OCR
RECOGNISING ACHIEVEMENT

GCE

Electronics

Advanced Subsidiary GCE

Unit **F612:** Signal Processors

Mark Scheme for June 2012

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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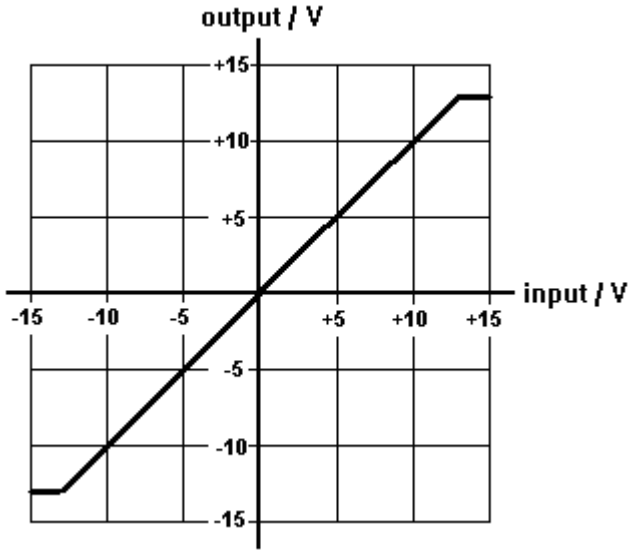
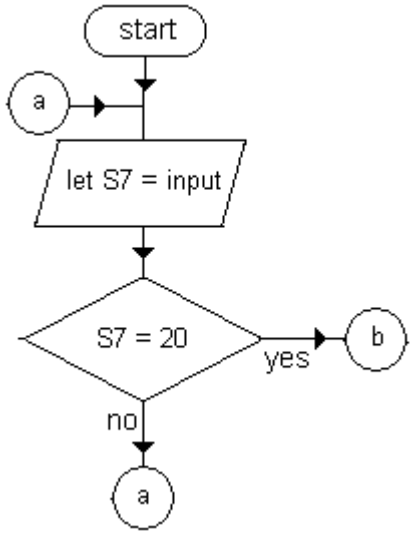
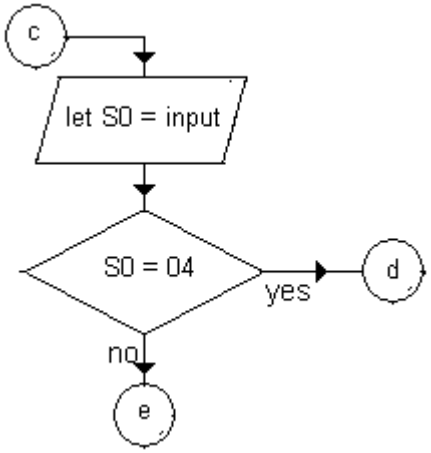
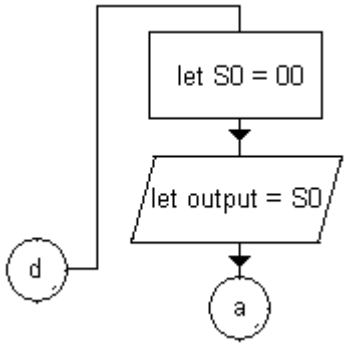
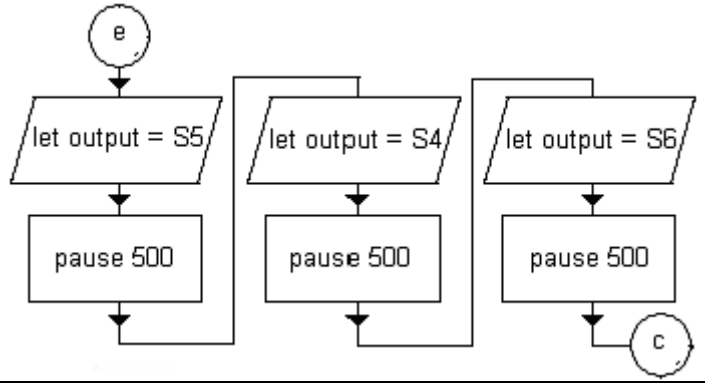
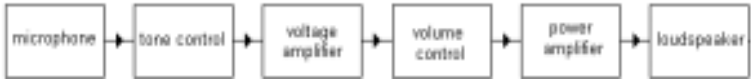
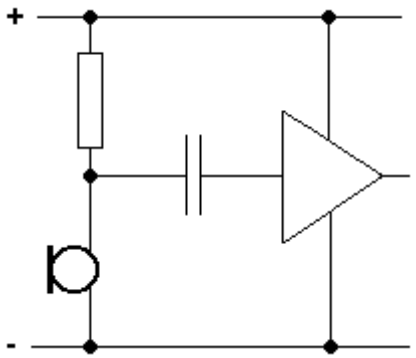
Question			Answer	Marks	Guidance
1	(a)			3	straight line through origin [1] gradient of +1 [1] saturating at +13 V and -13 V (± 1 V by eye) [1]
	(b)		power amplifier	1	
	(c)	(i)	any two of the following [1] each: • V_+ = voltage at X, V_- = voltage at Y; V_{out} = voltage at Z, • A is op-amp gain without any feedback; • voltage at output divided by difference at inputs; • when op-amp not saturated;	2	**accept** signal for voltage **reject** current / charge / power for voltage **accept** $A = \frac{V_{out}}{V_+ - V_-}$ instead of words
		(ii)	6.0 V	1	accept 5.95 V
		(iii)	$I = V/R$ (eor); = 6/16 = 0.375 A;	1 1	**accept** reverse calculation with $V = IR$ (not $R = V/I$) for [2] no ecf from incorrect V:
		(iv)	$P = VI$ = 2.25W	1	allow ecf from incorrect V, I 400 mA gives 2.4 W for [1]

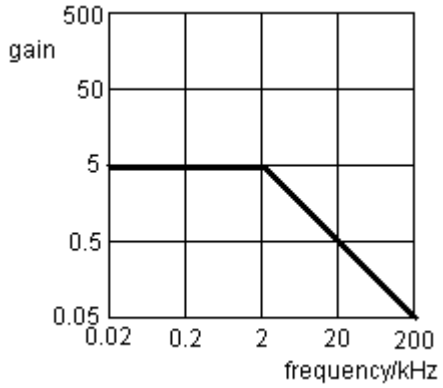
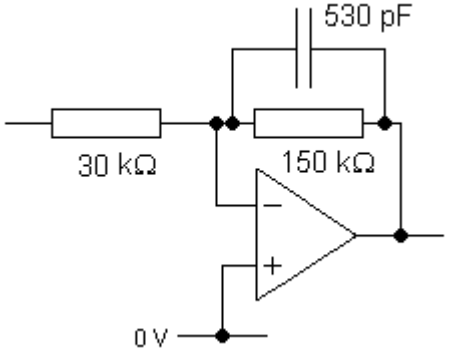
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td> 
</td><td>4</td><td>correct input box for [1]
correct decision box for [2]
incorrect decision box with S7 for [1]
correct connection labels for [1]

look for correct syntax

accept 20_{16} or 20_H</td></tr>
<tr><td>2</td><td>(b)</td><td></td><td><table>
<tr><td>S6</td><td>0110 000</td><td>1</td></tr>
<tr><td>S5</td><td>1111 0010</td><td>3</td></tr>
<tr><td>S4</td><td>1101 1010</td><td>2</td></tr>
</table></td><td>3</td><td>each correct binary word for [1] each
all three display numbers match binary for [1]</td></tr>
</table>

Question			Answer	Marks	Guidance
2	(c)			2	from c, copy input port to a register (not S4, S5, S6) for [1] test to see if register contains 04, pass to **d** if yes, pass to **e** if no for [1] **reject** decision box with ? **reject** 4 instead of 04
				2	load any register (not S4, S5 or S6) with 00 for [1] copy that register to output and return to a for [1] **accept** let output = 00 and return to a for [1]
				2	output contents of S5, S4 and S6 in order, pass to c for [1] **ecf:** incorrect sequence of numbers (3,2,1) from 2(b) with 500 ms delay after each output for [1] **ecf:** penalise incorrect box shape only once **ecf:** penalise missing arrows only once

Question			Answer	Marks	Guidance
3	(a)			4	microphone first, loudspeaker last for [1] power amplifier just before loudspeaker for [1] volume control anywhere before power amplifier for [1] tone control anywhere before voltage amplifier for [1]
	(b)	(i)		3	correct symbols for all three components, as shown [1] resistor and microphone in series with supply rails [1] capacitor between microphone-resistor to amplifier input [1]
		(ii)	10 kΩ or above; to allow most of the signal from the microphone to reach the amplifier owtte;	1 1	**accept** input impedance should always be larger than output impedance / reduce lost volts in microphone / reduce current in microphone / reduce loss of signal from microphone **reject** to match impedances

Question			Answer	Marks	Guidance
	(c)	(i)		3	correct shape (horizontal then dropping), any values [1] horizontal 5 from 0.02 to 2 kHz [1] dropping at 45° above 2 kHz [1]
		(ii)		5	correct resistor placement [1] correct capacitor placement [1] correct resistor values [1] correct capacitor value with ecf (RC = 80 μs) [1] use of $f_0 = \frac{1}{2\pi RC}$ to justify a capacitor value [1] no ecf from incorrect (c)(i)

<table>
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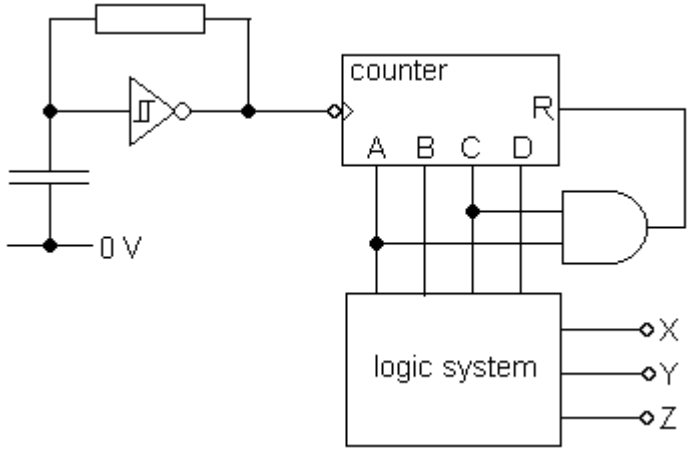
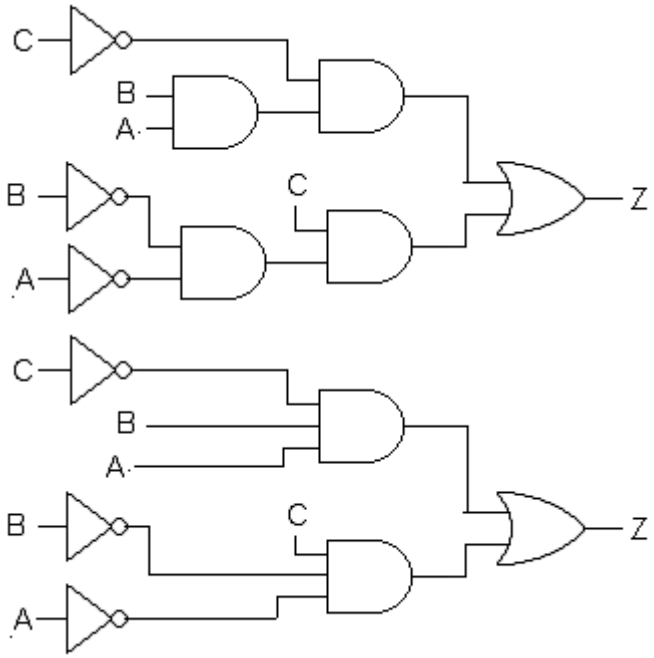
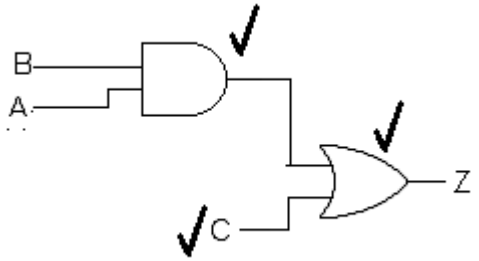
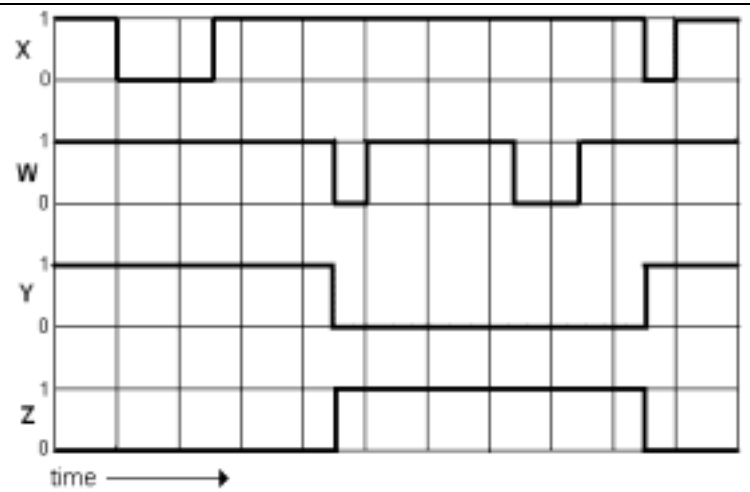
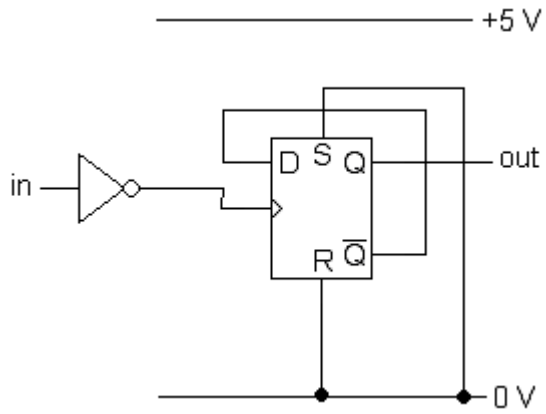
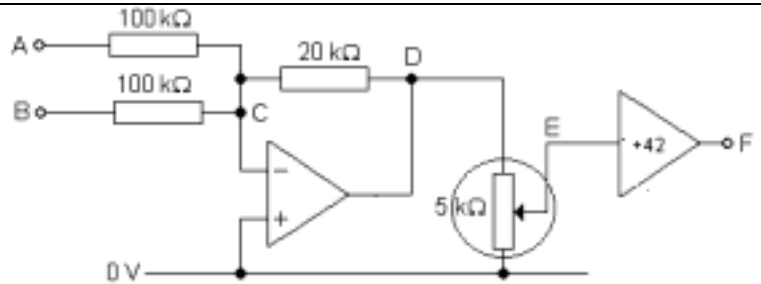
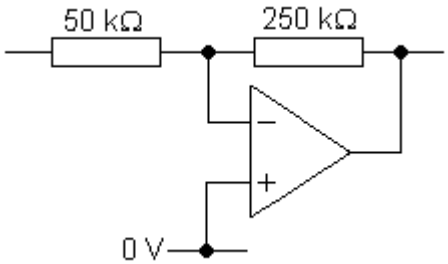
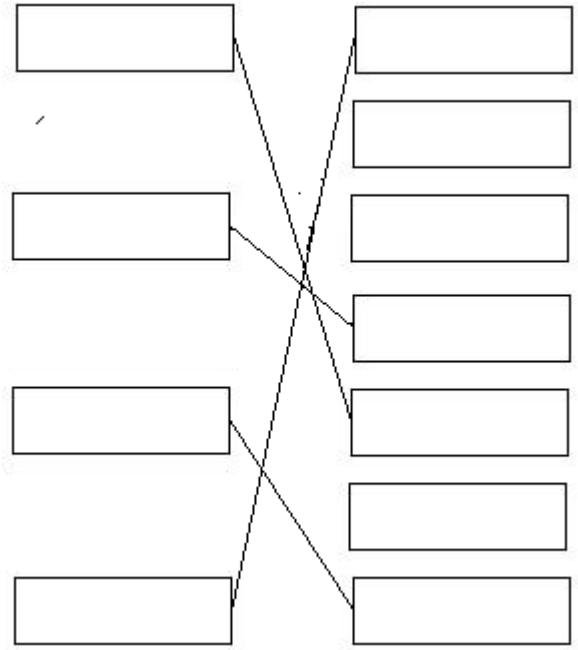
<tr><td>4</td><td>(a)</td><td></td><td> 
</td><td>2</td><td>AND gate output connected to R [1]
gate inputs to C and A [1]</td></tr>
<tr><td></td><td>(b)</td><td></td><td>R at least 1 kΩ;
RC = 8.0 s to give value of C;</td><td>1
1</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>
<table>
<tr><th>state</th><th>C</th><th>B</th><th>A</th><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>4</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
</table>
</td><td>2</td><td>correct pattern for [2]
A and C swapped round for [1]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>$Z = \overline{C}.B.A + C.\overline{B}.\overline{A}$</td><td>2</td><td>each correct term for [1]
accept ecf from if 4ci worth [1] e.g. $Z = \overline{A}.B.C + A.\overline{B}.\overline{C}$
accept simplified $Z = C + B.A$</td></tr>
</table>

Question			Answer	Marks	Guidance
		(iii)		3	use of NOT gates to invert each input [1] correct AND gates to generate both terms [1] correct OR gate to generate final expression [1] accept three input AND gates accept ecf **either** from $Z = \overline{A}.B.C + A.\overline{B}.\overline{C}$ **or** $Z = C + B.A$ for full marks accept correct simplified circuit for [3] 

Question			Answer	Marks	Guidance
5	(a)		output low when both inputs high; otherwise output high;	1 1	**accept** output *only* low when both inputs high for [2] **accept** 1 or 5V for high, 0 or 0V for low **reject** on/off, input/no input, positive/negative ...
	(b)	(i)	active-low: inputs need to go low to change output; set: make output high; reset: make output low;	1 1 1	**not just** normally held high, activates circuit **accept** Z for output throughout **accept** set and reset round wrong way for [1]
		(ii)	gate 1 has one input (X) low so Y must be high; gate 2 has two inputs (W, Y) high so Z must be low;	1 1	**not just** Y is high **not just** Z is low
		(iii)		3	Y and Z have opposite states throughout [1] Z goes high and stays high when W pulsed low [1] Z goes low and stays low when X pulsed low [1]

Question			Answer	Marks	Guidance
6	(a)	(i)		4	S and R to 0 V rail [1] $\overline{Q}$ to D and Q goes to output [1] NOT gate to clock [1] correct input and output [1]
		(ii)	2^{10} / 1024 Hz	1	
		(iii)	frequency less likely to change as time goes on / easier to get the correct frequency (than setting *RC* value)	1	**not just** more precise / accurate / reliable
	(b)		four; one nought; ten; seven;	1 1 1 1	in any order
	(c)		(F) E AD BC	3	first box E for [1] D immediately after A anywhere for [1] then C immediately after B for [1] remember AD before BC?

Question			Answer	Marks	Guidance
7	(a)			1	
	(b)		correct substitution into summing amp formula e.g. $-\frac{V_{out}}{20k}=\frac{5.2}{100k}+\frac{-1.3}{100k}$; - 0.78 V;	1 2	**accept** 20, 100 and 100 in substitution accept 0.78 V for [2] accept -0.8 V for [3]
	(c)			3	all resistors between 1 kΩ and 10 MΩ [1] resistors to give gain of magnitude 5 [1] correct inverting amplifier circuit [1]

Question			Answer	Marks	Guidance
8	(a)			4	each correct link for [1]
	(b)	(i)	one chip makes many different systems / only one chip for a complete system / (smaller pcb) because one chip replaces many in a system	1	**not just** programmable / reprogrammable owtte
		(ii)	any one of: • system is faster; • don't need programming skills; • easier to understand; • less complicated to design;	1	**not** cheaper

APPENDIX 1

Quality of Written Communication

3	The candidate expresses complex ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically. Arguments are consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.
2	The candidate expresses straightforward ideas clearly, if not always fluently. Sentences and paragraphs may not always be well connected. Arguments may sometimes stray from the point or be weakly presented. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
1	The candidate expresses simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas.
0	The language has no rewardable features.

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