OCR
RECOGNISING ACHIEVEMENT

GCE

# Electronics

Advanced GCE

Unit **F615:** Communications Systems

# Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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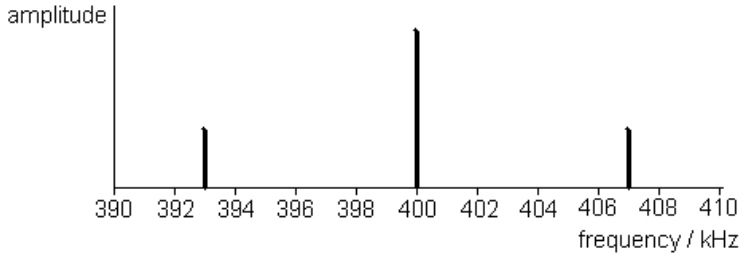
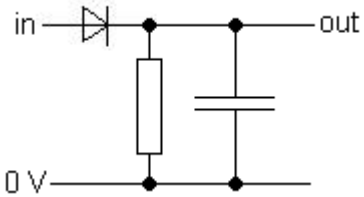
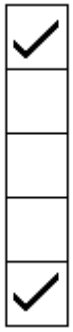
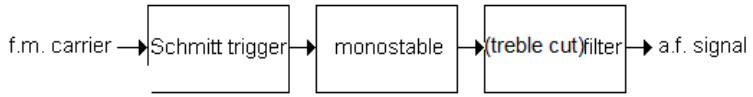
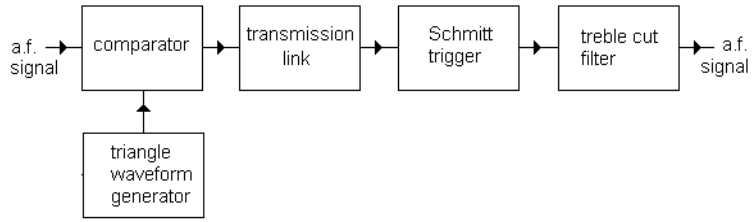
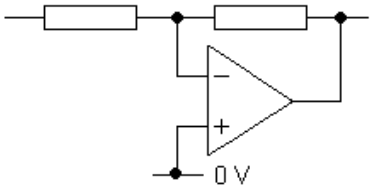
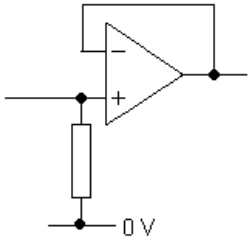
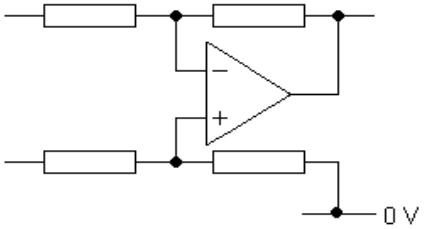
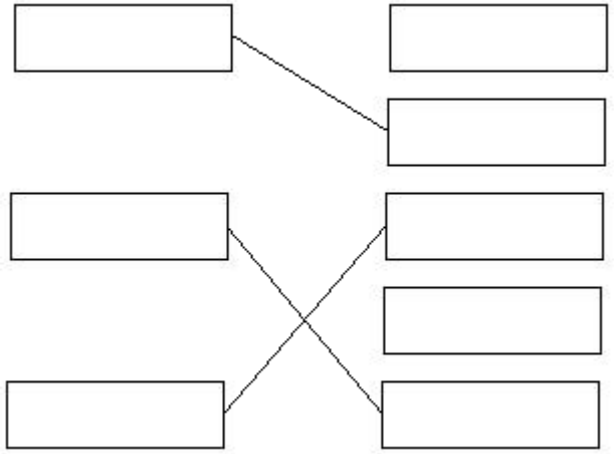
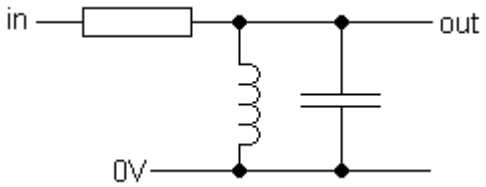
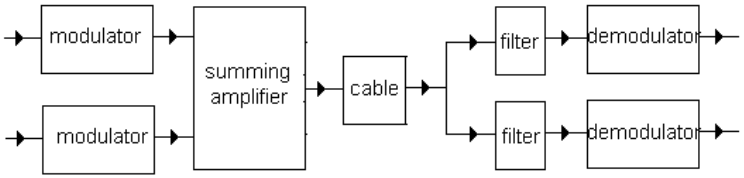
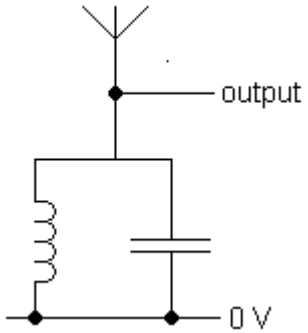
| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 1 | a | i | $2^6 = 64$ (which is greater than 42); | 1 | **accept** $\log_2 42 = 5.4$ (which rounds up to 6)<br>look for use of the $2^n$ rule to justify 6 bits<br>**not just** $2^5 = 32$ (so need 6 bits) |
| 1 | a | ii | any three of the following, [1] each:<br>• extra bits on either side of (six-bit) data word;<br>• start bit to tell screen that word is about to arrive;<br>• stop bit to allow next start bit to be recognised / restores line to resting state;<br>• start is 0, stop is 1 / start and stop have different values; | 3 | **ignore** references to function of six-bit word<br>**not just** extra bits are called start and stop<br>**accept** receiver |
| 1 | a | iii | word rate = $1024 \times 1280 \times 40 = 5.243 \times 10^7$ $s^{-1}$;<br>bit rate = $5.243 \times 10^7 \times 8 = 4.194 \times 10^8$ $s^{-1}$;<br>bandwidth = 209.7 MHz | 1<br>1<br>1 | <br>ecf incorrect word rate<br>ecf incorrect bit rate **accept** 210 / 209 MHz |
| 1 | b | | any three of the following, [1] each:<br>• raster scan delivers (video) signal to each LED in turn;<br>• from one end of a row to the other (owtte);<br>• line sync signal indicates start of the next row;<br>• frame sync signal indicates start of the next frame; | 3 | <br>**accept** pixel for LED<br><br><br>**accept** start of first line instead of new frame |
| 1 | c | | one cable each for red and blue signals;<br>to control intensity of red and blue LEDs / pixels;<br>(full colour) requires red, blue and green; | 1<br>1<br>1 | **accept** separate cables for red, green and blue<br>**look for** stepped analogue not binary signal<br>**accept** RGB |
| 2 | a | i | amplitude = 10 mV;<br>period = 200 μs<br>frequency = 5 kHz | 1<br>1<br>1 | <br><br>ecf incorrect period |
| 2 | a | ii | bandwidth = 10 kHz | 1 | ecf: 2×frequency from (i) for [1] |

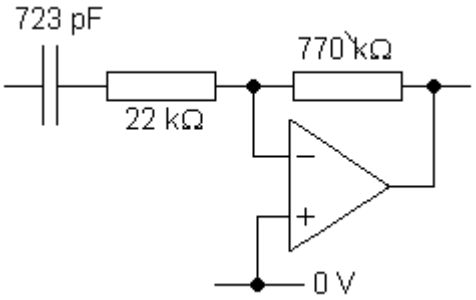
| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **2** | b | i |  | 3 | carrier spike at 400 kHz [1]<br>sideband spikes, same size, less than (half size of) carrier spike [1]<br>at 407 kHz and 393 kHz (by eye) [1] |
| **2** | b | ii |  | 4 | correct circuit symbols [1]<br>correct circuit, including labels and 0 V [1]<br>use of $f_0 = 1/2\pi RC$ to justify values [1]<br>1.6 μs ($f_0$ = 100 kHz) ≤ $RC$ ≤ 16 μs ($f_0$ = 10 kHz) [1]<br><br>**accept** any value of $R \geq 1\text{k}\Omega$<br>**accept**  |
| **3** | a | | frequency of carrier;<br>fixed by voltage of signal; | 1<br>1 | <br>**not** amplitude of signal |
| **3** | b | |  | 2 | correct pattern for [2]<br>one mistake for [1] |

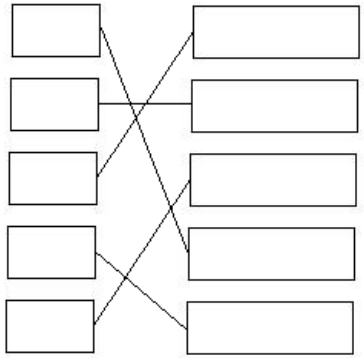
| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **3** | c | i |  | 3 | correct first box for [1]<br>**accept** logic gate / limiter / inverter for Schmitt trigger<br>correct second box for [1]<br>correct third box for [1]<br>**accept** smoother / filter for treble cut filter<br><br>**accept** monostable anywhere before filter for [2]<br>**accept** monostable anywhere for [1] |
| **3** | c | ii | Schmitt trigger (removes noise by) converting signal to a square wave;<br>monostable produces a fixed length pulse (at start of each cycle);<br>fliter removes frequency components above audio frequency / removes carrier; | 1<br>1<br>1 | each correct description of a stage for [1], no ecf on 3ci |
| **4** | a | |  | 4 | each correct entry for [1] |
| **4** | b | i | (+3 × 1.5 - 3 × 1.0) / 2.5 = 0.60 V | 1 | look for calculation of average voltage |
| **4** | b | ii | (PWM) sampling frequency = $1/2.5\times10^{-3}$ = 400 Hz;<br><br>must sample (at least) twice in each cycle; | 1<br><br>1 | look for working out of frequency from graph<br>**accept** working backwards from 400 Hz to 2.5 ms<br>**not just** 200 = 400 / 2<br>**accept** reference to Nyquist criterion |

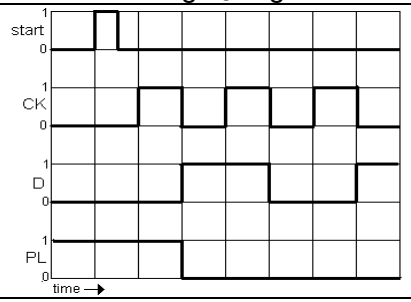
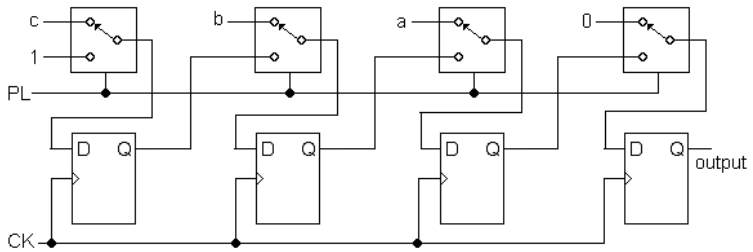
| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **5** | a | |  | 1 | look for 0 V rail |
| | | |  | 1 | accept absence of pull-down resistor or inclusion of feedback resistor |
| | | |  | 1 | look for 0 V rail |
| **5** | b | | any three of the following, [1] each<br>single cable:<br>• picks up interference from other electrical systems;<br>• introduces random signal (noise);<br>both cables in twisted-pair:<br>• pick up same interference;<br>• have different noise;<br>• have opposite (polarity) of signal;<br>difference amplifer<br>• rejects interference;<br>• transmits signal (and noise) | 3 | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 5 | c | |  | 3 | each correct link for [1]<br><br>**reject** multiple links |
| 5 | d | | any three of the following, [1] each<br>• Schmitt triggers / limiters;<br>• can remove noise / recover information;<br>• for FM and PWM but not AM / FM and PWM have greater SNR than AM;<br>• noise affects amplitude more than frequency<br>• FM and PWM are digital, AM is analogue (owtte) | 3 | **accept** interference as noise<br>**not** cleans up signal |
| 6 | a | i |  | 2 | correct circuit [1]<br>input, output and 0 V correctly labelled on correct circuit [1] |
| 6 | a | ii | $L = \frac{1}{f^2 4\pi^2 C}$;<br>$f$ = 750 kHz<br>$f = 750\times10^3$ Hz, $C = 47\times10^{-12}$ F<br>$L$ = 958 μH | 1<br><br>1<br>1<br>1 | evidence of correct rearrangement [1]<br><br>correct value from graph from 745 to 755 kHz for [1]<br>look evidence of correct units conversion<br>**accept** 960 μH, ecf incorrect $f$ and units conversion |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 6 | a | iii | any three of the following for [1] each:<br>• at resonant frequency, impedance of LC much larger than R;<br>• so most of signal appears across LC / little signal across R;<br>• above and below resonant frequency, impedance of LC much smaller than R;<br>• so most of signal appears across R / little signal across LC /;<br>• at low frequencies inductor reactance is small, at high frequencies capacitor reactance is small;<br>• L and C only same impedance at resonance, otherwise one always smaller than the other; | 3 | look for high quality detail to earn each mark |
| 6 | b | i |  | 5 | modulators in first two boxes on left [1]<br>correct summing amp [1]<br>correct cable [1]<br>both filters correct [1]<br>demodulator after filter in last pair of boxes [1]<br><br>**accept** swapped filters and demodulators for [1] |
| 6 | b | ii | bandwidth per channel = 2 × 5 = 10 kHz;<br>channels = 12000/10 = 1200; | 1<br>1 | <br>ecf incorrect bandwidth e.g 2400 channels for [1] |
| 7 | a | |  | 2 | correct circuit [1]<br>output and 0 V / earth / ground indicated on correct circuit [1]<br>**accept** variable capacitor |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 7 | b | | EITHER<br>increase size of rf signal / voltage / current;<br>to detect weak stations / improve sensitivity;<br>OR<br>reduce current / power drawn from tuned circuit;<br>to improve selectivity / reduce bandwidth of tuned circuit; | <br>1<br>1<br><br><br> | <br>**not** just amplifies / boosts signal<br>**not** make output louder<br><br><br> |
| 7 | c | | filter centre frequency = 0.35 MHz<br>local oscillator = 27.62 + 0.35 = 27.97 MHz; | 1<br>1 | **ecf** incorrect IF (between 0.40 and 0.30 MHz) for [1]<br>**accept** 27.62 - 0.35 = 27.27 MHz for [2]<br>look for 4 sig.figs.<br>**accept** anything from 28.02 MHz to 27.92 MHz for [1]<br>**accept** anything from 27.32 MHz to 27.22 MHz for [1] |
| 7 | d | |  | 5 | correct circuit [1]<br>input resistor 22 kΩ [1]<br>feedback resistor 35 times input resistor [1]<br>use of $C = 1/2\pi Rf_0$ [1]<br>capacitor 723 pF (accept 700-750 pF) [1]<br><br>no ecf on incorrect filter circuit for value and justification of *C*<br><br>look for *RC* = 16 μs |
| 8 | a | i | - 0.4; | 1 | |
| 8 | a | ii | A at +5 V;<br>E at $-5 \times 5\times10^3 / 40\times10^3 = -0.625$ V;<br>resolution = $-0.4 \times -0.625 = 0.25$ V; | 1<br>1<br>1 | <br>ecf from 8ai<br>ecf: A = 1 V gives 0.05 V for [2] |
| 8 | a | iii | CBA = 111 and use of summing amplifier formula;<br>top of range is 1.75 V;<br>bottom of range is 0 V; | 1<br>1<br>1 | alternative: $2^3 = 8$ levels so max output = (8-1) × 0.25;<br>ecf on incorrect resolution:<br>top of range = 7 x resolution) for [2], 8 x resolution for [1]<br>ecf: A, B and C at 1 V gives 0.35 V for [1] |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **8** | b | i |  | 4 | all five correct for [4]<br>three or four correct for [3]<br>two correct for [2]<br>one correct for [1] |
| **8** | b | ii | any two of the following, [1] each<br>• information about setting of multiplexer (X);<br>• so that demultiplexer (Y) is set correctly;<br>• either by adding a destination address to each packet of data;<br>• or by sending synchronisation signals between packets of data;<br>• so that signals at one input always arrive at the correct output<br>• start and stop bits<br>• so that SPC knows when a word arrives (owtte) | 2 | **ignore** references to parity / checksum / data bits |
| **9** | a | i | 128 kHz | 1 | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 9 | a | ii | any **two** of the following, [1] each<br>• crystal oscillator gives more stable frequency;<br>• transmitter needs to contain matched oscillator;<br>• resistors and capacitors change value with time;<br>• relaxation oscillator would need adjusting to obtain correct value of frequency;<br>• easier to obtain desired frequency than selecting R and C component values; | 2 | **not** more accurate / precise / reliable frequency |
| 9 | b | i | any four of the following:<br>• $\overline{Q}$ initially high;<br>• counter reset (and ignores pulses) when (its) R is high;<br>• (until pulse at start) copies (1 at) D to Q;<br>• so $\overline{Q}$ goes to 0<br>• counter no longer reset (and reacts to pulses);<br>• flip-flop resets when C and F both high;<br>• making $\overline{Q}$ high and resetting counter; | 4 | |
| 9 | b | ii |  | 3 | correct square wave for C for [1]<br>D changes on each falling edge of CK for [1]<br>PL goes low and stays low when D goes high for [1]<br><br>apply ecf from one row to the next one down. |
| 9 | c | |  | 4 | PL correct [1]<br>CK correct [1]<br>Q to either mux input, D from mux output [1]<br>other multiplexer input to c, b, a, 0 and correct output label [1]<br><br>**accept** mux inputs in reverse order, ignore second input to first mux |
| **Q** | | | sample from 1b, 1c, 5b, 5d and 9bi | | |

**Quality of Written Communication**

| | |
|---|---|
| 3 | The candidate expresses complex ideas extremely clearly and fluently.<br>Sentences and paragraphs follow on from one another smoothly and logically.<br>Arguments are consistently relevant and well structured.<br>There will be few, if any, errors of grammar, punctuation and spelling. |
| 2 | The candidate expresses straightforward ideas clearly, if not always fluently.<br>Sentences and paragraphs may not always be well connected.<br>Arguments may sometimes stray from the point or be weakly presented.<br>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.<br>Arguments may be of doubtful relevance or obscurely presented.<br>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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