OCR
Oxford Cambridge and RSA

GCE

Electronics

Unit **F615:** Communications Systems

Advanced GCE

Mark Scheme for June 2018

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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.

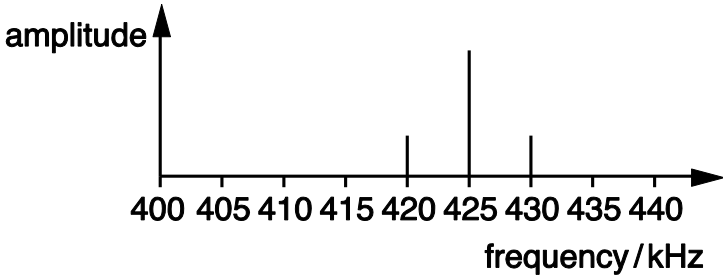
Annotations

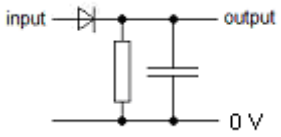
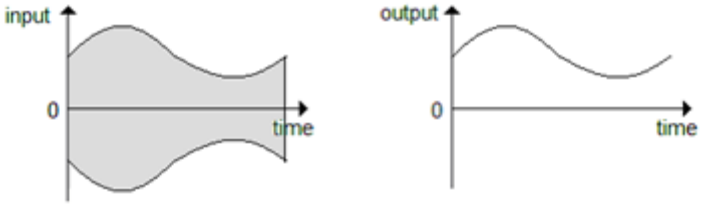
1		31	BOD	Benefit of doubt
2		21	Cross	Cross
3		241	ECF	Error carried forward
4		191	NBOD	Benefit of doubt not given
5		1841	Not Relevant	Expandable vertical wavy line
6		271	REP	Repeat
7		201	TV	Too vague
8		11	Tick	Tick
9		1741	ZERO	Zero (big)

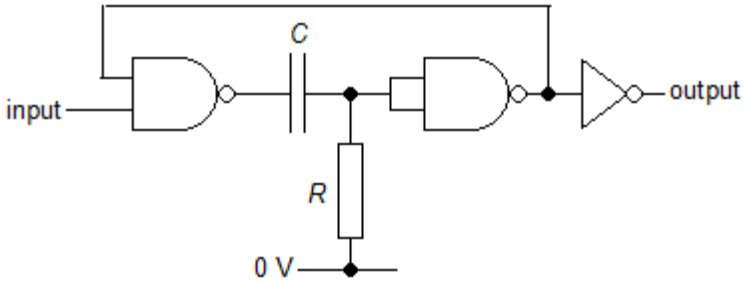
Question			Answer	Mark	Guidance
1	(a)	i	Red, green and blue (intensity) line (sync) frame (sync)	1 1 1	**Not** accept R,G,B, without words accept descriptions of function instead of name list principle applies to more than five responses
1	(a)	ii	any of the following for [1] each • noise/interference (picked up in transmission) • can be removed at video screen / receiver • using limiters / Schmitt triggers to restore signal • to improve picture quality • allows compression • for faster transmission • and/or less memory for storage • allows encoding/encryption • allows video / sound / text etc. • easier to store (in memory) • easier to edit picture • allows (time-division) multiplexing • allows for error detection/correction	4	**not** faster unqualified
1	(b)	i	$2^7 = 128$	1	
1	(b)	ii	pixels per frame = $720 \times 1280 = 921600$; bits per frame = $921600 \times 7 = 6451200$;	1 1	ecf from incorrect pixels per frame
1	(b)	iii	20 Hz to 50 Hz image seen to flickers if frame rate too low (owtte)	1 1	
1	(b)	iv	bit rate = $6451200 \times 60 = 3.87 \times 10^8$; bandwidth = $0.5 \times 3.87 \times 10^8 = 193.5$ MHz (or about 200 MHz)	1 1	**accept** 102 / 100 MHz for [1] **ecf** incorrect calculated bit rate for [1] **accept** incorrect values for frame rate and/or bits per frame from b(ii) and b(iii) for [2] Correct answer = full marks.

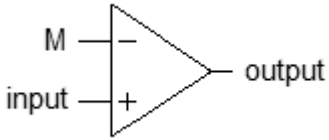
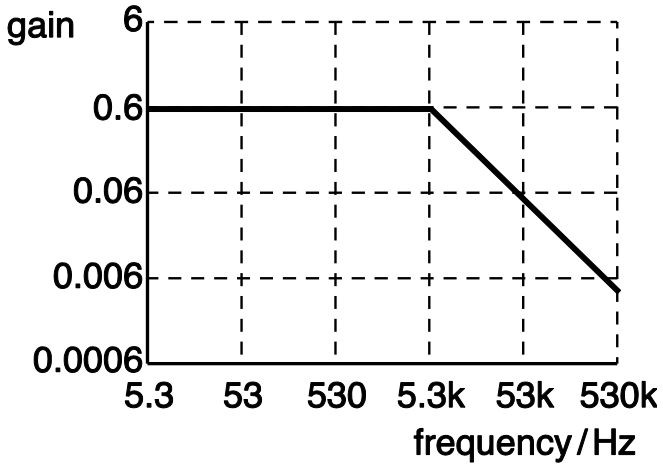
Question	Answer	Mark	Guidance

1	**(c)**	**i**	reduces bits (per frame / second); smaller bandwidth / less memory required;	1 1	 **accept** faster transmission
1	**(c)**	**ii**	loss of quality / data	1	**accept** increased time delay / cost more because of extra circuitry

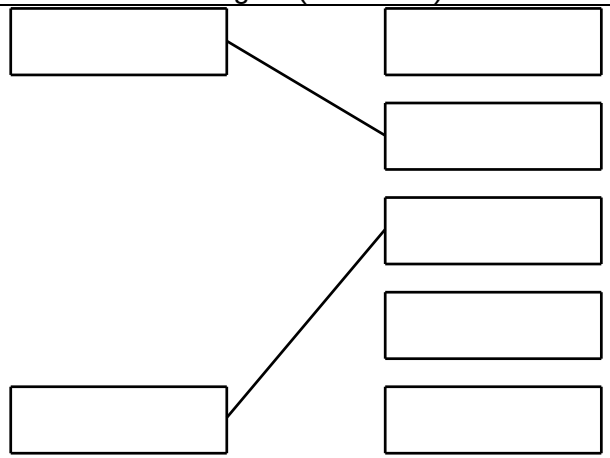
Question			Answer	Mark	Guidance
2	(a)	i	amplitude of (carrier) at S determined by voltage of signal at M	1 1	
2	(a)	ii	spike at 425 kHz smaller same-height spikes at 420 kHz and 430 kHz  	2	
2	(b)		9.28 kΩ (accept 9.2 or 9.3) EITHER $I = (15 - 1.8) / 68\times10^{3} = 1.94\times10^{-4}$ A $R = 1.8 / 1.94\times10^{-4} = 9278$ ... OR $(15\text{-}2.2) / 2.2 = 47\text{k}/R_2$ ... OR $2.2 = 15\times \frac{R_2}{47 + R_2}$	2	correct answer for [2] otherwise look for correct method for [1]
2	(c)		op-amp set up as amplifier for S; gain depends on resistance of MOSFET; which is determined by voltage at gate; so gain of amplifier altered by M;	1 1 1 1	

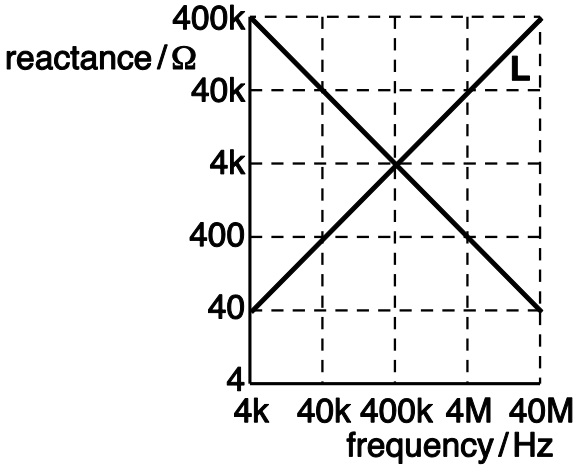
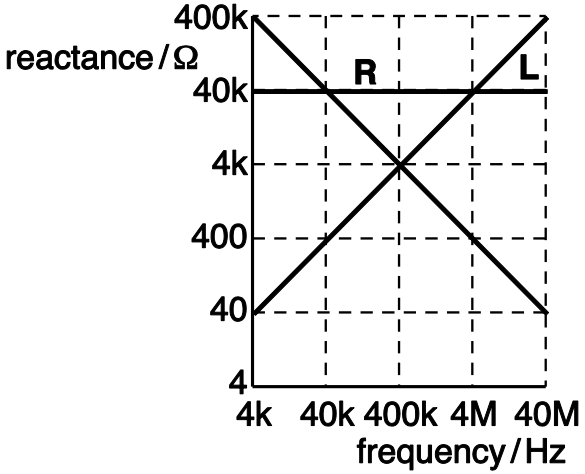
Question			Answer	Mark	Guidance
2	(d)	i	correct symbols for resistor, capacitor, diode circuit as shown below 	1 1	Diode symbol doesn't need a line thro it.
2	(d)	ii	diode rectifies signal / removes negative part of signal RC network filters out high frequency components sketch of AM signal at input sketch of matching demodulated signal at output 	1 1 1 1	**accept** smoothes signal **accept** output signal centred on zero

Question			Answer	Mark	Guidance
3	(a)		Removes frequencies above audible Effectively removes the carrier wave	1 1	NOT remove unwanted / preserve wanted signals Accept correct operation of circuit as explanation for [2]
3	(b)			4	Correct NAND gate monostable with NOT gate at output [1] *R* at least 10kΩ [1] *RC* = 4μs (actually 4.3 μs) Use of T = 0.7 *RC* to justify values [1]
3	(c)	i	(108 - 87.5)/0.2 = 102.5 or 102	1	**accept** reverse calculation: 100 stations gives 205 kHz answer must be an integer
3	(c)	ii	FM bandwidth is $5f_s$, AM bandwidth is $2f_s$ = 80 kHz channels = (108 - 87.5)/0.08 = 256 (or 250-60)	1 1	answer must be an integer ecf incorrect AM bandwidth between 10 and 100 kHz
3	(c)	iii	noise added to signal in transmission can be removed from FM by Schmitt trigger / limiter but not possible for AM	1 1 1 1	**accept** alternative answer: • AM codes with amplitude [1] • FM codes with frequency [1] • noise affect amplitude more than frequency [1]

Question			Answer	Mark	Guidance
4	(a)		**ST threshold calculation** • I = 13/380k = 3.4×10^{-5} A; • V = $3.4\times10^{-5}\times$ 150k = 5.13 V; **RG calculation** • $\frac{4 \times 5.13}{T} = \frac{13}{56k \times 1.0nf}$ • T = 8.8×10^{-5} s, so f = 11.3 kHz;	1 1 1 1	Method shown [1] Correct value [1] Method shown [1] Correct value [1] **accept** anything that rounds to 11 kHz with correct method for [2]
4	(b)	i		2	comparator with any input to M [1] correct input and output labels [1]
4	(b)	ii	voltage at input; sets mark-space ratio of output;	1 1	**ignore** amplitude / signal **ignore** frequency **ignore** description of op-amp behaviour
4	(c)	i		5	use of $= -\frac{R_f}{R_{in}}$ to calculate low frequency gain of (-) 0.6 [1] use of $f_0 = \frac{1}{2\pi RC}$ to calculate break frequency of 5.3 kHz [1] suitable log axes labelled [1] correct shape [1] correct break frequency [1] **accept** 5.3, 53, 530 ... as frequency axis labels

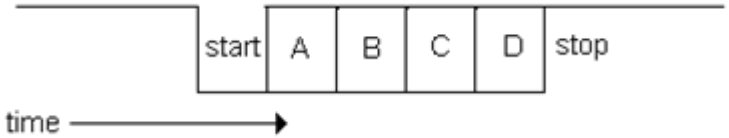
Question			Answer	Mark	Guidance
4	(c)	ii	break frequency is close to maximum signal frequency that can be correctly coded; need at least two samples per signal cycle; maximum signal frequency should be 11.3 / 2 = 5.65 kHz;	1 1 1	

Question			Answer	Mark	Guidance
5	(a)		noise is random signal (from components) interference is signal from other electrical systems	1 1	
5	(b)		any three of the following, [1] each single cable: • picks up interference from other electrical systems; • introduces random signal (noise); both cables in twisted-pair: • pick up same interference; • have different noise; • have opposite (polarity) of signal; difference amplifer • rejects interference; • transmits signal (and noise)	3	
5	(c)			2	each correct link for [1] **reject** multiple links

Question			Answer	Mark	Guidance
6	(a)	i	$X_L = 2\pi \times 1.6\times10^{-3} \times 40\times10^{3}$; = <u>402</u> Ω;	2	substitution [1] evaluation for [1]
6	(a)	ii		2	straight line through 400 Ω, 40 kHz [1] gradient of 45 degrees [1] **accept** missing label
6	(a)	iii		1	

Question			Answer	Mark	Guidance
6	(b)	i	$f_0^2 = \frac{1}{4\pi^2 LC}$ e.g.\ specify 1.6 mH = L so C = $\frac{1}{4\pi^2 f_0^2 L}$ = $\frac{1}{4\pi^2 \times (390 \times 103)^2 \times 1.6\ mH}$ = 104 pF	1 1 1 1	use of formula specify a value for either L or C powers of 10 answer
6	(b)	ii	to create sharper filter than simple LC circuit; so that only one carrier + sidebands gets through;	1 1	**accept** labelled gain-frequency graphs **accept** to improve selectivity

Question			Answer	Mark	Guidance
7	(a)		- 0.2;	1	
7	(b)		A at +5 V; E at -0.5; resolution = -0.5 × -0.2 = 0.1 V;	1 1 1	 ecf from 7(a) ecf: A = 1 V gives 0.05 V for [2]
7	(c)		CBA = 111 and use of summing amplifier formula; top of range is 0.7 V; bottom of range is 0 V;	1 1 1	

Question			Answer	Mark	Guidance
8	(a)	i		2	each bit correct for [1] stop bit must be immediately after D
8	(a)	ii	start bit tells receiver that word is about to arrive; stop bit returns cable to resting state (wtte); 	1 1	 **not** tells receiver that word is complete
8	(b)	i	maximum bit rate = 2 × 12 = 24 Mbits per second; so each bit lasts for $1/24 \times 10^{+6}$ = 42 ns	1 1	 **accept** reverse calculation **not** 128 ns
8	(b)	ii	each packet lasts for $1024 \times 42 \times 10^{-9}$ = 43μs; so packets per second = 1 / 43μs = 23000 s^{1}	1 1	**ignore** 10μs delay between packets **accept** 16×10^{3} or 15×10^{3} **allow** ecf from incorrect packet length

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>9</td><td>(a)</td><td></td><td>V = 5 - 2.1 = 2.9 V;
R = 2.9/5 x 10^{-3} = 580Ω;</td><td>1
1</td><td></td></tr>
<tr><td>9</td><td>(b)</td><td>i</td><td>B · $\overline{W}.X + \overline{X}.\overline{Y}$ for [2]
B · $(\overline{W}.X).(\overline{X}.\overline{Y})$ for [1]</td><td>2</td><td></td></tr>
<tr><td>9</td><td>(b)</td><td>ii</td><td>
<table>
<tr><th>Input signal</th><th>W</th><th>X</th><th>Y</th><th>B</th><th>A</th></tr>
<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>1.55 V</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>2.65 V</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
</table>
</td><td>4</td><td>[1] per correct column
ecf on incorrect W, X, Y: B · $\overline{W}.\overline{X}.\overline{Y}$ · $\overline{W}.X.Y$
no ecf from (b)(i)</td></tr>
<tr><td>9</td><td>(c)</td><td></td><td>number of levels = ($2^{\text{word length}}$=) 2^2 = 4
resolution = range/number of levels = 2.8/4 = 0.7 V</td><td>1
1</td><td>accept words, codes for levels
accept reverse argument
look for explanation and calculation for each mark</td></tr>
<tr><td>9</td><td>(d)</td><td></td><td>time for on cycle = 2 x 12 x 10^{-6} = 24 x 10^{-6} s;
frequency = 42 kHz / 42000Hz;</td><td>1
1</td><td>83000 Hz = 1 mark</td></tr>
</table>

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