

Electronics

Advanced GCE

Unit **F615**: Communications Systems

Mark Scheme for June 2013

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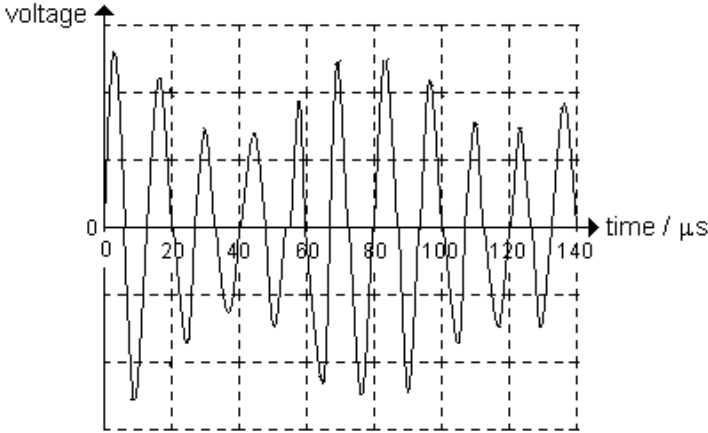
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

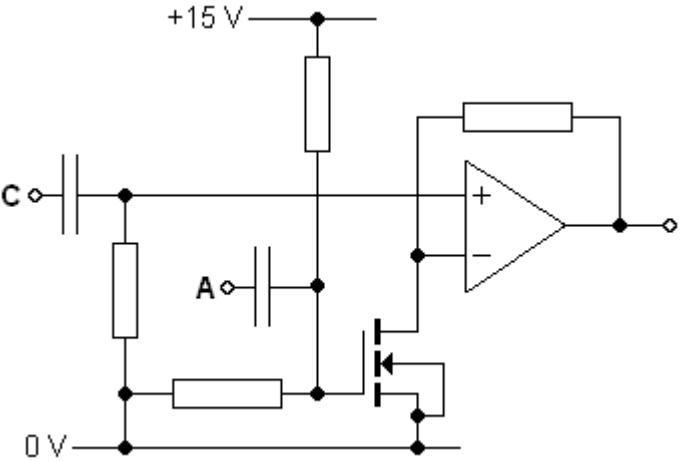
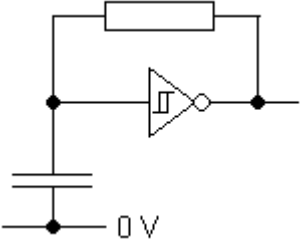
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

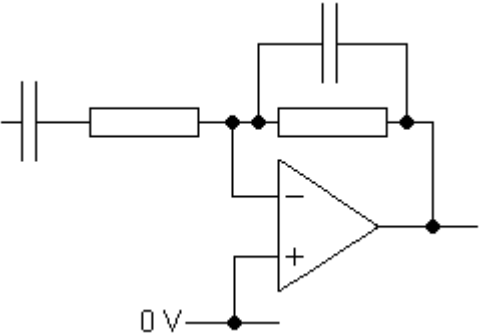
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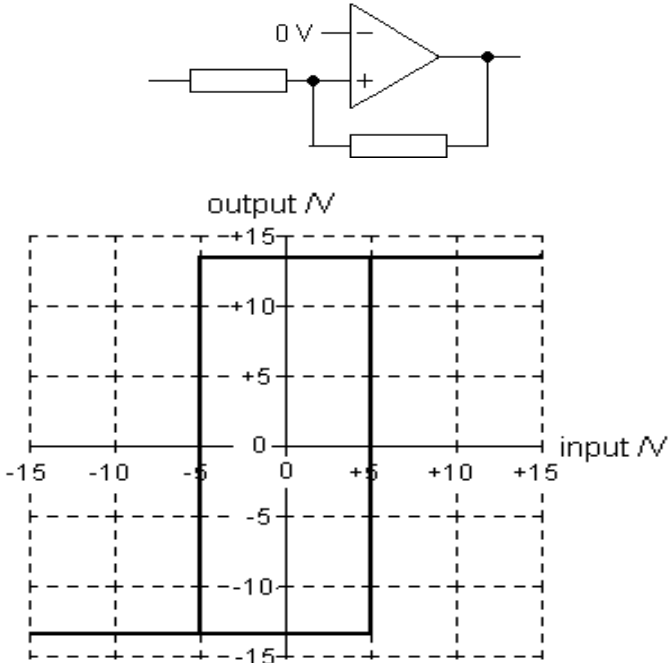
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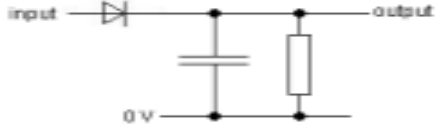
Question		Answer	Marks	Guidance
1	(a)	number of levels = $1.27/0.01 + 1 = 128$; $2^7 = 128$;	1 1	accept 1.27/0.01 (=127 levels) accept reverse calculation e.g. $\log_2 128 = 7$ etc.
	(b) (i)	pixel rate = $1024000 \times 60 = 6.1 \times 10^7 \text{ s}^{-1}$; bandwidth = $0.5 \times 6.1 \times 10^7 = 30.7 / 31 \text{ MHz}$;	1 1	look for calculation/explanation for each step accept reverse calculation: 5 MHz gives 1×10^7 bps; refresh rate = 9.8 Hz / pixel rate = $1.7 \times 10^3 \text{ s}^{-1}$; ecf bandwidth from incorrect pixel rate
	(ii)	fine detail of picture would be lost / image out of focus; as higher frequencies of video signal would not get through;	1 1	not just poor picture quality
	(iii)	EITHER assuming lbw cable refresh rate would need to be reduced; to 10 Hz / if went below 25 Hz; and image would flicker; OR assuming hbw cable allows high refresh rate; above 25 Hz; to avoid flicker	1 1 1	accept anything from 20 Hz to 30 Hz
	(iv)	rows = $1024000/1280 = 800$; frequency = $60 \times 800 = 48 \text{ kHz}$;	1 1	no ecf

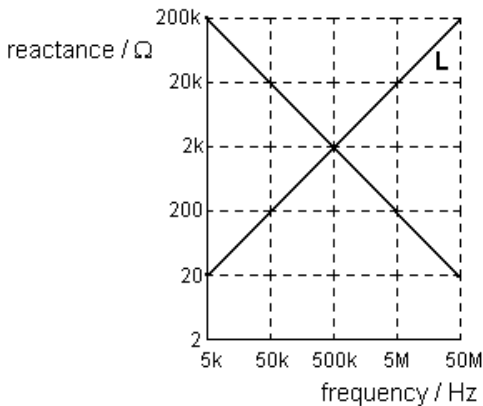
Question			Answer	Marks	Guidance
2	(a)	(i)	75 kHz	1	
		(ii)	13 kHz	1	
	(b)			3	<p>any sinusoidally modulated carrier centred on 0 V [1] accept high frequency fuzz for carrier accept just envelope lines for modulated carrier ignore envelope lines otherwise two cycles of modulation across screen [1] 9 - 13 cycles of carrier across screen [1]</p> <p>any amplitude, any depth of modulation</p>

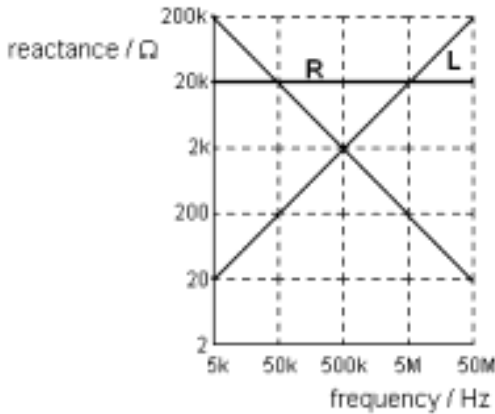
Question	Answer	Marks	Guidance
(c) (i)		1	both labels correct for [1] accept carrier for C and a.f. signal for A
(ii)	any four from: <ul style="list-style-type: none"> • potential divider biases (owtte) a.f. signal • mosfet resistance varied • by (a.f.) signal at gate; • op-amp connected as non-inverting amplifier; • amplifying carrier signal; • with gain depending on resistance of mosfet; 	4	not just identifies bias network
(iii)		4	correct circuit, including ST NOT gate [1] R at least $1\text{ k}\Omega$ [1] $RC = 27\ \mu\text{s}$ (ecf from a(i)) [1] accept anything which rounds to $27\ \mu\text{s}$ use of $T = 1/f$ and $T = 0.5RC$ [1] not astable, crystal oscillator accept enable diode at ST input

Question	Answer	Marks	Guidance
3 (a) (i)		8	non-inverting input to 0 V (accept via resistor) [1] effective treble cut circuit [1] effective bass cut circuit [1] all resistors between 1 kΩ and 1MΩ [1] $R_F / R_{IN} = 30$ [1] input $RC = 1.1$ ms [1] accept 1 ms feedback $RC = 11$ μs [1] accept 10 μs quote and use of $f_0 = \frac{1}{2\pi RC}$ to justify value(s) [1] accept two filters in series for full marks
	(ii) bandwidth = 5 × maximum signal frequency; 15 × 5 = 75 kHz;	1 1	ecf 750 Hz, 74 kHz [1] 7.5 kHz [0] no ecf on incorrect rule
	(iii) EITHER prevent interfering with neighbouring channels; OR narrow bandwidth allows more channels; OR their broadcasting licence specifies frequencies allow to use	1	look for idea of neighbouring stations in spectrum
(b)	any three of the following, [1] each: <ul style="list-style-type: none"> • frequency at output is variable; • depends on voltage at (a.f.) input; • frequency changes linearly with voltage; • amplitude at output does not change; • frequency is 75 kHz for no signal at input; 	3	accept voltage-frequency graph for full marks not amplitude / signal for voltage

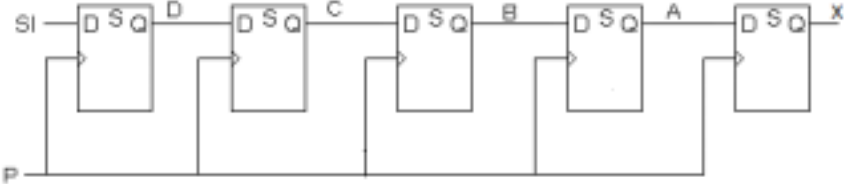
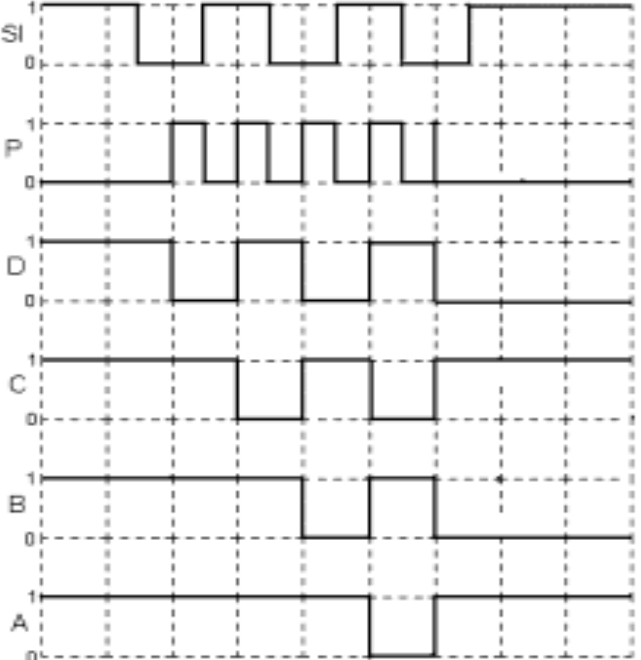
Question	Answer	Marks	Guidance
<p>4 (a)</p>		<p>4</p>	<p>correct circuit for [1]</p> <p>correct shape of graph for non-inverting ST [1] not just a square output only changes at trip points of ± 5 V [1] output only at ± 13 V [1] accept from 14 to 12</p> <p>ignore arrows on graph</p>
<p>(b)</p>	<p>values from graph; use of $\Delta V_{out} = -V_{in} \frac{\Delta t}{RC}$; R from 1 kΩ to 1 MΩ; $RC = 39 \mu\text{s}$;</p>	<p>1 1 1 1</p>	<p>look for sensible substitution e.g. $-10 = -13 \times \frac{30 \times 10^{-6}}{RC}$</p> <p>no ecf for incorrect values from graph accept correct answer and no working for [4]</p>
<p>(c)</p>	<p>any three of the following:</p> <ul style="list-style-type: none"> • amplitude must be less than <u>5 V</u>; • or comparator output does not change; • frequency must be less than $1/120 \times 10^{-6} = \underline{8.3 \text{ kHz}}$; • to get at least two samples per cycle; 	<p>3</p>	<p>wa</p>

Question	Answer	Marks	Guidance
5 (a)	noise is random signal; from materials in the link / processors; interference is unwanted signal picked up by receiver; from other electrical systems / signals;	1 1 1 1	accept picked up during transmission owtte accept interference is non-random accept example of a source of interference
	(b) cables carry signal and its inverse; both cables pick up the same interference; which is rejected by difference amplifier in receiver; noise from cables doesn't cancel (in difference amplifier);	1 1 1 1	accept voltage, current for signal ignore references to shielding, random noise
	(c) restores signal to high and low; removing information about amplitude (of incoming signal);	1 1	accept square wave output not just removes noise ignore references to frequency
6 (a)		5	[1] per correct block
(b) (i)		3	input in series with diode [1] capacitor in parallel with resistor to 0 V / ground [1] inputs and outputs labelled [1]
	(ii) any three of the following, [1] each: <ul style="list-style-type: none"> • diode (and resistor) rectify signal (owtte); • to generate af signal; • capacitor and resistor filter; • to eliminate rf signal (owtte); 	3	accept negative parts of signal accept capacitor and resistor smooth signal not just sidebands

Question	Answer	Marks	Guidance
(c)	Increase the length of the aerial. Increase the gain of the rf amplifier. Decrease the gain of the af amplifier. Increase the impedance of the loudspeaker. Reduce the break frequency of the diode detector.	2	completely correct for [2] one mistake for [1]
7 (a) (i)	$X_L = 2\pi \times 640 \times 10^{-6} \times 50 \times 10^3;$ $= \underline{201} \Omega;$	2	substitution [1] accept 640μ, 50k evaluation for [1]
(ii)		2	straight line through 200 Ω, 50 kHz [1] gradient of 45 degrees [1] accept missing label

Question	Answer	Marks	Guidance
(iii)		1	
(b)	<p>each LC circuit must have a different (resonant) frequency f_0; to create better filter than simple LC circuit; so that only one carrier + sidebands gets through;</p>	1 1 1	<p>accept centre frequency for f_0 accept labelled gain-frequency graphs accept to improve selectivity</p>
(c)	<p>X is a buffer/amplifier/MOSFET follower; any two of the following:</p> <ul style="list-style-type: none"> • X has a high impedance input; • which reduces current drawn from LC circuit ; • so that it is not affected / loaded by the next one; 	1 2	<p>not op-amp accept voltage follower</p> <p>accept next stage has not got high (input) impedance ignore increases amplitude of signal accept not affecting its selectivity / bandwidth</p>

Question		Answer	Marks	Guidance																														
8	(a)	$V = 5 - 1.5 = 3.5 \text{ V};$ $R = 3.5/2 \times 10^{-3} = 1750 \text{ } \Omega;$	1 1	accept 1.8 k Ω ecf :: 1.5 V gives 750 Ω , 4.5 V gives 2250 Ω [1] accept 5 - 2.1 = 2.9 V gives $R = 1.45 \text{ k}\Omega$ [1] $5/2 \times 10^{-3} = 2.5 \text{ k}\Omega$ [0]																														
	(b) (i)	$B = \overline{W}.X + \overline{X}.Y$ for [2] $B = (\overline{\overline{W}.X}).(\overline{\overline{X}.Y})$ for [1]	2																															
	(ii)	<table border="1"> <thead> <tr> <th>input signal</th> <th>W</th> <th>X</th> <th>Y</th> <th>B</th> <th>A</th> </tr> </thead> <tbody> <tr> <td>0.25 V</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>0.75 V</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1.25 V</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>1.75 V</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> </tr> </tbody> </table>	input signal	W	X	Y	B	A	0.25 V	0	0	0	1	1	0.75 V	0	0	1	0	0	1.25 V	0	1	1	1	0	1.75 V	1	1	1	0	1	4	[1] per correct column ecf on incorrect W, X, Y: $B = \overline{W}.X.Y + \overline{W}.X.Y$ no ecf from (b)(i)
input signal	W	X	Y	B	A																													
0.25 V	0	0	0	1	1																													
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1.75 V	1	1	1	0	1																													
	(c)	number of levels = $(2^{\text{word length}} =) 2^2 = 4;$ resolution = range/number of levels = 2.0/4 ;	1 1	accept words, codes for levels accept reverse argument look for explanation and calculation for each mark																														
	(d)	time for one cycle = $2 \times 15 \times 10^{-6} = 30 \times 10^{-6} \text{ s};$ frequency = 33 kHz;	1 1	accept 67 kHz for [1]																														

Question	Answer	Marks	Guidance
9 (a)	0/start bit alerts receiver that a new word is about to arrive; 1/stop bit sets line so that the next 0/start bit can be detected;	1 1	accept sets the bistable / enables the clock not to signal end of word
(b)	2048 × 6 ; = 12 288 Hz or 12.3 kHz;	1 1	accept 2048 × 4 = 8.19 kHz for [1]
(c)		3	Q to following D throughout [1] clocks in parallel to P [1] accept CK, clock for P SI and DCBAX correctly labelled [1] accept serial input for SI
(d)		4	each correct row for [1]

APPENDIX 1

Quality of Written Communication

3	<p>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.</p>
2	<p>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.</p>
1	<p>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.</p>
0	<p>The language has no rewardable features.</p>

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

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