]	1			1	
	(b)	(i)	Input impedance of amp A is infinite. [1]	1			1	
		(ii)	Input impedance of amp D is 10kΩ. [1]	1			1	
	(c)	(i)	Voltage gain of amp A = 1 + 270/4.7 = 58.4 [1] Voltage at W **=** 58.4 x 10 = 584mV (or 0.58V) [1] Use of formulae [1]	1	2		3	2
		(ii)	Using mixer gain formula, voltage at Z = - 150 (0.02 / 150 + 0.06 / 300) = - 0.05V Use of formula [1] Answer [1]		2		2	2
	(d)	(i)	Most appropriate voltage at Q = 6V [1]	1			1	
		(ii)	Allows maximum voltage swing across the loudspeaker without distortion. [1]		1		1	1
	(e)		To remove any stray DC voltage present in the output of amp C which otherwise will be amplified in the following stage [1] and could cause the output to saturate, creating distortion of the audio signal. [1] (or equivalent answer)	2			2	
			Question 4 total	**8**	**5**	**0**	**13**	**5**

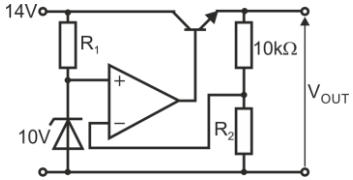
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
5.			**Indicative content:** **Boost bass frequencies –** wrong circuit. The one shown is a bass cut filter. The answer contains the correct circuit diagram. **Break frequency = 200Hz –** with current component values arranged as correct type of filter. The one shown, cuts frequencies below 998Hz (994.7Hz.) **High frequency gain = 5 –** the resistor ratio is correct for this gain, but the resistor values should both be >1kΩ. **5-6 marks** A detailed analysis of the system is given, including calculations for voltage gain and break frequency. All factors identified above are evaluated accurately. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** The analysis includes one calculation. Two of the factors, break frequency, high frequency gain and / or type of filter are evaluated accurately. *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 circuit is identified as incorrect for a bass boost filter. *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.			6	6	
			Question 5 total	**0**	**0**	**6**	**6**	**0**

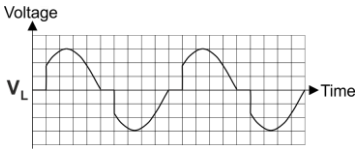
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6.	(a)		 Evidence of PWM in upper graph [1] Consistently drawn [1] Evidence of PPM in lower graph [1] Consistently drawn [1]	2	2		4	4
	(b)	(i)	 Upper four blocks correct [1] Clocks correct [1]	2			2	
		(ii)	I. Sampling gate produces a PAM output signal. [1] II. Highest signal frequency = 2kHz [1] III. Low-pass filter cuts out higher frequencies. [1]	2	1		3	1
		(iii)	Resolution = $10 / 2^n$ where n = no. of bits = < 0.01V Selection of formula [1] Use of formula [1] Minimum number of bits = 10 [1]		3		3	3

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(c)	(i)	Voltage starts at -11V and stays there until input reaches 7V. The output rises to +11V and stays there until input reaches 12V Identification and use of saturation voltages [1] Identification and use of threshold voltages [1]		2		2	2
		(ii)	Threshold occurs when non-inv. input sits at +1V. In positive sat., voltage across 22kΩ resistor = (11 - 1) = 10V. Threshold = -4V so voltage across R = (-4 - 1) = -5V. Hence R must be half the size of 22kΩ = 11kΩ. Evaluation of voltage across 22kΩ [1] Evaluation of voltage across R [1] (or equivalent for negative saturation)		2		2	2
			Question 6 total	**6**	**10**	**0**	**16**	**12**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
7.	(a)	(i)	Single-mode fibres - smaller diameter than multi-mode, [1] (or equivalent answer.)	1			1	
		(ii)	Single-mode - All light constrained to travel down the same path so less prone to modal dispersion, so can travel greater distances. It is more expensive. Multi-mode - Light has a range of routes down the fibre and so suffers more modal dispersion, reducing the transmission range. It is cheaper to produce/instal. Discussion of dispersion / transmission modes [1] Implication for transmission range [1] Discussion of relative costs [1] (or equivalent answers.)	3			3	
	(b)	(i)	Reason - Attenuation is less at these wavelengths OR - fewer regenerators are needed. [1] (or equivalent answer.)	1			1	
		(ii)	Bandwidth = ($2x10^8$ / 1535 x 10^{-9}) - ($2x10^8$ / 1565 x 10^{-9}) = 2.498 x 10^{12}Hz (Accept 2.49 - 2.5 x 10^{12}Hz) Use of $c=f\lambda$ formula [1] Interpretation of multipliers [1] Working [1] Answer [1]	1	3		4	3

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(iii)	No. of channels = bandwidth / channel width = $2.5 \times 10^{12} / 18 \times 10^{9} = 138.9$ rounded down to 138 Working [1] Answer [1] ecf (ii)		2		2	2
	(c)	(i)	Energy transmitted per second = 3J Energy transmitted per pulse = 3 / 6000J [1] This is transmitted in 500ns, so power per pulse = $3 / (6000 \times 500 \times 10^{-9})$ [1] = 1kW [1] (or equivalent answer.)		3		3	3
		(ii)	 I 30kΩ resistor correct [1] Op-amp inputs correct [1] Photodiode connected correctly [1]	2				3
			II Photodiode current = 0.2mA = current through 30kΩ resistor [1] Voltage drop across resistor = 0.2 x 30 [1] Output voltage = 6V (ignore +/-) [1]		1 3		3 3	
			Question 7 total	**8**	**12**	**0**	**20**	**11**

Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
8.	(a)	(i)	**Load** regulation….	[1]	1			1	
		(ii)	**Line** regulation….	[1]	1			1	
	(b)	(i)			4			4	
			Zener diode sub-system correct	[1]					
			Op-amp connected correctly	[1]					
			Emitter follower correct	[1]					
			Voltage divider across output	[1]					
		(ii)	When zener is in reverse breakdown,						
			voltage across R_1 = 18 - 10 = 8V	[1]					
			use of Current through zener = 40mA	[1]			4	4	4
			as op-amp input current ~0						
			Ideal value of R_1 = 8 / 40 = 0.2kΩ	[1]					
			E24 value = 200Ω AND labelled	[1]					
			Using $V_{OUT} \approx V_Z (1 + R_F / R_2)$	[1]					
			$R_2 = R_F / (V_{OUT} / V_Z) - 1$	[1]					
			= 50kΩ	[1]			4	4	4
			E24 value above this = 51kΩ AND labelled	[1]					
			(or accept 47kΩ)						
		(iii)	I. Zener current (average) decreases (or varies).	[1]					
			II. Load current causes ripple voltage. (or equivalent)	[1]	1	1		2	2
			Question 8 total		**7**	**1**	**8**	**16**	**10**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9.	(a)	(i)	Anode-cathode current must be > holding current rating. [1] (or equivalent)	1			1	
		(ii)	Before S_2 is closed, voltage at X = 0V (approx) and voltage at Y =24V [1] i.e. voltage across capacitor = 24V (approx) After S_2 is closed, voltage at Y =0V. [1] Capacitor has not had time to charge / discharge and so still has 24V across it. Voltage at X = -24V (approx). [1] Thyristor is reverse-biased and switches off [1] (or equivalent answers.)	2	2		4	2
	(b)	(i)	Triac conducts during both half-cycles of the supply [1] and so offers greater energy efficiency. [1] (or equivalent)	2			2	
		(ii)	I. Point 'X' labelled anywhere where V_T = 0V [1] II.  Correct shape [1] Correct synchronisation [1]	2	1		3	3

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(c)	(i)	$X_C = 1 / 2 \pi 50\ 0.33x10^{-6} = 9646\Omega$ (Accept 9645.8Ω) Use of formula [1] Answer [1] $\phi = \tan^{-1}(22x10^3 / 9646) = 66^O$ Use of formula [1] Answer [1]	2	2		4	4
		(ii)	As R reduces, ϕ reduces [1] Lamp is switched on for greater proportion of power cycle and so is brighter. [1] (or equivalent)	2			2	1
			Question 9 total	**11**	**5**	**0**	**16**	**10**

ELECTRONICS A LEVEL – COMPONENT 2

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	5	10	0	**15**	10
2	3	15	2	**20**	11
3	5	12	1	**18**	2
4	8	5	0	**13**	5
5	0	0	6	**6**	0
6	6	10	0	**16**	12
7	8	12	0	**20**	11
8	7	1	8	**16**	10
9	11	5	0	**16**	10
TOTAL	**53**	**70**	**17**	**140**	**71**