OCR
Oxford Cambridge and RSA

GCE

Electronics

Unit **F615:** Communications Systems

Advanced GCE

Mark Scheme for June 2016

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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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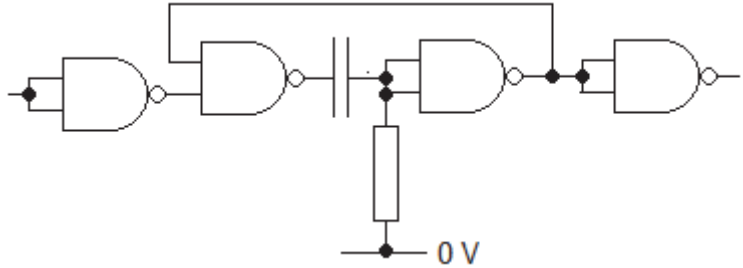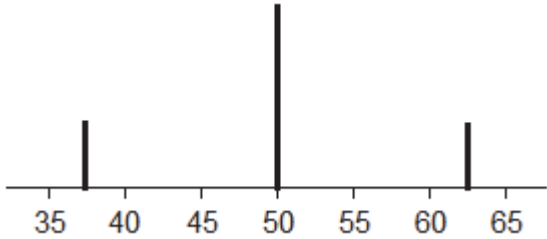
Annotations

1	BOD	31	BOD	Benefit of doubt
2	✖	21	Cross	Cross
3	ECF	241	ECF	Error carried forward
4	NBOD	191	NBOD	Benefit of doubt not given
5	〰	1841	Not Relevant	Expandable vertical wavy line
6	REP	271	REP	Repeat
7	TV	201	TV	Too vague
8	✔	11	Tick	Tick
9	0	1741	ZERO	Zero (big)
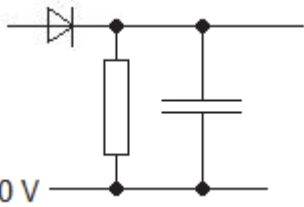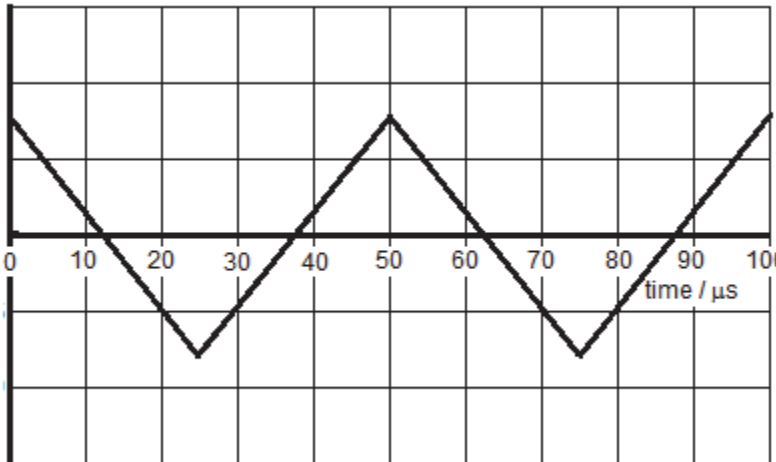
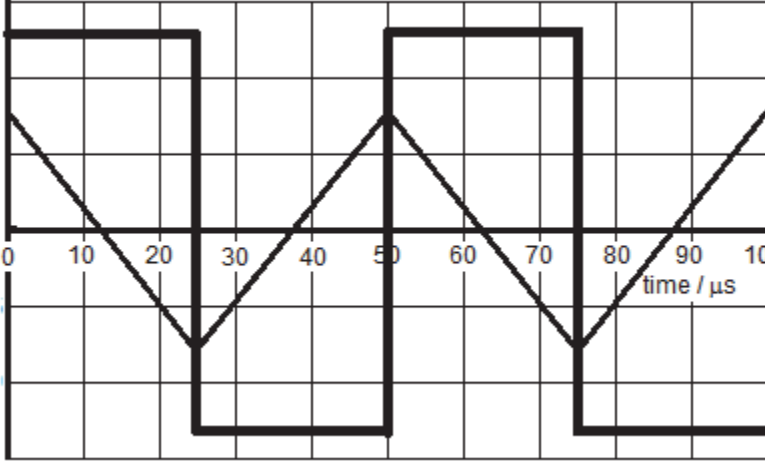| Question			Answer	Mark	Guidance
1	a		connection from C to T on Fig. 1.1; video signal does four cycles in each line; line sync pulses to start new line;	1 1 1	
	b		GFC connected to AND gate; 100 in decimal is 1100100 in binary; frame sync pulses every 100 rows / lines	1 1 1	Ok if expressed as decimal 64+32+4

	c	i	bit rate = 768 000 per second;
			 refresh rate = 768 000 / 12 800 = 60 Hz;
			 which is above 25 Hz;
			 so image will be flicker-free;
				1
				 1
				 1
				 1
					ecf incorrect bit rate
					 correct comment about appearance from their calculated frame rate

	c	ii	edges of pattern will be blurred; high frequency data will be lost;	1 1	
	d			4	two NAND gates as monostable [1] NOT gates at input and output [1](allow NOT or NAND) RC = 40 μs with R at least 1 kΩ [1] justified with $T = 0.7RC$ [1]

2	a	i	amplitude = 0.5 x 500 mV = 250 mV;
			 period = 4 x 20 = 80 μs;
			 frequency = $1/80 \times 10^{-6}$ = 12.5 kHz;
				1
				 1
				 1
					accept 220 mV to 280 mV
					
					 ecf from incorrect period of 160 μs (6.25kHz) or 20 μs(50kHz)

		ii		3	correct pattern [1] correct carrier frequency [1] correct placing of sidebands with ecf [1]
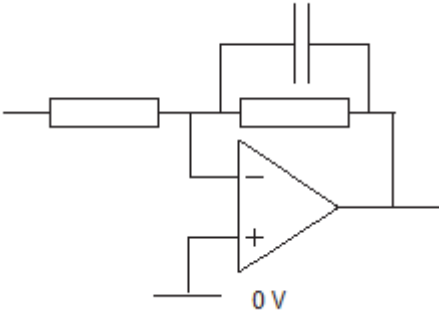
Question			Answer	Mark	Guidance
	b			3	correct circuit [1](must have 0V labelled) RC = from 13 µs to 6 µs [1] use of $f_0 = \dfrac{1}{2\pi RC}$ to justify values [1] Ignore subsequent circuit
3	a	i	175.0 - 173.8 = 1.2 MHz range; number = 1.2/0.2 = 6;	1 1	
		ii	prevent interference; with/from other broadcasters e.g. TV, mobiles, wif-fi;	1 1	 Not vague!
	b	i	voltage of signal; varies frequency of carrier for FM; varies amplitude of carrier for AM;	1 1 1	Not just 'depends on' Allow 'encoded on to frequency of carrier' Allow 'encoded on to amplitude of carrier'
		ii	bandwidth for FM = 2.5 bandwidth for AM; 6 x 2.5 = 15	1 1	 ecf on part a
		iii	FM less affected by noise/interference; use of Schmitt trigger / limiter **in receiver;** keeps frequency information / loses amplitude information; use of ST not possible in AM;	1 1 1 1	 Or comment on signal stored in amplitude
4	a	i		3	triangle wave; lines at 45 degrees by eye two complete cycles;(may begin at any point in wave) amplitude 7.5 V;(by eye)

Question			Answer	Mark	Guidance
		ii		3	square wave; correct crossing points (ecf part i); amplitude 13 V (by eye)
		Riii	= 30 k x (13 / 7.5); 52 kΩ;	1 1	method [1] answer [1] ecf on incorrect amplitude of X in graph.
	b		if signal goes above +7.5 V (or below -7.5 V), output of comparator will not change; signal needs to be sampled at least twice in each cycle;	1 1	Eg will not switch properly
	c			5	correct circuit [1] must have 0V resistors at least 1 kΩ [1] feedback parallel RC = 80 - 40 μs [1] justified by use of $f_0 = \dfrac{1}{2\pi RC}$ [1] feedback resistor 2.5 x input resistor [1]
5	a		(other) radio signals (with the same frequency); from electrical systems / circuits;	1 1	**ignore** noise

Question			Answer	Mark	Guidance
	b		strength of radio signal goes down;	1	Allow 'attenuated'
			signal-to-interference/noise ratio goes down;	1	Allow 'degraded '
			making it harder for receiver to reject interference;	1	
			quality of information gets worse;	1	
	c		(as current in) twisted-pair cable / shielded cable;	1	not just cable
			(as infrared in) optical fibre;	1	
6	a			4	each correct entry [1]
	b	i		4	inductor in parallel with capacitor [1] correct labels (in, out (any order)**, 0V or E symbol**) [1] correct inductor value [1] use of $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$ to justify value [1]
		ii	aerial supplies current over a range of frequencies; which pass through LC circuit to 0 V; LC has large impedance at narrow range of frequencies; and very low impedance at all others; so only voltage for one carrier and sideband appear at out;	5	Explanation in terms of reactances of individual components linked to output voltage.
7	a		$I = \dfrac{0.5}{2.2\times10^3} = 2.27\times10^{-4}\,\text{A}$; V = 15 - 1.5 = 13.5 V; $R = \dfrac{13.5}{2.27\times10^{-4}} = 59\,k\Omega$;	1 1 1	Not 60k

Question			Answer					Mark	Guidance
	b	i						2	**accept** low swapped for high throughout for [1]

X	Y	Z	B	A
low	low	low	1	1
high	low	low	0	1
high	high	low	1	0
high	high	high	0	0

Question			Answer	Mark	Guidance
	b	ii	$B = \overline{X}.\overline{Y}.\overline{Z} + X.Y.\overline{Z}$	1	accept $B = \overline{X}.\overline{Y} + Y.\overline{Z}$ accept correct expression consistent with truth table
		iii		3	use of NAND gates as inverters for X, Y and Z [1] each term correctly generated for [2] no ecf on incorrect expression for B except low for high swapped throughout ignore redundant gates
	c		R_A twice the value of R_B; R_C, R_D and R_E to give 0.5 V for BA = 01; Use of formula to justify values;	1 1 1	$R_c = 0.1R_a$ if $R_d = R_e$
8	a			6	each correct entry for [1]

Question			Answer	Mark	Guidance
	b	i	first 0 tells receiver (at end of link);	1	
			that a word is about to arrive;	1	
			final 1 leaves the link in resting state (so that next 0 can be detected);	1	
		ii	sample rate per channel = 3×10^4 Hz;	1	
			bit rate = $4 \times 12 \times 3 \times 10^4 = 1.44 \times 10^6$;	1	
			bandwidth = 720 kHz;	1	
		iii	levels = 2^{10} = 1024;	1	
			range = 2 x 1.2 = 2.4 V;	1	
			resolution = 2.4/1024 = 2.34 mV;	1	**ecf**: 2.4 / 4096 = 0.59 mV for [2], 1.2 / 1024 = 1.2 mV for [2], 1.2 / 4096 = 0.29 mV for [1]
9	a		one of the signals S appears at L;	1	Accept enumeration of states
			depending on the binary word at BA;	1	
			a different signal for each of the different words;	1	
	b		each signal placed on link;	1	
			for a short interval of time;	1	
			one after the other;	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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