GCE

Electronics

Unit **F615:** Communications Systems

Advanced GCE

Mark Scheme for June 2015

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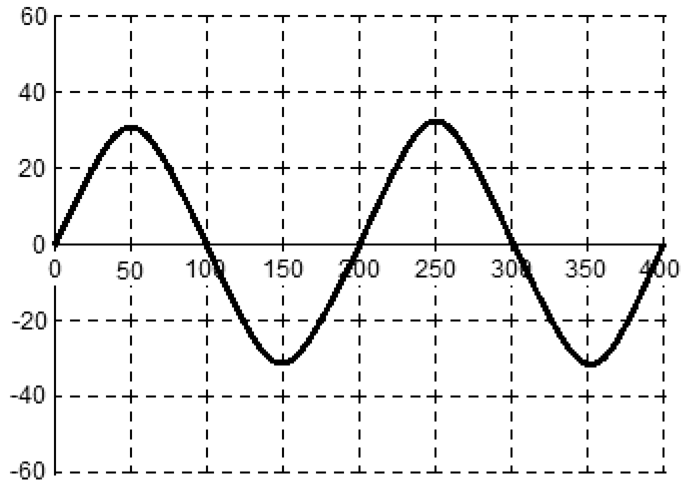
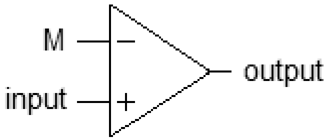
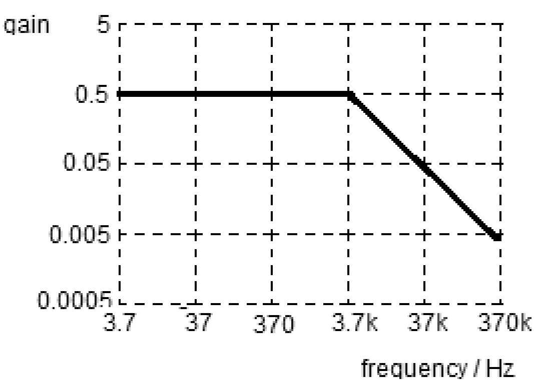
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

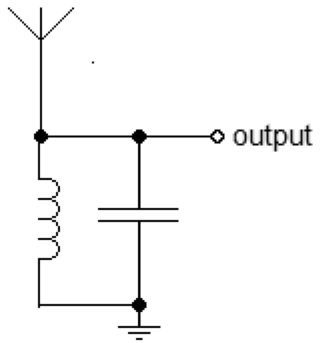
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Question			Answer	Mark	Guidance
1	a	i	set intensity / brightness; of each pixel; one after the other / from left to right in successive rows / from top to bottom (on the screen);	1 1 1 1	**ignore** raster scan
		ii	as each pulse arrives; start to scan a new row of pixels;	1 1	**not just** new line
			pixels per second = 320 / 80µ = 4.0×10^6; bandwidth = 2.0 MHz;	1 1	**no ecf** for incorrect pixel rate
	iii iv		frame display time = 220 × 80µ = 17.6 ms; refresh rate = 57 Hz; greater than 25 Hz; so image is flicker-free;	1 1 1 1	**accept** range of 20 to 30 Hz **ecf** from calculated refresh rate if less than 25 Hz
	b		two more cables needed; allows separate video signals (for three pixels in a cluster); for red, green and blue pixels;	1 1 1	**ignore** RGB
2	a			3	correct sinusoidal shape with constant amplitude [1] correct amplitude [1] correct period [1] **accept** any phase

Question			Answer	Mark	Guidance
	b		Z; Y; 113; X	2	113 kHz for [1] X, Y and Z correct for [1] **accept** X and Y interchanged
	c	i	break frequency from 5 kHz to 10 kHz; use of $f_0 = \frac{1}{2\pi RC}$; *C* between 50 pF and 100 pF;	1 1 1	**no ecf** for incorrect break frequency
		ii	**transfer characteristic** • diode only conducts in forward bias; • with voltage drop; • which rises steeply with increasing current; **circuit operation** • only <u>negative</u> parts of signal amplified; • carrier frequency filtered out by capacitor and (feedback) resistor	1 1 1 1 1	**accept** any value below 1 V **look for** high quality responses to circuit operation **accept** (rectified) signal smoothed by capacitor and resistor **accept** treble cut filter as capacitor and feedback resistor **ignore** references to gain
3	a		output has a frequency of 27.2 MHz (for zero volt signal); frequency increases/decreases with increasing signal voltage; amplitude of output remains constant;	1 1 1	**ignore** amplitude
	b		bandwidth = 200 kHz maximum frequency = 40 kHz	1 1	**no ecf** on incorrect bandwidth
	c		removes noise / interference added to FM signal; by restoring FM signal to a square wave / digital signal;	1 1	
	d		output of monostable is a fixed duration pulse; for each cycle/pulse of FM carrier; so mean voltage of monostable output changes for changing frequency of FM carrier; (treble cut) filter removes carrier frequencies; smoothing / averaging the pulses (producing a copy of the original signal);	1 1 1 1 1	**accept** rising / falling edge for cycle **accept** pulse spacing depends on frequency of carrier

Question			Answer	Mark	Guidance
4	a		**ST threshold calculation** • I = 13/42k = 3.09×10^{-4} A; • V = 3.09×10^{-4} × 27k = 8.4 V; **RG calculation** • $\frac{4 \times 8.4}{T} = \frac{13}{15\text{k} \times 3.3\text{n}}$ • T = 1.3×10^{-4} s, so f = 7.8 kHz;	 1 1 1 1	 method shown [1] **accept** 13 x (27/42) **not** 13 x (-27/42) correct value [1] method shown [1] correct value [1] **accept** anything that rounds to 8 kHz with correct method for [2]
	b	i		2	comparator with any input to M [1] correct input and output labels [1]
		ii	voltage at input; sets mark-space ratio of output;	1 1	**ignore** amplitude / signal **ignore** frequency **ignore** description of op-amp behaviour
	c	i		5	use of $G = -\frac{R_f}{R_{in}}$ to calculate low frequency gain of (-) 0.51 [1] use of $f_0 = \frac{1}{2\pi RC}$ to calculate break frequency of 3.7 kHz [1] suitable log axes labelled [1] correct shape [1] correct break frequency [1] **accept** 4, 40, 400 ... as frequency axis labels
		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 7.8 / 2 = 3.9 kHz;	 1 1 1	

Question			Answer	Mark	Guidance
5	a		Any of the following for [1]; • put metal shielding around cables • keep cables away from other systems • keep cables short idea that interference is signal from other circuits;	1 1	**accept** use optical fibre [1] as cladding stops outside signals [1] **accept** use frequency / digital coding [1] as intereference can be removed by ST (at receiver) [1]
b			any **two** of the following: • both cables follow same path • pick up the same interference • so can be removed by difference amplifier	2	**not** noise
	c		signal at A is copied to C by voltage follower; signal at A is inverted and placed at B; signals arrive at D and E with interference; difference amplifier cancels out interference; and recreates (double) the original signal (at F);	1 1 1 1 1	
6	a		each station is allocated a channel / carrier frequency; with a unique range of frequencies / bandwidth;	1 1	**allow** frequency for carrier
	b	i	channel bandwidth = 9 kHz; channels = (1607 - 527) / 9 = 120	1 1	**ecf** 4.5 kHz gives 240 channels for [1]
		ii	much larger bandwidth per channel; so fewer channels / stations in the band;	1 1	
iii			EITHER FM (receivers) can eliminate noise; by using limiters / Schmitt triggers; to restore shape of signal; OR AM (receivers) can't eliminate noise; because it affects amplitude; so can't be separated from signal by demodulator;	 1 1 1	**accept** interference for noise, **accept** less susceptible to noise

Question			Answer	Mark	Guidance
7	a			5	correct arrangement of components [1] **ignore** resistor in series with aerial earthing / 0 V shown <u>and</u> output labelled [1] $LC = 1.9\times10^{-15}$ s [1] C in range 1 pF to 1 μF [1] use of $f_0 = \frac{1}{2\pi\sqrt{LC}}$ to justify correct values [1]
	b	i	filter centre frequency 470 kHz; oscillator = 3650 + 470 = 4120 kHz;	1 1	**accept** 3180 kHz for [2] **accept** 4100, 4140, 3200 or 3160 kHz for [1]
		ii	any four of the following: • oscillator produces signal of one frequency; • which is at carrier ± filter frequency; • which amplitude modulates tuner signal in mixer; • to produce a copy of tuner signal; • which can pass through filter;	4	**not** mixes / combines **accept** create sidebands
	c	i	amplifier; boosts signals from weak transmitter;	1 1	**accept** aerial [1] altering position / length increases signal from weak stations [1].
		ii	filter; only lets through carrier and sidebands from one transmitter;	1 1	**not** tuned circuit
8	a	i	takes (serial) bits from link one after the other; assembles them into (parallel) words;	1 1	**allow just** serial-to-parallel converter for [1]
		ii	takes in binary words; outputs corresponding voltage;	1 1	**allow just** digital-to-analogue converter for [1]
	b	i	number of states = 4/0.025 = 160; $2^7 = 128$, $2^8 = 256$; so needs 8 bits;	1 1 1	**accept** $\log_2 160 = 7.32$ correct answer with no working for [1]
		ii	must sample twice in each cycle; sample frequency = 1/125μ = 8 kHz; maximum signal frequency = 4 kHz;	1 1 1	

Question			Answer	Mark	Guidance
	c	i	any five of the following; • pulse sets flip-flop • makes register load word from input • AND gate with one input high outputs pulses • clock pulses appear at CK • contents of register / bits appear at output in turn • counter output increases on each clock pulse • logic system resets flip-flop and counter at end	5	
		ii	need one for each bit of the word at input; one for the start bit (before the word); one for the stop bit (at the end of the word);	1 1 1	
			Total	107	
			QWC	3	Overleaf
			=	110	

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