OCR
Oxford Cambridge and RSA

GCE

Electronics

Unit **F612:** Signal Processors

Advanced Subsidiary GCE

Mark Scheme for June 2015

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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.

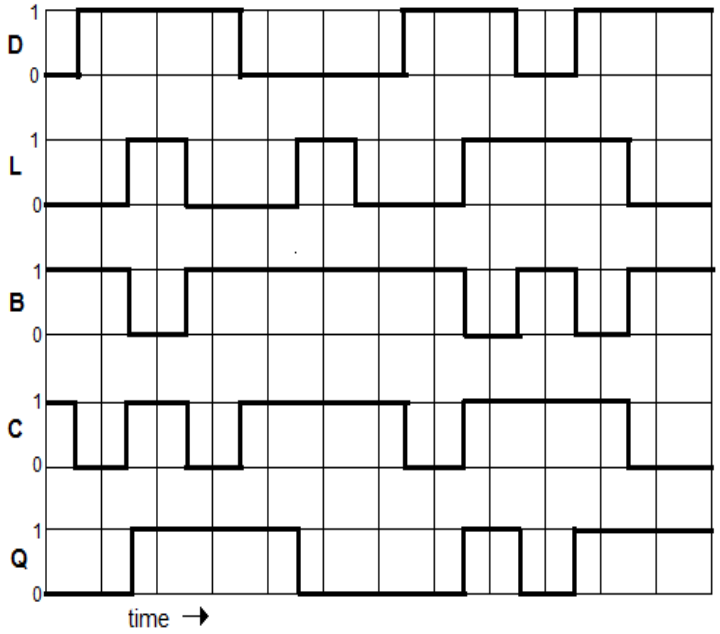
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

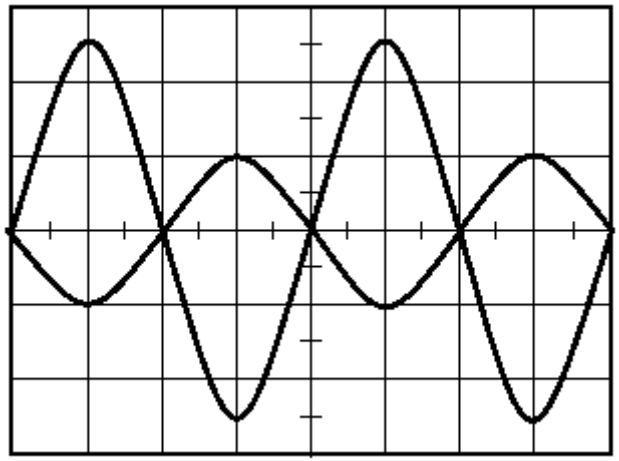
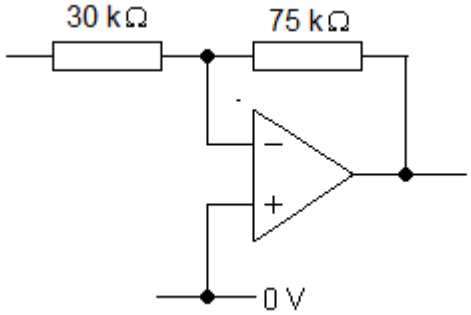
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

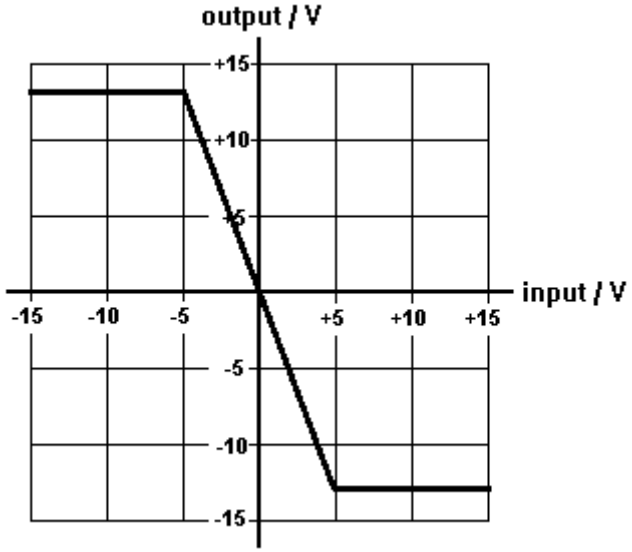
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>a</td><td>i</td><td>set means output/Q is high/1/5V;
reset means output/Q is low/0/0V;
active-high means inputs need to go high/1/5V to affect state of output;</td><td>1
1

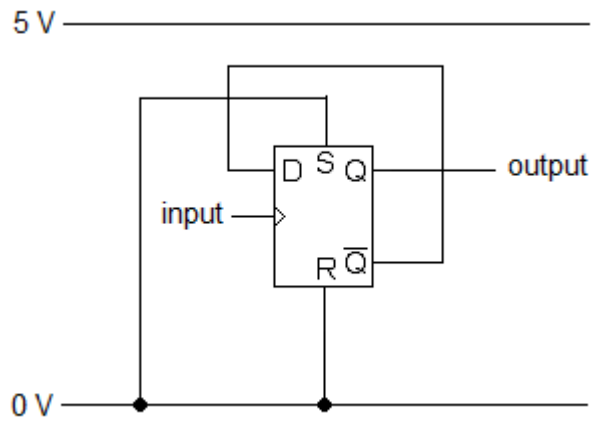
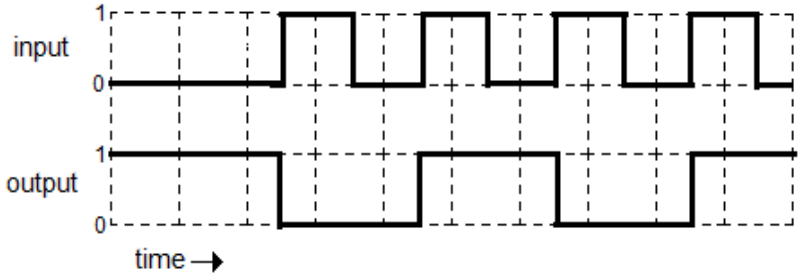
1</td><td>

accept rising-edge not falling edge</td></tr>
<tr><td></td><td></td><td>ii</td><td>does not change from previous value</td><td>1</td><td>not unqualified high or low not indeterminate</td></tr>
<tr><td></td><td>b</td><td>i</td><td><table><tr><td>A</td><td>P</td><td>Q</td></tr><tr><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td></tr></table></td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>hold A low;
pulse / hold B high;
forcing P to be low and Q to be high;</td><td>1
1
1</td><td>

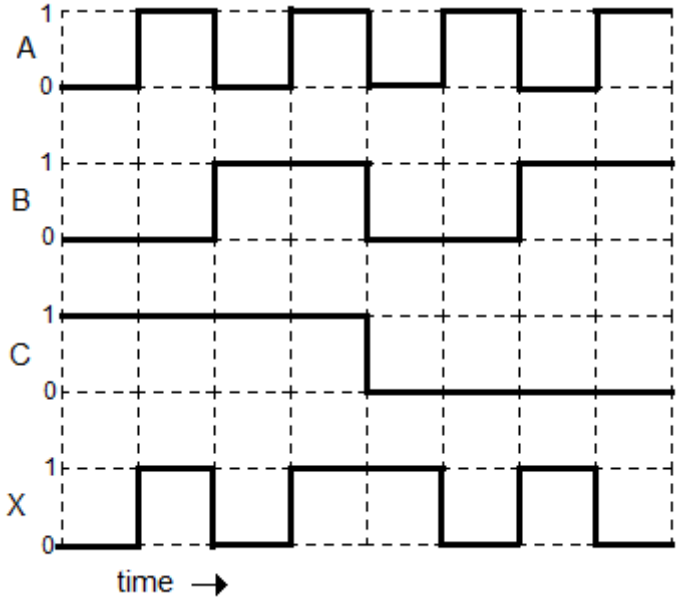
Accept output of gate 1 as P</td></tr>
<tr><td>2</td><td></td><td></td><td> 
</td><td>5</td><td>B correct [1]
C correct [1]
Q correct for first 4.5 squares [1]
Q correct from 4.5 to 8.5 [1]
Q correct from 8.5 to 12 [1]</td></tr>
</table>

Question			Answer	Marks	Guidance
3	a	i		3	correct shape [1] correct phase [1] correct amplitude [1]
		ii		4	correct negative feedback circuit [1] non-inverting input directly to 0 V [1] correct input resistor [1] feedback resistor 2.5 x input resistor with ecf [1] **accept** non-inverting amplifier circuit • correct circuit for [1] • correct resistor ratio and input resistor for [1]
	b	i	amplitude	1	**accept** phase, (peak) voltage, power, polarity
		ii	(waveform) shape; frequency / period;	1 1	 **not** wavelength

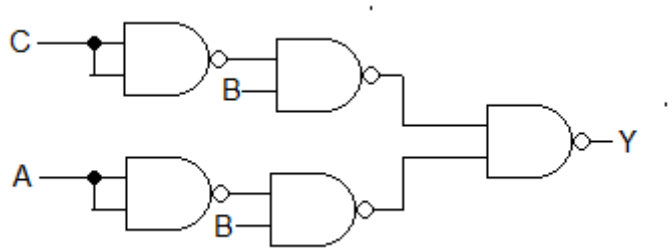
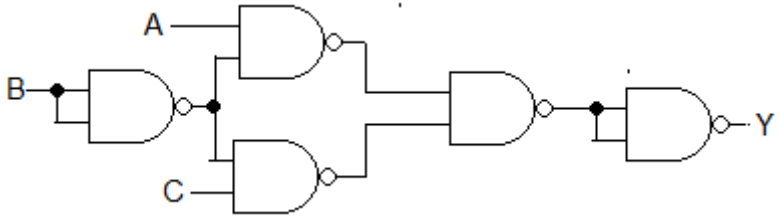
Question			Answer	Marks	Guidance
	c			3	straight line through origin [1] correct gradient [1] saturation at +13V and -13 V [1] **accept** 12.5 V to `13.5 V by eye for saturation **look for** three straight lines (by eye)
4	a	i	use of $G = 1 + \frac{R_f}{R_d}$; G = 8.0(2); amplitude = 1.2 V;	1 1 1	**look for** resistor values of 33 kΩ, 22 kΩ or 4.7 kΩ **ecf** from any incorrectly calculated G G = -7.0(2) gives (-)1.05 V for [1] G = 2.5 gives 0.375 V for [2]
		ii	amplifies difference between inputs; with very high gain; negative feedback (reduces overall gain); so that tiny difference between inputs can result in finite signal at output (that is not saturated);	1 1 1 1	**accept** $V_{out} = A(V_+ - V_-)$ A at least 1000
	b	i	less signal loss / greater signal transfer / greater output voltage with 120 kΩ; 12 kΩ and 22 kΩ form a voltage divider; some microphone signal lost across 12 kΩ / appears across 22 kΩ; input impedance needs to be much greater than output impedance for good signal transfer;	1 1 1 1	**look for** words, not calculations

Question			Answer	Marks	Guidance
		ii	current in 22 kΩ = 0.25/22k = 1.14×10^{-5} A; internal signal amplitude = $1.14\times10^{-5}\times$ (22k + 12k) = 0.386 V; current in 120 kΩ = 0.386 / (12k + 120k) = 2.93×10^{-6} A; amplitude at X = $2.93\times10^{-6}\times$ 120k = 351 mV	1 1 1 1	**accept** 350 mV
5	**a**	**i**		3	D to $\overline{Q}$ [1] Q as output [1] S and R to 0 V [1]
		ii		2	only rising edges of input change the output [2] only falling edges of input change the output [1] **accept** input signal with any mark-space ratio **ignore** the position of the last falling edge
	b	**i**	counter resets when both C and A are high; which happens on every fifth pulse (at input);	1 1	**accept** when output is 0101 / gate inputs are high

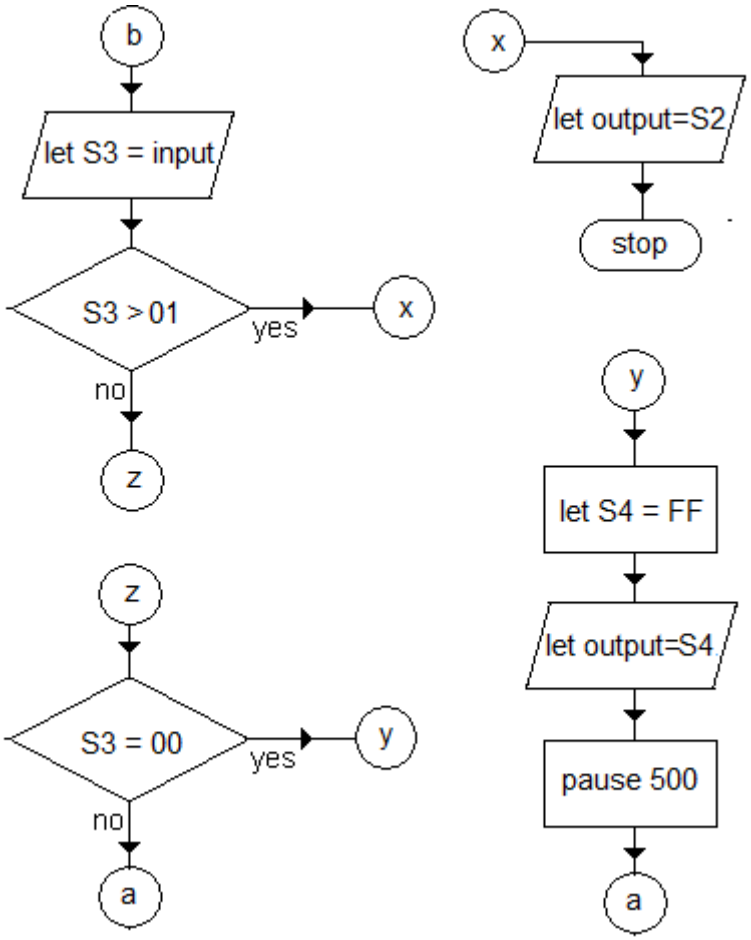
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>ii</td><td>
<table>
<tr><td>input</td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>4</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>3</td><td>second row correct for [1]
third row correct for [1]
last two rows correct for [1]</td></tr>
<tr><td></td><td></td><td>iii</td><td>3 kHz</td><td>1</td><td></td></tr>
<tr><td>6</td><td>a</td><td></td><td>use of $T = 0.5RC$;
period of pulses at P = 0.5 × 270k × 32μ = 4.32 s;
counter sequence has 2^3 states;
sequence period is 8 × 4.32 = 34.6 s;</td><td>1
1
1
1</td><td>

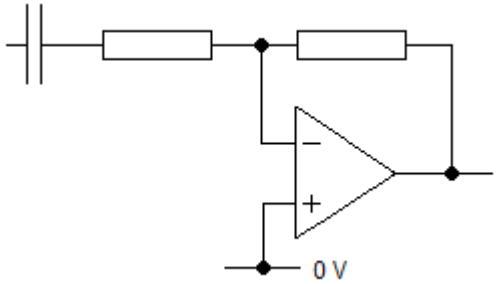
accept 8 states
ecf on incorrect calculated value of T</td></tr>
<tr><td></td><td>b</td><td></td><td> 
</td><td>4</td><td>A correct [1]
ecf on A: B changes on each falling edge of A [1]
ecf on B: C changes on each falling edge of B: [1]

X is only high when A and C are the same. [1]</td></tr>
<tr><td></td><td>c</td><td>i</td><td>$Y = \overline{C}.B.\overline{A} + \overline{C}.B.A + C.B.\overline{A}$</td><td>1</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
		ii	any two of the following for [1] each: use of theorems to show that $\overline{C}.B.\overline{A}+\overline{C}.B.A=\overline{C}.B$; use of theorems to show that $\overline{C}.B.\overline{A}+C.B.\overline{A}=B.\overline{A}$; use of theorems to show that $\overline{C}.B+C.B.\overline{A}=B.\overline{A}$; use of theorems to show that $\overline{C}.B.A+B.\overline{A}=\overline{C}.B$;	2	**Ignore** names of rules **look for** use of brackets and $A+\overline{A}=1$ **look for** use of brackets and $C+\overline{C}=1$ **look for** $B.(\overline{C}+C.\overline{A})$ and $\overline{C}+C.\overline{A}(=\overline{C}+C.\overline{A}+\overline{A})=\overline{A}$ **look for** $B.(\overline{C}.A+\overline{A})$ and $\overline{A}+\overline{C}.A(=\overline{A}+\overline{C}.A+\overline{C})=\overline{C}$
		iii	EITHER  OR  	3	Correct circuit [3] One mistake for [2] Two mistakes for [1] A mistake is: • an extra gate • a missing gate • an incorrect gate • a missing input label (allow un-simplified version) **ignore** pairs of redundant inverters **allow** use of more than two inputs to gates

Question			Answer	Marks	Guidance
7	a	i	77 is 01110111, C7 is 11000111	1	
		ii	any three from following, [1] each: • MOSFET gate goes low / driver not activated; • so buzzer does not makes a noise / no current in buzzer; • LEDs a, b, c, d, e and f have current in them / glow; • so O is displayed;	3	**accept** alarm / speaker
	b		any **six** of the following, [1] each: • reads input port until > 00010101; • switch A closed gives > 00010101; • then puts 01110111 on output port; • which turns off buzzer; • displays A; • waits 500 ms • until input port is not 000000001; • which means flooding / either switch pressed; • so passes control to b;	**6**	**ignore** incorrect statements **not** until > 15

Question	Answer	Marks	Guidance
c	for example:  	4	each correct segment of the program for [1] **accept** alternative which works as required a segment is incorrect if it does not have correct use of arrows, symbols and syntax **top left segment**: tests input port to see if I4 or I2 are high, where I0 can be high or low **bottom left segment**: tests input port to see if I0 is low and return control to **a** if I0 is high **top right segment:** if I4 or I2 are high, outputs the contents of S2 (C7) and either stops or loops back to **x** or **b** **bottom right segment**: if I0 is low, outputs FF, waits for 500 ms and returns to **a**

Question			Answer	Marks	Guidance
8	a		reduce amplitude of (unwanted) low frequency signals; any one of the following: • from recording / microphone / signal source; • to remove noise / interference • signals can't be heard • compensates for transfer characteristic of microphone • compensates for transfer characteristic of speaker • adjusts balance to suit the listener	1 1	**accept** remove/cut low frequencies or bass (notes) **not just** bass cut filter
	b			5	correct circuit [1] resistor values between 1 kΩ and 10 MΩ [1] feedback resistor = 30 x input resistor [1] *RC* of filter network = 8 ms [1] use of $f_0 = \frac{1}{2\pi R\,C}$ to justify *RC* value [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.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

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Facsimile: 01223 552627
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