GCE A LEVEL MARKING SCHEME

AUTUMN 2021

A LEVEL
ELECTRONICS – COMPONENT 2
A490U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2021 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

AUTUMN 2021 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.

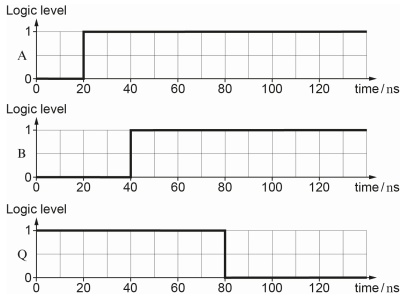
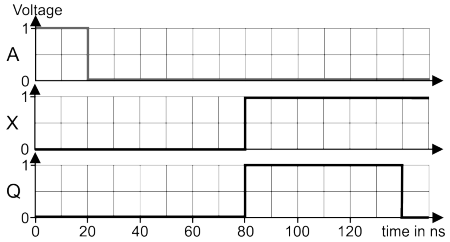
Extended response question

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

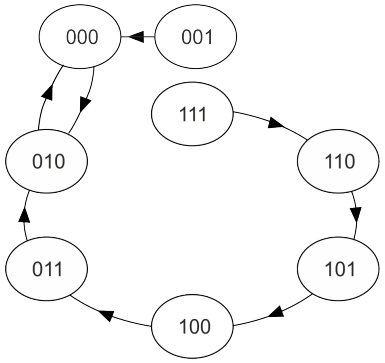
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
1.	*(a)*	(i)	 Correct logic [1] Correct timing [1]	1	1		2	1
		(ii)	 For X: Correct logic [1] Correct timing [1] For Q: Correct logic [1] Correct timing [1]	2	2		4	2
	(b)	(i)	YX = 11 [1]		1		1	1
		(ii)	Decimal = 3 [1] Hex = 3 [1] Allow ecf from binary answer to dec and hex answers.		2		2	2
		(iii)	Freq. at X = 1Hz[1] Freq. at Y = half of freq at X [1] Freq. at Z = freq at Y [1]	1	2		3	2
			Question 1 total	**4**	**8**	**0**	**12**	**8**

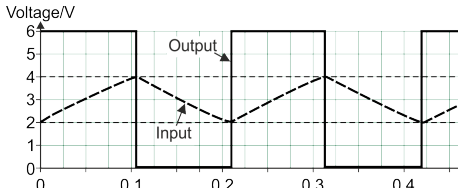
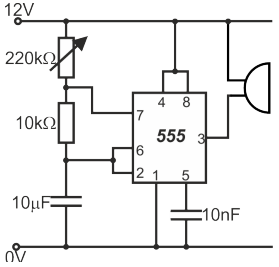
<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="5">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>$\mathbf{D_C} = \mathbf{C} \,.\, (\mathbf{B} + \mathbf{A})$ [1]
$\mathbf{D_B} = \overline{\mathbf{B} \oplus \mathbf{A}}$ [1]
$\mathbf{D_A} = \mathbf{C} \,.\, \overline{\mathbf{A}}$ [1]</td><td></td><td>3</td><td></td><td>3</td><td>3</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th>C</th><th>B</th><th>A</th><th>D_C</th><th>D_B</th><th>D_A</th></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
</table>
$\mathbf{D_C}$ column correct [1]
$\mathbf{D_B}$ column correct [1]
$\mathbf{D_A}$ column correct [1]

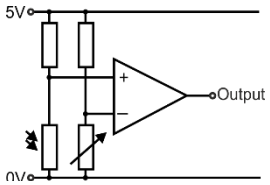
(Allow e.c.f.) from (a)
</td><td></td><td>3</td><td></td><td>3</td><td>3</td></tr>
<tr><td></td><td>(c)</td><td></td><td>Indicative content:

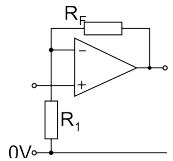
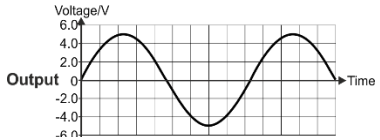
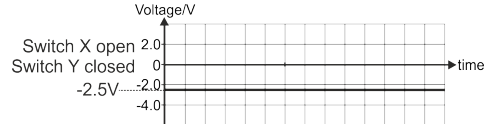
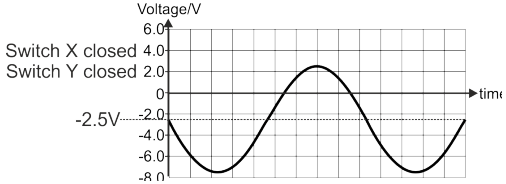
State diagram:
 
</td><td>2</td><td></td><td>4</td><td>6</td><td></td></tr>
</table>

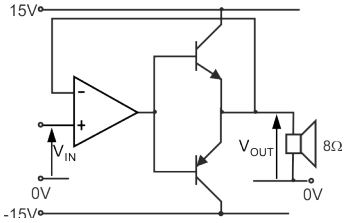
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(c)		**Indicative content:** **Count Down switch -** meets the spec. - starts counting when closed. **Always starts counting on '7'** - does not meet the spec. It continues counting from its previous state, if the power supply is not disconnected, or from a random state on power up. **Counts down from '7' to '0'** - providing that it starts in the main sequence at '7', the count proceeds as a down count until it reaches the number '2' (010). Then it jumps to zero. It does not meet the spec. **Stops counting when it reaches '0'** - does not meet the spec. It reaches '000' but then enters a loop, alternating between '000' and '010'. **5-6 marks** A detailed analysis of the system is given, including the state diagram. 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 a correct state diagram. Most factors identified above are evaluated accurately. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.*					

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
			1-2 marks The performance of the system is discussed in qualitative terms only. The main sequence of the state diagram is given and is correct. Two of the factors are evaluated correctly. *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	**2**	**6**	**4**	**12**	**6**

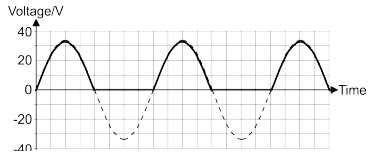
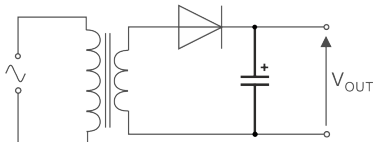
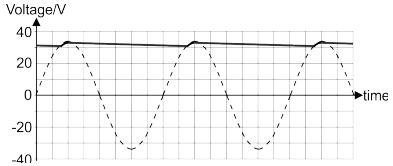
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3.	*(a)*	(i)	Time constant = RC = 100 x 10^3 x 2.2 x 10^{-6} = 0.22s [1]		1		1	1
		(ii)	Time to charge to 4V = -RC ln (1 - V_C/V_0) = -0.22 ln (1 - 4/6) = 0.24s [1] Time to charge to 2V = -0.22 ln (1 - 2/6) = 0.09s [1] Time to charge from 2V to 4V = 0.24 - 0.09 [1] = 0.15s [1] Use of formula or equivalent solution. [1]	2	3		5	4
	(b)	(i)	Frequency ~ 4.5Hz [1]		1		1	1
		(ii)	 Timing correct [1] Thresholds correct [1] Logic correct [1] Output voltages [1]	1	3		4	3
	(c)	(i)	 Connections for pins 1, 3, 4 and 8 [1] Timing network correct [1] Buzzer correct [1] 0.6 = 1.44 / (R_1 + 2 x 10k) 10 x 10^{-6} Use of formula [1] Var. res. value = 220kΩ [1] (Accept values in the range 220 to 250kΩ)	2		3	5	3
			Question 3 total	**5**	**8**	**3**	**16**	**12**

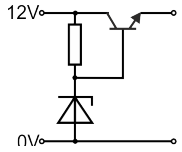
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4.	*(a)*		 Two voltage dividers on inputs [2] Ability to adjust threshold [1] Correct orientation [1] or equivalent solution	1		3	4	
	(b)		sensor_check clrf **PORTB** [1] btfsc PORTA,0 goto **light** [1] **btfsc** PORTA,1 [1] goto buzz **goto** sensor_check [1] light bsf **PORTB,1** [1] goto sensor_check buzz **bsf** PORTB,2 [1] **call** onesec [1] goto **sensor_check** [1]	1	7		8	
	(c)	(i)	102 goto **fire** [1] 103 **retfie** [1]	1	1		2	
		(ii)	Line 100 switches on the siren [1] Line 101 tests the state of the reset switch. If pressed, the ISR ends. If not pressed, the siren continues to sound. on the siren (or equivalent answers) [1]	1	1		2	
			Question 4 total	**4**	**9**	**3**	**16**	**0**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
5.	*(a)*	(i)	 Circuit correct [1] $R_F = 99 \times R_1$ [1] All resistors > 1kΩ [1]			3	3	1
		(ii)	 Correct amplitude (5V) [1] Correct phase [1]	1	1		2	1
		(iii)	Bandwidth = $10 \times 10^6 / 100 = 10^5$ [1] Audio frequency range = 20kHz so much smaller. [1] (or equivalent)	1	1		2	1
	(b)	(i)	 Correct shape [1] Correct voltage (-2.5V) [1]	1	1		2	1
		(ii)	 Correct shape (inverted) [1] Correct amplitude (5V) [1] Correct position (-2.5V) [1]	1	2		3	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(c)	(i)	 Collectors to power rails [1] Common base to op-amp output [1] Common emitter to L/S [1] Op-amp inputs correct [1] Negative feedback correct [1]	3	2		5	
		(ii)	Optimum output impedance = 8Ω [1]	1			1	
			Question 5 total	**8**	**7**	**3**	**18**	**6**

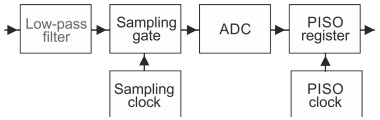
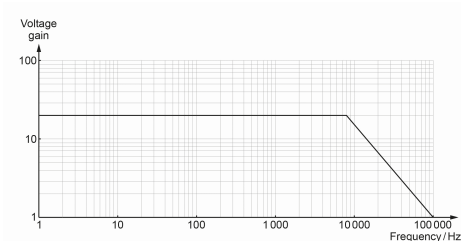
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6.	*(a)*		Audio frequency range is 20Hz to 20kHz. Sampling frequency is more than twice highest audio freq. [1] (or equivalent)	1			1	
	(b)		Bit rate = no. of samples per second x no. of bits per sample = 50,000 x 12 = 600kbps [1] File size = bit rate x duration of sampling = 600,000 x 20 x 60 = 720Mb [1] Use of formulae [1]	1	2		3	2
			Question 6 total	**2**	**2**	**0**	**4**	**2**

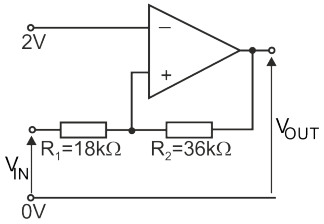
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
7.	*(a)*		 No negative voltage [1] Half-wave signal [1]	1	1		2	1
	(b)	(i)	 Correct connections [1] Polarity correct [1]		2		2	
		(ii)	Ripple voltage = I / f x C = 1.8V (Accept 1.82V) Use of formula [1] Correct answer [1]	1	1		2	2
		(iii)	 Evidence of ripple [1] Accurate level of ripple [1] (Accept initial growth from 0V)		2		2	2
		(iv)	Modify circuit to full-wave rectifier [1] Increase value of capacitance [1]	2			2	

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	(c)	(i)	Using P=IxV, I = P/V = 500/8.2 = 61mA Use of re-arranged formula [1] Answer with correct multiplier [1]	1	1		2	2
		(ii)	Using V = IxR, R = V/I = (15-8.2) / 61 x 10^{-3} = 110Ω Use of re-arranged formula [1] Evidence of voltage drop calculation across R [1] Answer [1]	1	2		3	3
		(iii)	Maximum output current = 61-5=56mA [1] Output voltage = 8.2V [1] Using V = IxR, R = V/I = 8.2/56 x 10^{-3} = 146Ω [1]	1	2		3	3
	(d)	(i)	 All connections correct [1]	1			1	
		(ii)	New Zener voltage = VOUT + Voltage drop across transistor = 8.2 + 0.7 [1] = 8.9 V [1]	1	1		2	
		(iii)	Resistor Zener circuit only regulating transistor instead of load, lower power required.	1			1	
			Question 7 total	**9**	**13**	**0**	**22**	**16**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8.	*(a)*	(i)	Thyristor conducts in ony one direction. A triac can conduct in both. (or equivalent) [1]	1			1	
		(ii)	Forward bias [1] Sufficient gate current [1] (or equivalent)	2			2	
	(b)	(i)	Rapid turn-on. (or equivalent) [1]	1			1	
		(ii)	Increasing resistance reduces brightness of the lamp. (or equivalent) [1] It increases the phase shift between V_C and V_S OR [1] It delays the turn-on each half-cycle	1	1		2	
	(c)	(i)	12 squares = 1 cycle = 1/50s = 20ms [1] Triac is 'on' for 8 squares each cycle = 13.3ms [1] (or equivalent)		2		2	2
		(ii)	Forward breakover voltage = 40V [1]		1		1	
		(iii)	V_C lags by one square = 1/12th of a cycle 1 cycle = 360^0, hence [1] phase difference = 30^0 lag [1]		2		2	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(iv)	$R = X_C \tan \phi$ $X_C = 1 / (2 \pi 50\,680 \times 10^{-9}) = 4681\Omega$ $\tan 45 = 1$ $R = 4.7k\Omega$ (Accept $4.68k\Omega$) [1] Use of $\tan \phi$ formula [1] Calculation of X_C [1]	1	2		3	2
			Question 8 total	**6**	**8**	**0**	**14**	**6**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
9.	*(a)*		 Sampling gate and clock [1] ADC [1] PISO register and clock [1]	3			3	
	(b)	(i)	$f_B = 1 / (2 \pi 360 \times 10^3 \times 0.1 \times 10^{-9})$ Use of 360kΩ resistor [1] Break freq. = 4.4kHz (Accept 4.42kHz) [1] Use of formula [1]	1	2		3	2
		(ii)	 Correct low freq. gain 20 [1] Correct break freq. 4.4kHz [1] Correct shape [1] (Allow e.c.f. from (i)	1	2		3	2
	(c)		The staircase waveform is passed through a low pass filter, which 'smoothes out' quantisation steps. (or equivalent.) [1]	1			1	
	(d)	(i)	Output saturates at +10V/-10V [1] Switching thresholds are +8V/-2V [1]		2		2	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(ii)	 Circuit diagram correct [1] In positive sat: $(10 - 2) / R_2 = (2 - -2) / R_1$ In negative sat: $(8 - 2) / R_1 = (2 - -10) / R_2$ Calculation of resistor ratio [1] $R_2 = 2 \times R_1$ [1] Resistors > 1kΩ [1]			4	4	3
	(e)	(i)	One sample occurs every 1/12000s. In this time, SIPO clock processes the 10 bits in the sample. Maximum SIPO period is 1/12000 x 10 s [1] Minimum SIPO frequency = 12000 x 10 = 120kHz. [1]	1	1		2	2
		(ii)	10 bits creates 2^{10} voltage levels separated by 3mV. [1] Biggest output is $(2^{10}-1)$x3mV = 3.07V. (Accept 3.1V) [1] (or equivalent approach)		2		2	2
			Question 9 total	**7**	**9**	**4**	**20**	**13**

<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>10</td><td>(a)</td><td></td><td>Does not transmit e/m radiation [1]
Difficult to tap without affecting the whole transmission [1]
(or equivalent)</td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th>Property</th><th>LED</th><th>L D</th></tr>
<tr><td>Cost</td><td>Low</td><td>High</td></tr>
<tr><td>Power output</td><td>Low</td><td>High</td></tr>
<tr><td>Speed</td><td>Low</td><td>High</td></tr>
<tr><td>Frequency range</td><td>High</td><td>Low</td></tr>
</table>
LED correct [1]
LD correct [1]
</td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td>Less attenuation than for visible light [1]
so fewer repeaters needed. [1]</td><td>2</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Question 10 total</td><td>6</td><td>0</td><td>0</td><td>6</td><td>0</td></tr>
</table>

A LEVEL ELECTRONICS - COMPONENT 2

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	4	8	0	12	8
2	2	6	4	12	6
3	5	8	3	16	12
4	4	9	3	16	0
5	8	7	3	18	6
6	2	2	0	4	2
7	9	13	0	22	16
8	6	8	0	14	6
9	7	9	4	20	13
10	6	0	0	6	0
TOTAL	**53**	**70**	**17**	**140**	**69**