Oxford Cambridge and RSA

GCE

Electronics

Unit **F615:** Communications Systems

Advanced GCE

Mark Scheme for June 2014

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

Annotation	Meaning of annotation
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.

Subject-specific Marking Instructions

Accept +5 V, 1 and high as equivalent throughout

Accept 0 V, 0 and low as equivalent throughout

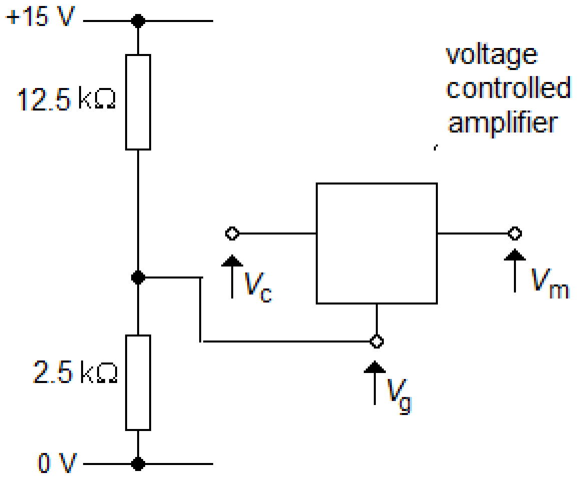
Accept numerical answers which round up to values in mark scheme

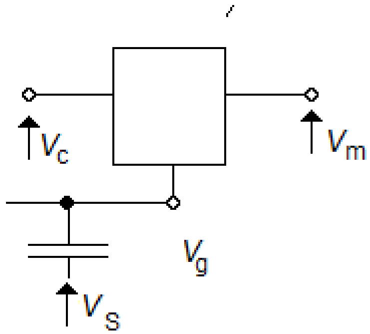
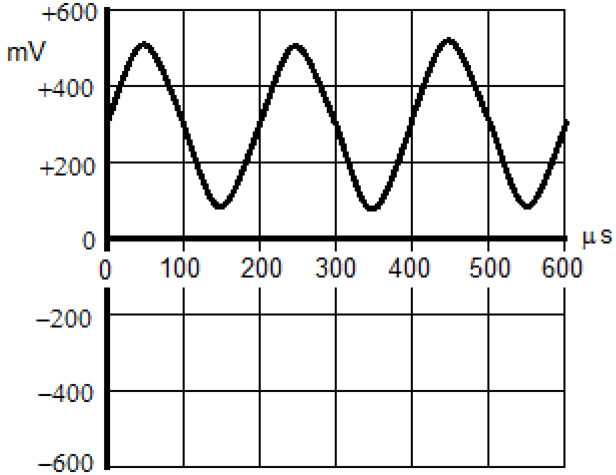
Method marks require correct values substituted into correct equation. Accept k, μ etc as powers of ten.

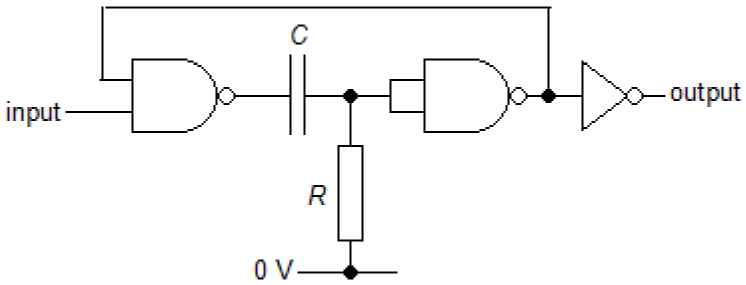
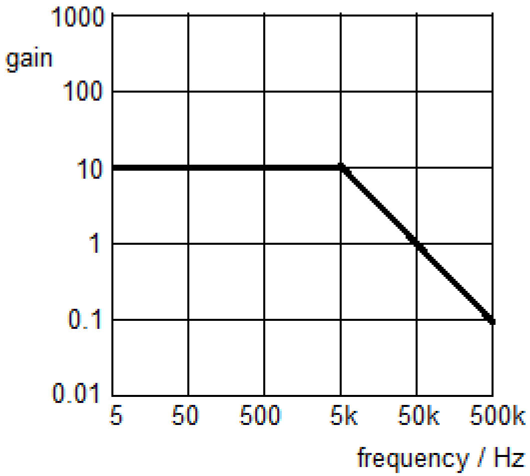
$$V_g = V_s \frac{R_b}{R_b + R_t} = 15 \times \frac{2.5\text{k}}{2.5\text{k} + 12.5\text{k}} = 2.5\text{ V}$$

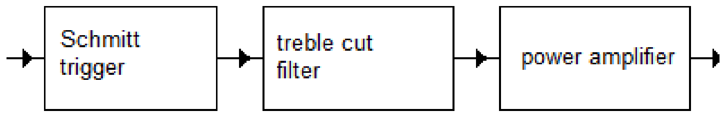
Question			Answer	Mark	Guidance
1	a		R(ed), G(reen) and B(lue) control intensity of pixels; which are red, green and blue; one after the other along a line; line sync signals start of a new line; frame sync signals end of last line / start of first line (of a frame) / start of a new frame (of lines);	1 1 1 1 1	**accept** brightness

	b		packet has start and stop bit;
			payload is (7 - 2 =) 5 bits;
			number of levels = 2^5 = 32;
				1
				1
				1
					accept reverse calculation e.g. $\log_2 30 = 4.9 \approx 5$
					accept 2^7 = 128 for [1]

	c		bit rate = 2 x 170 = 340 MHz; packet rate = 340 / 7 = 49 MHz;	1 1	**accept** ecf incorrect bit rate e.g. 170 / 7 = 24 MHz for [1]
	d		period = 5.5 x 2×10^{-3} = 11×10^{-3} s; frequency = 1/ 11×10^{-3} = 91 Hz;	1 1	**allow ecf** on incorrect period from 10 ms to 12 ms for [1]
2	a	i		3	voltage divider between supply rails connected to V_g [1] correct ratio to hold terminal at 2.5 V [1] **accept** 2.4 V or 2.6 V justified by appropriate calculation [1] EITHER $I = \frac{V}{R} = \frac{15}{12.5\times10^3 + 2.5\times10^3} = 1.0\times10^{-3}$ A $V = IR = 1.0\times10^{-3} \times 2.5\times10^3 = 2.5$ V OR $V_g = V_s \frac{R_b}{R_b + R_t} = 15 \times \frac{2.5k}{2.5k + 12.5k} = 2.5$ V **allow ecf** on incorrect voltage for [2]

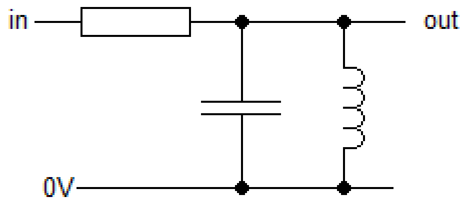
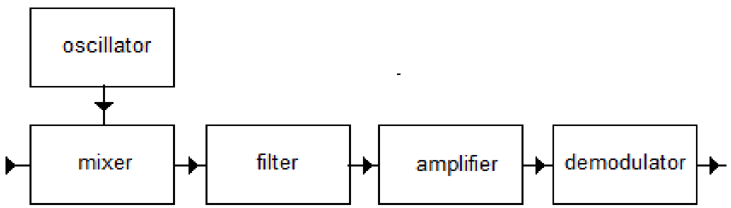
Question			Answer	Mark	Guidance
		ii		1	capacitor with one terminal directly connected to the gain control terminal and the other terminal labelled V_S [1] **accept** missing arrow **accept** label input instead of V_S
		iii	1.0 V; to keep V_g between 3.5 V and 1.5 V; so that changes in V_S can result in changes of gain / so that V_g remains on linear part of transfer characteristic;	1 1 1	**accept** 1.1 V or 0.9 V **ignore** references to distortion of signal being modulated
	b	i	$C = \frac{1}{2\pi \times 220k \times 5k}$; 145 pF	1 1	**accept** 150 pF to 30 pF for [2] **ecf** 50 Hz gives 14 500 pF for [1]
		ii		3	sine wave with period of 200 μs [1] amplitude 200 mV [1] centre value +300 mV [1] **accept** any phase

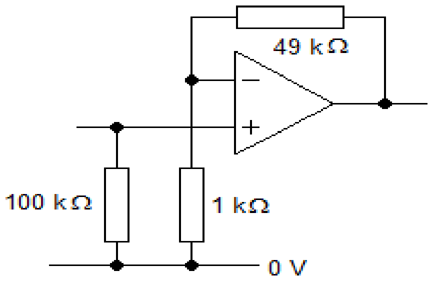
Question			Answer	Mark	Guidance
3	a		converts f.m. signal to square wave; to remove noise / to remove interference / to provide triggering edge for monostable / clean signal;	1 1	**accept** regenerates/restores f.m. signal **accept** converts f.m. to digital signal
	b			4	correct NAND gate monostable with NOT gate at output [1] *R* at least 10 kΩ [1] *RC* = 3 μs [1] use of *T* = 0.7*RC* to justify values [1]
	c	i		4	show calculation of break frequency [1] $\frac{1}{2\pi \times 32\text{k} \times 1\text{n}} = 5.0 \times 10^3\,\text{Hz}$ show calculation of low frequency gain [1] $\frac{32\text{k}}{3.2\text{k}} = 10$ draw gain of 10 below 5 kHz [1] dropping at 45° above 5 kHz [1] **allow ecf** for graph on incorrect calculation of b.f. or gain
		ii	maximum signal frequency = 5 kHz; bandwidth = 5 x 5 = 25 kHz;	1 1	**look for** bandwidth equal to break frequency from (c)(i) **allow ecf** on incorrect bandwidth for (c)(i) for [2]

Question			Answer	Mark	Guidance
4	a		non-inverting (plus) input must go above 0 V; so current in feedback resistor = 13/52k = 250 μA; voltage across input resistor = 250μ $\times$ 16k = 4 V;	1 1 1	**look for** explicit statement, not just implicit in calculations **accept** correct use of voltage divider rule for [2] **not** use of gain formula e.g. $G = \frac{R_f}{R_{in}}$
	b		$8 = -13 \frac{\Delta t}{120\text{k} \times 330\text{p}}$; $\Delta t = 24\ \mu\text{s}$;	1 1	correct substitution [1] final value [1] **accept** 12 μs for [1] **ecf:** 15 V at opamp output gives 21 μs for [1]
	c		time between samples is 48 μs; need at least two samples per cycle of input; input frequency less than 1 / 96μ = 10 kHz;	1 1 1	**ecf** from (b) e.g. 12 μs gives 24 μs between samples **allow ecf** from incorrect sample time **allow ecf** from incorrect time for one cycle
	d	i		2	each correct entry for [1]
		ii	any one of the following • reduces output impedance of system • provides current to drive the next stage • provides isolation for demodulator and next stage	1	
5	a		infrared	1	**accept** IR, (visible) light
	b		intensity / strength / height of pulses falls; as they lose energy / are absorbed;	1 1	**accept** pulse shape changes for [1] **accept** pulse picks up noise or interference for [1] **accept** pulse is (internally) reflected for [1]
	c		low noise (from fibre); pulses can be regenerated at receiver; by Schmitt trigger / limiter;	1 1 1	**accept** low interference (from outside fibre)

Question			Answer	Mark	Guidance
	d	i	many electrical devices emit radio waves ; signal intensity drops as waves move away from source; so interference can easily alter signal / give low signal-to-noise ratio;	1 1 1	**accept** other radio stations broadcast signals **accept** any reason for signal strength dropping with distance
		ii	code the signal in the wave frequency (as in FM or PWM); as frequency can be restored at receiver; noise / interference affects amplitude (not frequency);	1 1 1	**accept** digital alternative: code the signal as pulses of waves [1] as used in digital transmission systems (e.g. DAB) [1] as pulses can restored at receiver [1]
6	a		allows many phones to communicate with one mast; FDM gives each phone a different range of frequencies; so that they don't interfere/disrupt with each other;	1 1 1	**accept** channel
	b		915.625 - 909.375 = 6.25 MHz; phones = 6250 / 64 = 97	1 1	**accept** 97.6 or 98 for [1]

	c		signal bandwidth = 64k / 2 = 32 kHz;
			FM bandwidth = 5 x 32k = 160 kHz;
			phones = 6250 / 160 = 38 or 39;
				1
				1
				1
					allow ecf on incorrect signal bandwidth
					accept just correct answer for [3]

	d		 	2	correct circuit with correct symbols [1] correct labels on correct circuit including 0 V rail [1] **accept** inductor with any number of loops **accept** earth symbol for 0 V
7	a		 	5	oscillator correct [1] mixer correct [1] ... filter - amplifier - demodulator [3] ... filter - demodulator - amplifier [2] ... amplifier - filter - demodulator [2] ... anything - filter - demodulator [1] ....filter - demodulator - anything [1]
	b		$C = \frac{1}{4\pi^2 \times 4.7\text{n} \times 902.5\text{M}^2}$; C = 6.6 pF;	1 1	look for correct transposition and substitution

Question			Answer	Mark	Guidance
	c		selective receiver can block out neighbouring stations; superhet has fixed frequency filter to do selecting; so can have steeper edges; than variable LC circuit in simple receiver;	1 1 1 1	**accept** (fixed frequency) stacked filter
	d			4	correct input resistance of 100 kΩ [1] correct circuit [1] all resistors between 1 kΩ and 10 MΩ [1] feedback resistor 49 x pull-down resistor [1] **ecf:** for correct inverting amplifier circuit [1] with gain of -50 with resistors between 1 kΩ and 10 MΩ [1] and input resistance of 100 kΩ [1]
8	a	i	voltage of output is determined by (binary) word at input;	1	**accept** level of analogue signal
		ii	number of levels = 2^6 = 64; 64 - 1= 63 steps so range is 63 x 0.1 = 6.3 V;	1 1	**accept** 63 is largest decimal value for 6 bit binary number
	b		a rising edge at L; reads (counter) word at input; and displays/stores it at output (until next rising edge at L);	1 1 1	**not** pulse or high at L
	c		counter has 2^6 = 64 steps for each sample; sample frequency = 1024 kHz / 64 (= 16 kHz);	1 1	**not** just 2^6 = 64
	d		(each pulse at **P** makes) counter output increase (by 1); making DAC output **A** increase (by 100 mV); until **A** is greater than **input**; when the opamp/comparator output **L** rises; and latch transfers current counter signal to **output**;	1 1 1 1 1	
9	a		destination address to identify the intended receiver; source address to identify the sending computer; payload contains information e.g. text, video, music; checksum to allow errors to be detected / corrected;	1 1 1 1	**not** just the name of each part, [1] for all four named without explanation **accept** correct explanation with incorrect name

Question			Answer	Mark	Guidance
	b		each computer • waits until no signal on cable before transmitting; • stops if packet is corrupted by another signal; • waits for a (random) time before trying again;	 1 1 1	**accept** TDM alternative: • each computer has a different time slot [1] • and can only use line in this time [1]
	c		(serial) transmitter needs switch; so that only one (output) device is connected to cable at a time / transmitter can be disconnected from cable; receivers don't affect the signals on the cable;	1 1 1	 **accept** receiver always connected to detect packets / clashes

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.

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

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored