GCE

Electronics

Unit **F612:** Signal Processors

Advanced Subsidiary GCE

Mark Scheme for June 2014

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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.

These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning of annotation
✔	Tick
✖	Cross
？	Unclear
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
BOD	Benefit of doubt
EE	Effective evaluation
L1	Level 1
L2	Level 2
L3	Level 3
L4	Level 4
NAQ	Not answered question
OFR	Own figure rule
SEEN	Noted but no credit given
TV	Too vague
^	Omission

Subject-specific Marking Instructions

Accept +5 V, 1 and high as equivalent throughout

Accept 0 V, 0 and low as equivalent throughout
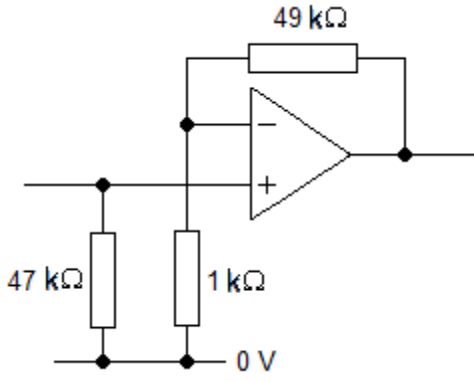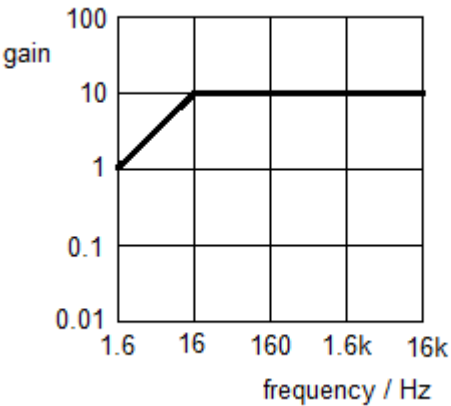
Accept numerical answers which round up to values in mark scheme

Method marks require correct values substituted into correct equation. Accept k, μ etc as powers of ten.

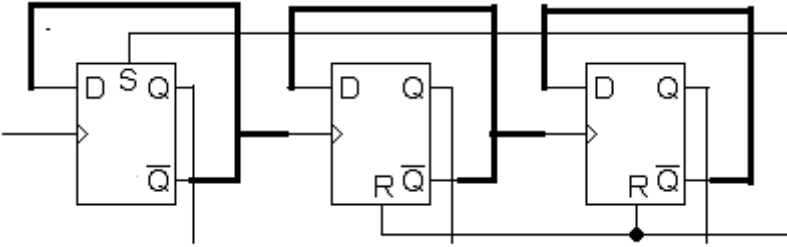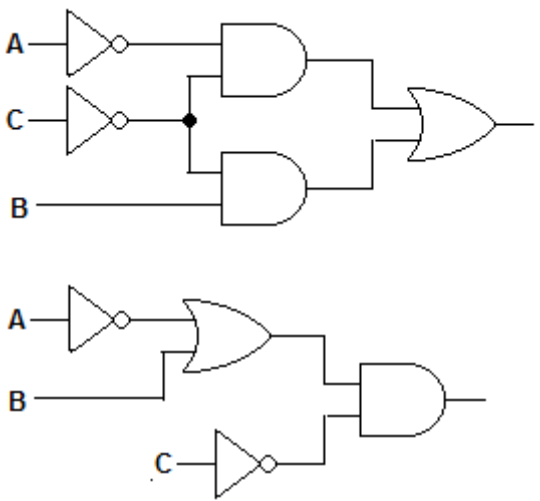| Question			Answer	Mark	Guidance
1	a		<table><tr><td>**P**</td><td>**R**</td><td>**Q**</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	2	all four input states (any order) for [1] THEN correct Q for [1]
	b		S goes high so P goes low, both inputs (P and R) are low; so Q goes high (so LED forward biased and glows);	3	no ecf from incorrect truth table
	c		LED stays on; P stays low because one input (Q) is high; Q is high because both inputs (P and R) are low;	3	
	d			1	Q is high until R goes high Q changes state on first rising edge of R (by eye)
2	a		S makes Q high and $\overline{Q}$ low; when it is high;	1 1	ignore correct statement for S is low i.e. has no effect on Q or $\overline{Q}$
	b		place bit at D; pulse CK / feed rising edge into CK;	1 1	not just 'D copied to Q', not 'just hold D high' not hold/make/send CK high
3	a		-4.7	2	accept 4.7 for [1] accept - 4.6 for [1]
	b		$V_{in} = 0.75$ V; $V_{out} = 0.75 \times 4.7 = 3.5(3)$ V; $T = 600$ µs; $f = 1.7$ kHz;	1 1 1 1	ignore sign, allow ecf from incorrect **a** ecf: accept 7.0(6) V for [1], accept 0.75 V for [1] ecf: 300 µs gives 3.3 kHz for [1] accept 1.6 kHz for [1]

Question			Answer	Mark	Guidance
	c		amplitude of output signal should be 3 x 4.7 = 14 V;	1	
			top and bottom of signal flattened / clipped;	1	not just top or bottom
			because op-amp output saturates at +13 V and -13 V;	1	
	d	i	0 V	1	
		ii	$1.2 / 47{\times}10^3 = 2.55{\times}10^{-5}$ A;	1	method [1]
			26 μA.	1	answer [1] accept just 25 μA for [1]
		iii	$1.2 \times 2.55{\times}10^{-5} = 3.06{\times}10^{-5}$ W	1	accept ecf incorrect (ii) e.g. 25 μA gives 30 μA for [2]
			31 μW	1	method [1] answer [1]
					accept use of $P = V^2/R$
		iv	$V_{out} = 4.7 \times 1.2 = 5.6(2)$ V;	1	accept ecf incorrect (a)
			$I_{out} = 5.6 / 1.2{\times}10^3 = 4.7{\times}10^{-3}$ A, $P_{out} = 5.6 \times 4.7{\times}10^{-3} = 27$ mW;	1	accept 26 mW for [2], ecf: 1.2 mW for [1]
4	a		(circuit diagram of three flip-flops: D S Q / Q̄, D Q / R Q̄, D Q / R Q̄)	2	D to Q̄ on all three flip-flops [1]
					Q̄ to next clock for first two flip-flops [1]
	b		Y is a decoder;	1	not converter
			which converts word from counter into a different word;	1	accept binary to seven segment conversion
					not binary to decimal conversion
					accept binary (number) for word
			Z is a seven-segment (LED) display;	1	
			which displays a number; .	1	
	c	i	3;	1	
			100;	1	
		ii	six has CBA = 110;	1	accept seven has CBA = 111
			when CBA = 111 X goes high;	1	
			making CBA = 001 / resetting CB and setting A;	1	not resets counter to one
		iii	$10 = 0.5R \times 330{\times}10^{-6}$;	1	use of correct rule [1]
			$R = 61$ kΩ;	1	answer [1]
					accept just 60 kΩ for [1]
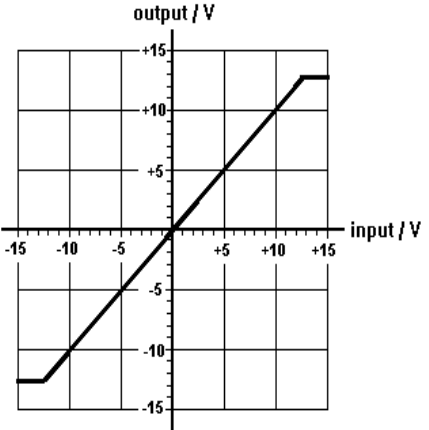
Question			Answer						Mark	Guidance
5	a	i							1	completely correct for [1]

	Z	**C**	**B**	**A**	**X**
	one	0	0	1	0
	four	1	0	0	0

Question			Answer	Mark	Guidance
		ii	$X = \overline{C}.\overline{B}.\overline{A} + \overline{C}.B.\overline{A} + \overline{C}.B.A$; EITHER $X = \overline{C}.(\overline{B}.\overline{A} + B.\overline{A} + B.A)$ $X = \overline{C}.(\overline{A}.(\overline{B} + B) + B.(\overline{A} + A)) = \overline{C}.(\overline{A} + B) = \overline{C}.\overline{A} + \overline{C}.B$; OR $\overline{C}.\overline{B}.\overline{A} + \overline{C}.B.\overline{A} = \overline{C}.\overline{B}.\overline{A} + \overline{C}.B.\overline{A} + \ \overline{C}.\overline{A} = \overline{C}.\overline{A}$ $\overline{C}.B.\overline{A} + \overline{C}.B.A = \overline{C}.B.\overline{A} + \overline{C}.B.A + \ \overline{C}.B = \overline{C}.B$;	1 1	allow ecf from incorrect (i) for initial expression [1] valid use of rules to link required answer to truth table expression completely.
		iii	 EITHER OR	3	OR gate to generate output for $X = \overline{C}.\overline{A} + \overline{C}. B$ [1] AND/NOT gates to generate $\overline{C}.\overline{A}$ [1] AND/NOT gates to generate $\overline{C}.B +$ [1] if they state $X = \overline{C}.(\overline{A} + B)$, then AND gate to generate output for $X = \overline{C}.(\overline{A} + B)$ [1] NOT gate to generate $\overline{C}$ [1] NOT / OR gate to generate $\overline{(A + B)}$ [1] accept correct circuit without algebra for [3]
	b		(at end of sequence) Z is low because CBA = 100 / C is high; no pulses at Z to be counted / counter output stays at 100; X goes high when pulse at S resets counter / CBA to 000;	1 1 1	accept counter frozen

Question			Answer	Mark	Guidance
6	a	i	power amplifier	1	accept current amplifier / power amp
		ii	increases current (of a signal); because loudspeaker has low resistance / current from volume control too low / loudspeaker needs high current;	1 1	ignore power
	b			5	correct feedback arrangements [1] - look for clear use of necessary blobs or bypass symbols correct ratio of feedback resistors [1] use of $G = 1 + \dfrac{R_F}{R_D}$ to justify values [1] all resistors between 1 kΩ and 10 MΩ [1] correct pull-down resistor / input impedance [1] if inverting amplifier correctly drawn, then • input resistor of 47 kΩ [1] • feedback resistor of 2.4 MΩ [1]
	c	i	$f_0 = \dfrac{1}{2\pi \times 10k \times 1\mu}$; 16 Hz;	1 1	ecf: 100 kΩ gives 1.6 Hz for [1]
		ii		3	break in the curve at 16 Hz [1] horizontal portion of curve at gain of 10 [1] gain drops at 45° below 16 Hz [1] accept ecf from (c)(i)

Question			Answer	Mark	Guidance
7	a			4	correct process box [1] correct input box (n = any integer) [1] correct decision box [1] accept variant below for any value from 0F to 00 not Sn<XX if decision box correct, then correct flow direction labels [1] not a for b
		b	S6 is 10000010; so lock is closed and yellow LED on; S5 is 01110001; so lock is open and green LED is on;	1 1 1 1	accept Q7, Q1 are high and rest low accept Q6, Q5, Q4.Q0 are high and rest low
		c	(when red LED glows) press V, W and X (simultaneously); (until) yellow LED glows; then press U, W and X (simultaneously); for at least the next 2 s; lock opens for 8 s (and green LED comes on);	1 1 1 1 1	 not after 2s ignore references to returning control to **a**

Question			Answer	Mark	Guidance
		d		4	lock closed all the time i.e. msb 1 to output [1] all LEDs on all the time i.e. 3 lsb 1 to output [1] square wave to O3 [1] 4 ms per cycle [1] ignore boxes with syntax errors/incorrect shape
8	a		$V_{out} = A(V_{in} - V_{out}) = AV_{in} - AV_{out}$; $V_{out} + A \times V_{out} = A \times V_{in}$, so $V_{out}(1 + A) = AV_{in}$ and $\dfrac{V_{out}}{V_{in}} = \dfrac{A}{1 + A}$;	1 1	correct substitution of V_{in} and V_{out} for V_+ and V_- [1] accept V_+ for V_{in} if used throughout correctly clear rearrangement to gain formula [1]
	b		1	1	accept 0.99, but not 0.9

Question			Answer	Mark	Guidance
	c			3	straight line through the origin [1] accept freehand line slope of +1.00 [1] with ecf from b saturating at +13 V and -13 V [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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