



GCE A LEVEL MARKING SCHEME

SUMMER 2024

**A LEVEL
ELECTRONICS – COMPONENT 2
A490U20-1**

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

EDUQAS A LEVEL ELECTRONICS – COMPONENT 2

APPLICATION OF ELECTRONICS

SUMMER 2024 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.

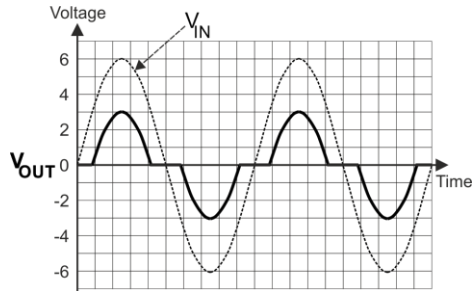
Marking abbreviations

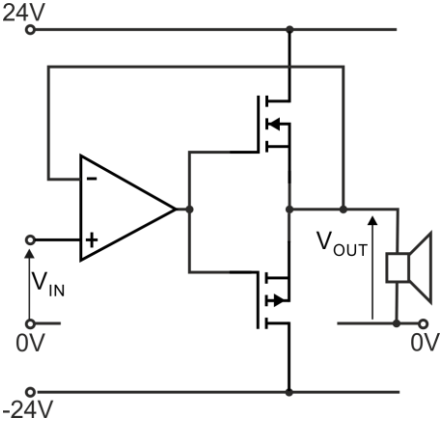
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

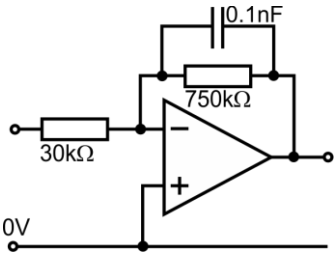
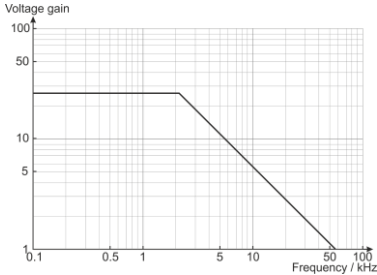
Question			Marking details				Marks available																																																																
							AO1	AO2	AO3	Total	Maths																																																												
1	a	(i)	Four states in the main sequence. [1]					1		1	1																																																												
		(ii)	Unused state: '111', '010' or '101' [1]				1			1																																																													
		(iii)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th colspan="3">Current Outputs</th> <th colspan="3">Next Outputs</th> </tr> <tr> <th>C</th> <th>B</th> <th>A</th> <th>D_C</th> <th>D_B</th> <th>D_A</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</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>0</td><td>1</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</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>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr> </tbody> </table> <p>Main sequence correct, with next states [1] Non-stuck unused states each with next state correct [1] Stuck state with next state correct [1]</p>				Current Outputs			Next Outputs			C	B	A	D _C	D _B	D _A	0	0	0	1	1	0	1	1	0	0	1	1	0	1	1	0	0	1	0	0	1	0	0	0	1	1	1	0	1	0	0	1	0	0	0	0	1	0	1	0	1	1	1	0	0	1	0	0		1		3	1
Current Outputs			Next Outputs																																																																				
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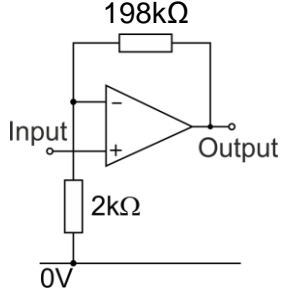
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
2	a		Purpose is to set up / configure ports (A and B) or equivalent answer [1]	1			1	
	b		Instruction in line 138 executed 4 times. [1] On fifth decrement, program skips line 138 (or equivalent) [1] Answer 5 – no marks		2		2	2
	c		Switch is connected to Port A [1] bit 0 [1]		2		2	1
	d		Switch checked in line 132 [1]		1		1	
	e		After execution, file 'count' contains '2'. [1]		1		1	1
	f		Processor checks zero flag in status register. If flag is set, then 'count' contains zero. Mention of status register [1] Mention of zero flag [1] Zero flag set [1] (or equivalent)	2	1		3	
	g	(i)	New instruction is: (start) movlw b'00001010' (value correct) [1]		1		1	1
		(ii)	Instruction occurs at line 134. [1]		1		1	1
Question 2 total				3	9	0	12	6

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3	a	(i)	LED - forward biased	[2]	2		2	
		(ii)	Photodiode - reverse biased.					
		(iii)	Silicon diode - reverse biased					
		(iv)	Thyristor anode-cathode - forward biased					
			All correct					
			One mistake - subtract 1 mark					
	b	(i)	Gate terminal is B	[1]	1		1	
		(ii)	Conducting channel is F	[1]	1		1	
		(iii)	Insulator is G	[1]	1		1	
	c	(i)	 <p>Crossover distortion [1] Pos. and neg. voltage components [1] Accuracy [1]</p>		2	1	3	3
		(ii)	Crossover distortion	[1]	1		1	

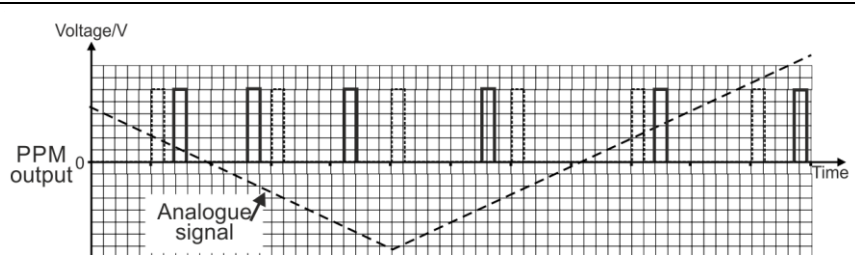
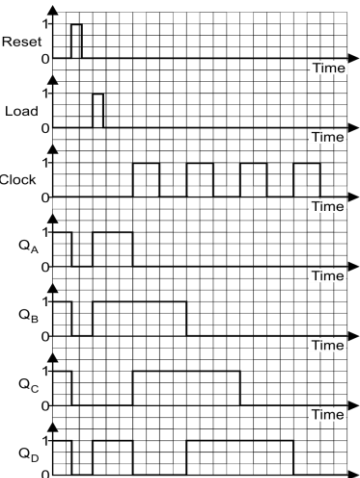
Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
	(iii)	 <p>Op-amp output connection correct [1] Inverting input connection correct [1] Non-inv. input connection correct ecf [1]</p>	3			3	
	(iv)	<p>Using $P_{MAX} = \frac{V_S^2}{8R_L}$ [1]</p> <p>Maximum output power = $\frac{48^2}{8 \times 8}$ [1] = 36 (W) [1]</p> <p>(Max. 2 if 24V used, answer 9W)</p>		3		3	2
Question 3 total			11	4	0	15	5

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4	a	(i)	Advantage such as: Greater bandwidth / greater information-carrying capacity / immune to electromagnetic interference / security of information [1] Disadvantage such as: Expensive (e.g. to install) / glass is weak structurally / transmission confined to fibre and not in free space. [1]	1	1		2	
		(ii)	Cable loss = $40 \times 0.8 = 32\text{dB}$ [1] Total gain = $15 + 15 - 32$ ecf = -2dB [1] -2 ecf = $10 \log \frac{P_{\text{OUT}}}{P_{\text{IN}}} = 10 \log \frac{P_{\text{OUT}}}{25}$ [1] Rearrange formula [1] $P_{\text{OUT}} = 15.8 \text{ m(W)}$ [1]	1	4		5	4
	b	(i)	Highest signal frequency = $\frac{1}{2}$ sampling clock frequency = 10 k(Hz) [1]		1		1	1
		(ii)	No. of sampling levels = 2^n where n = no. of bits $= 2^{12}$ [1] = 4096 levels [1]		2		2	2
		(iii)	Sampling gate period = $(20 \times 10^3)^{-1} = 5 \times 10^{-5} \text{ s}$ PISO register period = $(5 \times 10^6)^{-1} = 2 \times 10^{-7} \text{ s}$ Max no of channels = $\frac{\text{sampling period ecf}}{\text{no of bits} \times \text{PISO period ecf}}$ or equivalent $= \frac{5 \times 10^{-5}}{12 \times 2 \times 10^{-7}}$ [1] $= 20$ (20.83 rounded down) [1] Correct use of sampling gate frequency [1] Correct use of PISO frequency [1] Multipliers used correctly [1]		4		5	4
Question 4 total				3	12	0	15	11

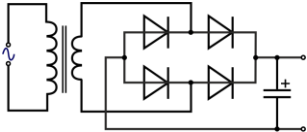
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
5	a	(i)	Using $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 100 \times 4.7 \times 10^{-9}} = 339 \text{ k}(\Omega)$ Populated formula [1] Answer [1]	1	1		2	1
		(ii)	$V_{OUT} \approx 0V$ (accept calculation giving 0.14 / 0.15V) Reactance of capacitor is large compared to value of resistor so nearly all voltage is dropped across capacitor (or equivalent.) Answer [1] Reason (or equivalent) [1]		2		2	1
	b		Active filters do not need a buffer when connected to a low impedance load. [1] Active filters can provide voltage gain >1. [1] (or equivalent)	2			2	
	c	(i)	 <p>Resistor connections and V^+ connection correct [1] Capacitor in parallel [1] Capacitor in feedback loop [1] Break frequency = $1/2\pi RC$ Hence correct feedback resistor [1] Gain = $-R_F / R_{IN} = 25$ (both > 1k) Hence correct input resistor ecf [1]</p>			5	5	
		(ii)	 <p>Shape of graph [1] Break freq. [1] Horizontal gain [1] 45 (+/- 2) degree roll-off [1]</p>	2	2		4	4
Question 5 total				5	5	5	15	6

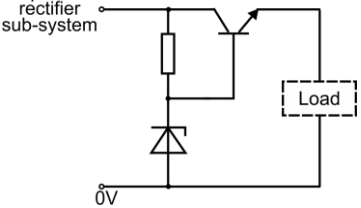
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6	a	(i)	 <p>Suitable circuit [1] Correct gain (100) [1] Input impedance >1MΩ [1] Bandwidth calculated (50kHz) [1] Resistors ≥1kΩ [1]</p>			5	5	4
		(ii)	Input impedance must be » output impedance of microphone [1] to reduce loss of voltage transferred from microphone [1]	2			2	
	b	(i)	Range of voltages at X is 0V to 2V [1]	1			1	
		(ii)	Correct populated formula [1] = - 1.4 (V) (accept +1.4) [1]	1	1		2	2
Question 6 total				4	1	5	10	6

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
7	a	Time constant = $RC = 150 \times 10^3 \times 100 \times 10^{-6}$ = 15 (s) [1] [1]		2		2	1
	b	Using half-life = $0.69RC$, (or use of charging formula) [1] time to reach 6V = $0.69 \times 15 = 10.4$ (s) [1]	1	1		2	1
	c	Capacitor cannot be re-used (No provision to discharge). Circuit not adjustable. Component tolerances. Only works when connected to a high input impedance device. Any other valid point. [1 mark per point, max 2]	2			2	
		Question 7 total	3	3	0	6	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8	a	(i)	 <p>Pulses shifted along time axis, with pulse height & width unchanged [1] Pulse displacement direction consistent [1] Pulse displacement proportional [1]</p>	1	2		3	2
		(ii)	<p>Interference affects amplitude [1] but PPM information is conveyed by displacement [1]</p>	2			2	
		b	(i)	<p>I. equivalent decimal number = $(8 + 0 + 2 + 1) = 11$ [1] II. equivalent hexadecimal number = B [1]</p>		2		2
		(ii)	 <p>Effect of reset [1] Effect of load [1] Rising edge triggering only [1] Effect of clock pulses [2]</p> <p>One mistake - subtract 1 mark</p>	2	3		5	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(iii)	'P' - 4 bits are loaded simultaneously by the 'Load' signal 'S' - each bit is delivered from Q _D consecutively, starting with the most-significant bit. Explanation of parallel [1] Explanation of serial [1]	2			2	
			Question 8 total	7	7	0	14	6

Question		Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths
9	a		Two diodes only added [1] Diode polarity correct [1] Smoothing capacitor with correct polarity [1]	3			3	
	b	(i)	Voltage V across resistor = 5V [1] From $I = V/R$, current through resistor = $5/10 = 0.5A = 500mA$ [1] Allowing 10mA to keep zener in breakdown, max. $I_{OUT} = 500 \text{ ecf} - 10 = 490 \text{ m(A)}$ [1]		3		3	2
		(ii)	Max power dissipated in zener when $I_{OUT} = 0$ i.e. $I_{Zener} = 500mA$ [1] Power dissipated in zener = $I_{Zener} \times V_{Zener} = 500 \times 10 = 5000 \text{ m(W)} = 5 \text{ (W)}$ [1]		2		2	1
		(iii)	Zener diode holds voltage across resistor constant at 5V so current through it is constant and power dissipated in it ($= I \times V$) is constant. Allow any 2 of I, V and R remain constant [1]	1			1	
	c	(i)	Ripple voltage $V_r = \frac{I}{f_r C} = \frac{0.5 \text{ (ecf from bi)}}{100 \times 2200 \times 10^{-6}} [1] = 2.3 \text{ (V)}$ [1] Use of 50Hz, answer 4.5V – 1 mark		2		2	2
		(ii)	I Minimum supply voltage = $15 - 2.3 \text{ ecf from i} = 12.7 \text{ (V)}$ [1] Minimum voltage across 10Ω resistor = $12.7 - 10V = 2.7 \text{ (V)}$ [1] II Minimum current through 10Ω resistor = $2.7 \text{ ecf} / 10 = 0.27 \text{ (A)}$ [1]		3		3	3
		(iii)	Max. output current reduced to $270 \text{ ecf} - 10 = 260 \text{ m(A)}$ [1] [1]		2		2	2

Question		Marking details	Marks available						
			AO1	AO2	AO3	Total	Maths		
	<i>d</i>	(i)	Smaller variation in zener current means smaller variation in output voltage or Reduced max current through zener so lower power rating needed. [1]		1			1	
		(ii)	<p>Output from rectifier sub-system</p>  <p>Emitter connected correctly [1] Base connected correctly [1] Collector connected correctly [1]</p>	3			3		
			Question 9 total	8	12	0	20	10	

Question		Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths
10	a		When S ₁ or S ₂ is pressed, the alarm is triggered (or thyristor is fired). [1] When S ₃ is pressed, the alarm is reset (or thyristor is reset). [1]	2			2	
	b	(i) (ii)	Alarm off - voltage at X = 12 V [1] Alarm on - voltage at X = 0 V [1]		2		2	
	c		Voltage across R ₁ = 12 - 1.5 = 10.5V [1] Current through R ₁ must be at least 20mA Maximum value of R ₁ = $\frac{10.5}{20} = 0.525 \text{ k}\Omega$ [1] ($\frac{12}{20} = 0.6 \text{ k}\Omega - 1 \text{ mark}$)		2		2	1
	d	(i)	Switch S ₃ pressed {briefly / at time 5s} [1]		1		1	
		(ii)	Initially thyristor is switched on. Alarm is on or Voltage at X = 0V and at Y = 12V [1] When S ₃ is pressed, at t = 5s, voltage at Y drops to 0V. Voltage at X must drop by same amount, i.e. to -12V. [1] Thyristor is reverse biased and turns off. [1] Then capacitor charges through R ₂ until voltage at X = 12V. [1]	2	2		4	
Question 10 total				4	7	0	11	1

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
11		<p>Indicative content:</p> <p>Power supply - 9V 600mAh. Voltage is correct. Total current demand = $15 \times 8 = 120\text{mA}$ (because of M:S) + 10mA (555 IC). Battery will 'run out' after $600 / 130 = 4.6\text{h}$ - does not meet spec.</p> <p>Protective resistor - total current = 180mA. Voltage drop across resistor = $7 - 2 = 5\text{V}$, so resistor should be $5 / 180 = 27\Omega$, so correct value.</p> <p>LED frequency - meets spec. - frequency = 1.02Hz.</p> <p>LED M:S - correct - 2:1.</p> <p>5-6 marks A detailed analysis of the system is given. All factors identified above are considered and evaluated using appropriate calculations. <i>There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.</i></p> <p>3-4 marks At least 3 factors identified above are evaluated accurately, supported by some calculation. <i>There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.</i></p> <p>1-2 marks The performance of the system is discussed in qualitative terms only. At least 1 of the factors outlined above is evaluated correctly. <i>There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.</i></p> <p>0 marks No attempt made or no response worthy of credit.</p>			6	6	
		Question 11 total			6	6	

Electronics A Component 2

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	5	10	1	16	10
2	3	9	0	12	6
3	11	4	0	15	5
4	3	12	0	15	11
5	5	5	5	15	6
6	4	1	5	10	6
7	3	3	0	6	2
8	7	7	0	14	6
9	8	12	0	20	10
10	4	7	0	11	1
11	0	0	6	6	0
TOTAL	53	70	17	140	63