GCE A LEVEL MARKING SCHEME

AUTUMN 2020

A LEVEL
ELECTRONICS – COMPONENT 2
A490U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2020 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 2020 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.
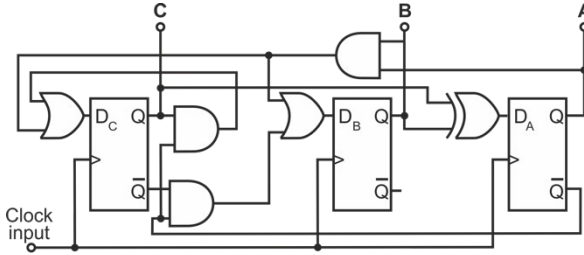
<u>Marking abbreviations</u>

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)*		Reset correct. Correct behaviour on three rising edges All items correct [2] Only two of the four items correct - one mark only	1	1		2	2
	(b)	(i)	$\overline{Q}$ to D connections [1] Clock connections [1] Outputs and MSB identified [1]	1	2		3	
		(ii)	In a synchronous counter, all stages are clocked at exactly the same time whereas in an asynchronous counter they receive clock signals at different times. [1] (or equivalent answer)	1			1	
	(c)		$X = \overline{\overline{B}}$ [1] $Y = \overline{C + B}$ [1] $Z = B \oplus A$ [1] Reset at **C** = 1, **B** = 1 [1]	1	2	1	4	3

Question			Marking details	AO1	AO2	AO3	Total	Maths
	(d)	(i)	<table><tr><td>Step</td><td>B</td><td>A</td><td>L</td><td>M</td></tr><tr><td>1</td><td>0</td><td>1</td><td>**0**</td><td>**1**</td></tr><tr><td>2</td><td>1</td><td>0</td><td>**1**</td><td>**0**</td></tr><tr><td>3</td><td>1</td><td>1</td><td>**1**</td><td>**0**</td></tr><tr><td>4</td><td>0</td><td>0</td><td></td><td></td></tr></table> One mark per correct row. [3]	1	2		3	3
			Question 1 total	**5**	**7**	**1**	**13**	**8**
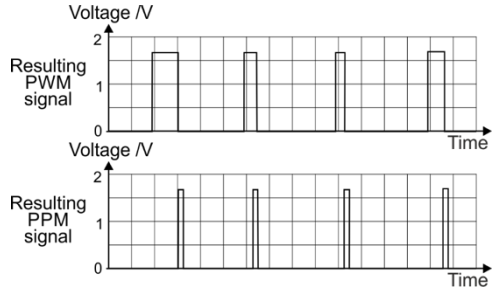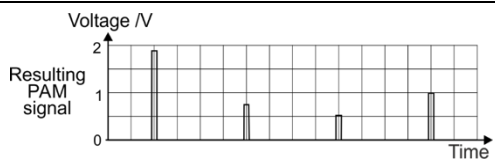
Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
2.	*(a)*		CBAD$_C$D$_B$D$_A$ table All eight rows correct [1]			1		1	
	(b)		$D_A = C.\overline{B} + \overline{C}.B$ (or $C \oplus B$) [2] $D_B = B.A = \overline{C}.\overline{A}$ One mark per term [1] $D_C = C.\overline{A} = B.A$ [1] (Allow unsimplified answers)			4		4	4
	(c)		Clock correct [1] D$_A$ correct [1] D$_B$ correct [1] D$_C$ correct [1] Gate count correct [1]			1	4	5	
			Question 2 total		**0**	**6**	**4**	**10**	**4**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3.	*(a)*		**movlw b'xxxx0000'** Use of TRISB [1] **movwf TRISB** Literal correct [1]		2		2	2

	(b)		**Indicative content:**
			
			Problems:
			
			Line 122 - should be **btfss** as otherwise the program lights team Y LED
			              when its switch is not pressed. (or swap lines 123 + 124)
			
			Line 125 - the instruction switches on only the buzzer.
			
			Line 126 - the instruction to initiate a subroutine is **call** not **goto**.
			
			Lines 127 / 130 - the goto instructions should return to the label init as
			              otherwise the buzzer / LED do not switch off.
			
			Line 128 - the instruction switches on the LED but not the buzzer.
			
			The program as a whole does not lock out the opposing team once a switch is pressed. After two seconds, both LEDs and buzzers can be switched on.
			
			Improvements:
			
			Line 125 should be followed by an extra instruction **bsf PORTB,1**, to switch on the LED as well.
			
			Line 128 should be followed by an extra instruction **bsf PORTB,2**, to switch on the buzzer as well.
						6	6	6
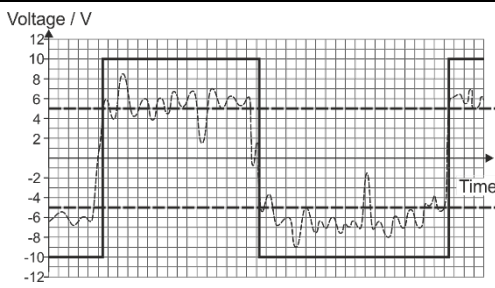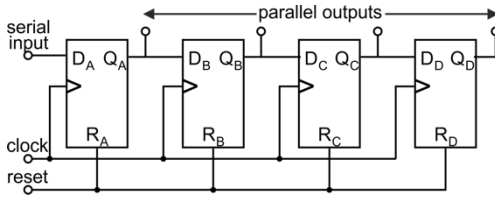
Question				Marking details	Marks available				
					AO1	AO2	AO3	Total	Maths
				5-6 marks A detailed analysis is given for all factors identified above. All faults are corrected. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** A general account is given of three issues involved including their correction. *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 program is discussed in qualitative terms only. At least two problems are identified and at least one solution is given. *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			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths

	(c)		117 'label' btfsc PORTA,3
			118 goto ready
			119 goto 'label'
			         Use of bit testing **AND** correct operand [1]
			         Use of 'goto' to locate start of main program [1]
			         Correct program logic [1]
			
			Other solutions are possible, using 'btfss' for example, and will be accepted.
					3		3	3

			Question 3 total	**0**	**5**	**6**	**11**	**11**
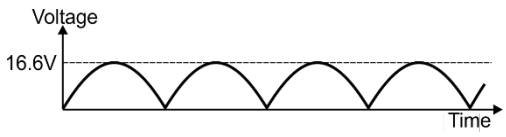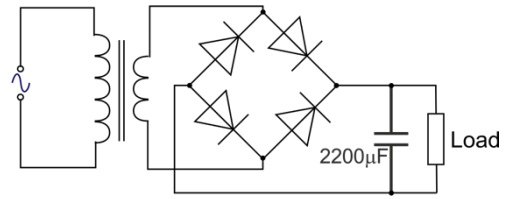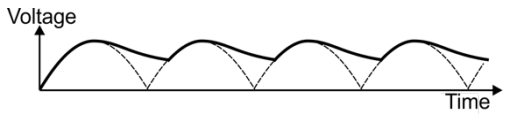
Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
4.	*(a)*	(i)	Time taken = 0.69RC = 3.2s. [1] Use of formula [1] Use of T = RC alone earns no marks.		1	1		2	2
		(ii)	Voltage drop across R = 12 - 2 = 10V [1] From Ohm's law R = V/I = 10/20 = 0.5kΩ [1]		1	1		2	2
		(iii)	Initially LED is off and comes on after 3.2s [1] (allow ecf from (ii)) It then stays on for the remaining time. [1] Opposite behaviour - 1 mark only		1	1		2	
	(b)	(i)	Pins 4 and 8 connected to 12V [1] RC network added [1] and connected to pins 6 and 7 [1]		2	1		3	
		(ii)	t = - 100 x 10^3 x 47 x 10^{-6} x ln(1 - 6/9) = 5.2s Use of charging formula [1] Correct answer [1]		1	1		2	2
			Question 4 total		6	5	0	11	6

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
5.	*(a)*		For each graph: correct procedure - 1 mark accuracy - 1 mark [4] (Pulses cannot begin before the initial pulses occur - 1 mark only)	2	2		4	4
	(b)		Correct procedure - 1 mark Accuracy - 1 mark [2] (Allow 'sample-and-hold' waveform)	1	1		2	2
	(c)	(i)	Recognition of highest signal frequency = 4kHz [1] Application of Nyquist theorem [1]	1	1		2	
		(ii)	Problem such as aliasing, (or equivalent) [1]	1			1	
		(iii)	Resolution = 4.9mV [1] Use of formula [1]	1	1		2	2

		(iv)	Sampling period = 100μs [1] PISO period = 0.69μs [1] No. of signals = $\underline{100}$ 10 x 0.69 = 14.5 Max No. of signals = 14 [1] Use of formulae [1]	1	3		4	3
			Question 5 total	7	8	0	15	11

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6.	*(a)*		Dispersion: • velocity of light through the glass depends on the wavelength of the light. [1] • problem - leads to spreading of the signal pulses so that eventually they overlap sufficiently to lead to errors. (or equivalent answers) [1]	2			2	
	(b)		Defects addressed by regeneration: • noise - additional signals coming from external sources; [1] • attenuation - reduction in signal amplitude because of energy losses in transmission. (or equivalent answers) [1]	2			2	
	(c)	(i)	Calculation of 0 to 1 threshold (= +5V) [2] Calculation of 1 to 0 threshold (= -5V) [2]		4		4	4
		(ii)	Non-inverting [1] 0 to 1 threshold (+5V) [1] 1 to 0 threshold (-5V) [1] Saturation voltages [1]		4		4	4
	(d)	(i)	Labels [1] Clock correct [1] Q to next D [1] Reset [1]			4	4	
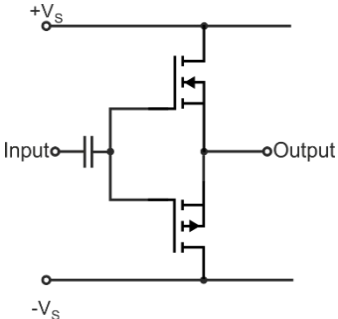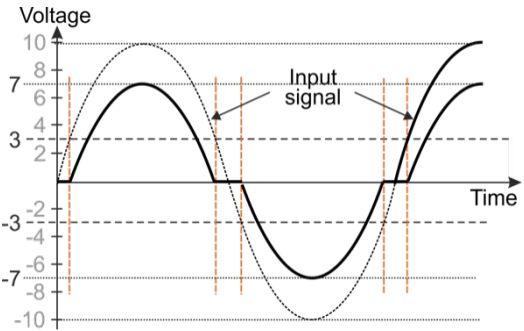
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(ii)	QA signal correct [1] QB signal correct [1] QC AND QD correct [1] (allow ecf from QA)		3		3	3
			Question 6 total	**4**	**11**	**4**	**19**	**11**
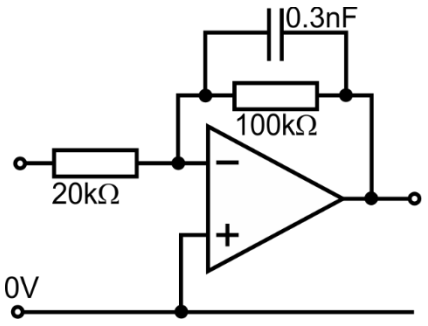
Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
7.	*(a)*		Peak voltage = V$_{RMS}$ x $\sqrt{2}$ = 339.4V Use of formula [1] Correct answer [1]		1	1		2	1
	(b)	(i)	Peak output voltage = 18 -1.4 = 16.6V [1]			1		1	1
		(ii)	DC waveform [1] Full wave waveform [1]		1	1		2	1
		(iii)	Capacitor connected correctly [1]		1			1	
		(iv)	Evidence of smoothing [1]		0	1		1	1
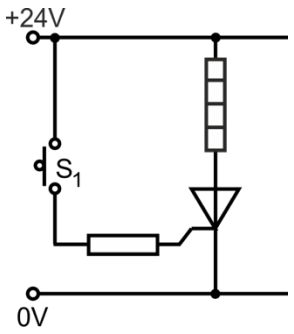
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(v)	Ripple voltage = I / f x C = 0.23V Use of formula [1] Correct answer [1]	1	1		2	2
			Question 7 total	**4**	**5**	**0**	**9**	**6**
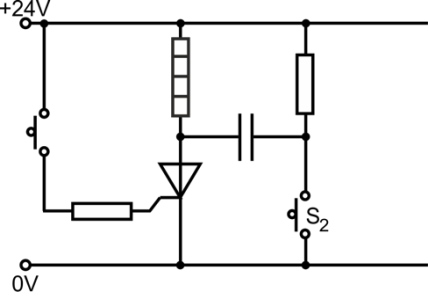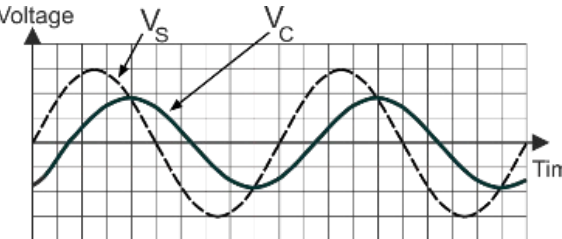
Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
8.	*(a)*	(i)	Voltage across resistor = 5V [1] Current through resistor = 5 / 20 = 0.25A = 250mA [1] Allowing 10mA to flow through the zener leaves 240mA available as output current [1]		1	2		3	3
		(ii)	Power rating for resistor = 0.25^2 x 20 $\qquad\qquad\qquad$ = 1.25W Use of formula [1] Correct answer [1] Maximum current through zener = 0.25A Power rating = 10 x 0.25 $\qquad\qquad$ = 2.5W Use of formula [1] Correct answer [1]		1	3		4	4
	(b)	(i)	Short-circuit current = 15 / 3 = 5A Use of formula [1] Correct answer [1]		1	1		2	2
		(ii)	When V_{OUT} = 10V, voltage across equivalent resistor = 5V [1] Output current = 5 / 3 = 1.67A [1] Load resistor = 10 / 1.67 = 6Ω [1]			3		3	3
			Question 8 total		**3**	**9**	**0**	**12**	**12**
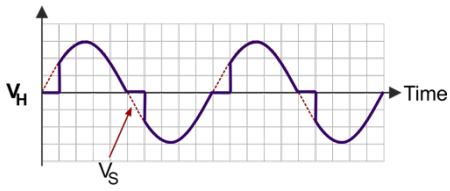
Question			Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths
9.	*(a)*	(i)	mixer	= **E**	[1]	3			3	
		(ii)	pre-amp	= **C or D**	[1]					
		(iii)	power amp	= **G**	[1]					
	(b)	(i)	Voltage at the inverting input = 0V	[1]	1			1	
		(ii)	V_{OUT} = -10(5/100 + 5/100 + 5/100) = -1.5V		1	2		3	2
			Use of variable resistor set to 0Ω	[1]					
			Use of formula	[1]					
			Correct answer (must be negative)	[1]					
	(c)	(i)	Non-inverting amp has higher input impedance and so draws less current from the signal source	[1]	1			1	
			or equivalent.						
		(ii)	Gain = 1 + R_F / R_1 = 48	[1]	1	1		2	2
			V_{OUT} = V_{IN} x gain						
			= 48 x 0.17 = 8.2V (accept 8.16V)	[1]					
			(Allow ecf from gain calculation)						
		(iii)	Voltage at X = 0.12V	[1]	1			1	

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
(d)	(i)		Use of complementary pair [1] Power supply connections [1] Common source connection [1] (Circuit symbols must be correct)	2	1		3	
	(ii)		Capacitor blocks any DC signal component, avoiding distortion [1]	1			1	
	(iii)		Correct shape [1] +ve and -ve [1] 7V / -7V labels [1]	1	2		3	2

Question	Marking details	Marks available				
		AO1	AO2	AO3	Total	Maths
(e)	Correct low frequency gain [1] Correct break frequency [1] Capacitor in parallel [1] Capacitor in feedback loop [1] Non-circ to 0V [1]	2		3	5	2
	Question 9 total	**14**	**6**	**3**	**23**	**8**

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
10.	*(a)*		Advantage such as no moving parts so no mechanical wear　　[1]	1			1	
	(b)	(i)	Switch unit　　[1] connected to gate　　[1]	2			2	
		(ii)	Max resistance = (24 - min gate voltage) / min gate current =4.64kΩ Use of formula　　[1] Correct answer　　[1]	1	1		2	1
		(iii)	Holding current = 12mA　　[1]		1		1	

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(iv)	Resistor connection correct [1] Switch connection correct [1] Capacitor connection correct [1]	2	1		3	
	(c)	(i)	Sine wave [1] Correct phase angle (±0.5sq) [1] Phase lag [1]	1	2		3	2
		(ii)	1R = X_C x tan ϕ = 3.18 x 1 = 3.18kΩ Use of formula [1] Correct answer [1]	1	1		2	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
		(iii)	Correct shape [1] +ve and -ve [1] Rest of VS [1]	1	2		3	2
			Question 10 total	**9**	**8**	**0**	**17**	**7**

A LEVEL ELECTRONICS - COMPONENT 2

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS
1	5	7	1	13	8
2	0	6	4	10	4
3	0	5	6	11	11
4	6	5	0	11	6
5	7	8	0	15	11
6	4	11	4	19	11
7	4	5	0	9	6
8	3	9	0	12	12
9	14	6	3	23	8
10	9	8	0	17	7
TOTAL	52	70	18	140	84

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