



**GCE**

**Electronics**

Unit **F614**: Electronic Control Systems

Advanced GCE

**Mark Scheme for June 2016**

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

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

© OCR 2016

## Annotations, abbreviations and subject-specific conventions

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	Expected Answer	Mark	Additional Guidance
1a	Potential divider from 9 V to 0 V with centre at X Top resistor 2.1 larger than bottom	1 1	or $V_D$ to 0 V top resistor 1.14 larger than bottom if $V_D$ used
1b	Output connected to VD through capacitor Input connected through capacitor Input connected to gate	1 1 1	Accept connected to X
1ci	Correct shape Transition at 2.8 V Slope of 100 mA / 0.5 V	1 1 1	
1cii	Use of correct equation and 0.2 S including - sign Use of 220 $\Omega$ resistor	1 1	-44
1di	So that the output can change up and down Without clipping/large amplitude	1 1	
1dii	$V = 9 - 5 = 4$ $4/220 = 18\text{mA}$ (no ecf)	1 1	
1e	Same shape as $V_{GS} = 5\text{V}$ Smaller max current and shallower gradient Transistion at lower VDS (no ecf)	1 1 1	

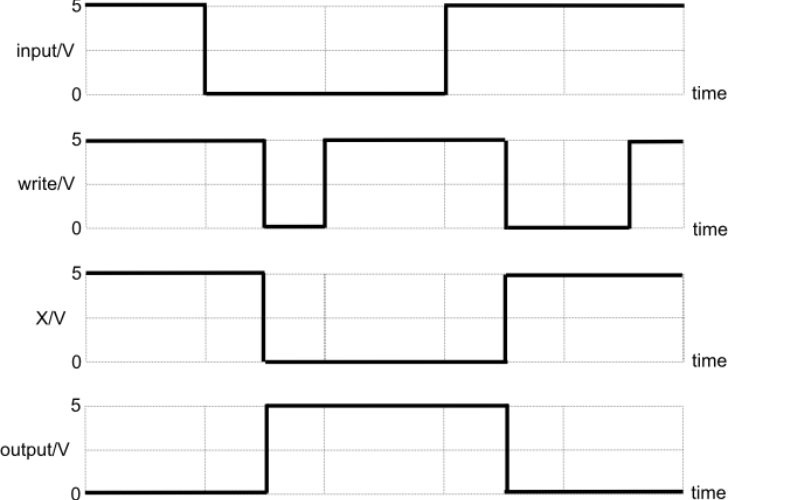
Question	Expected Answer	Mark	Additional Guidance
2a	Adjust/set the desired water temperature in the fish tank	1	
2b	When cold, voltage at T low So output of op amp high Turns on MOSFET Makes heater operate Discussion of signals to turn heater off Keeps turning on and off	1 1 1 1 1 1	Allow same marks for argument about when hot
2c	$I=4/4700=0.85\text{mA}$ $R=(12-4)/0.00085=9.4\text{k}\Omega$	1 1	
2d	T rises to 7 V T hunts around 7 V D digital 0V or 12 V D initially low D changes as T crosses 7 V	1 1 1 1 1	Curved lines only
2e	Proportional: No overshoot/reduced hunting Reduces drive as gets close to desired value On-off Fast / simple circuit Maximum drive to transducer / no need for difference amp (and ramp generator)	1 1 1 1	Allow other advantages with correct explanations

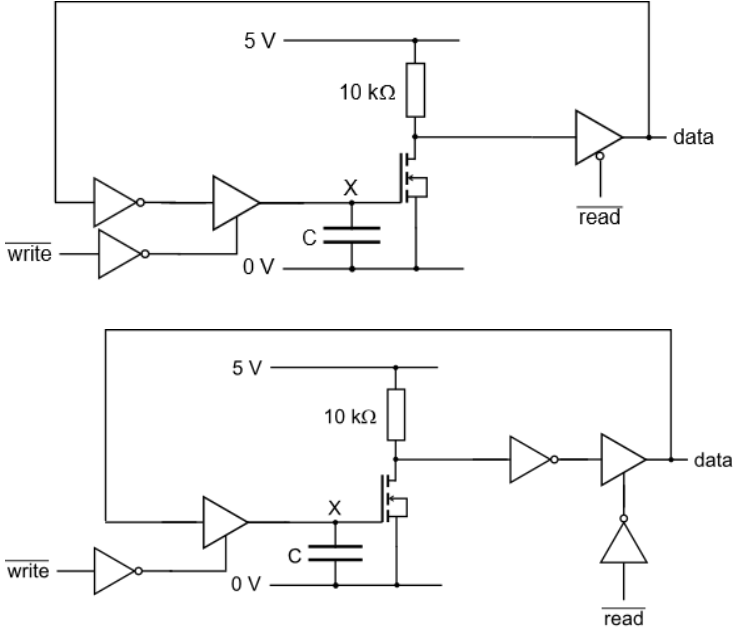
Question	Expected Answer	Mark	Additional Guidance
3a	Charges capacitor [through rectifier] increasing voltage [to above 5 V]  Max 3 from: <ul style="list-style-type: none"> <li>• Comparator changes state (wtte)</li> <li>• Opto-isolator turned on</li> <li>• Turns on oscillator</li> <li>• Produces an ac signal at output of transformer</li> </ul>	1  3	Accept explanation of how current to smoother increases output voltage  Answers to show understanding of on/off feedback
3bi	Correct shape Amplitude 6.3 V by eye Signal at 0 V when input < 0.7 V by eye	1 1 1	
3bii	T = 40 $\mu$ s F = 25 kHz	1 1	
3ci	Ring around zener (and resistor)	1	
3cii	Valid method (same I in both resistors or by ratio) R2 = 1.17 * R1	1 1	
3ciii	(V-1.7)/0.008=R Reasonable assumption about op amp high saturation voltage V	1 1	e.g. output saturates high saturates at 5 V, saturates 2 V below supply so saturates at 3 V, or any other reasonable assumption [412 $\Omega$ for 5V]

Question	Expected Answer	Mark	Additional Guidance
4ai	Proportional control system	1	
4aai	It contains a <u>difference amp</u>	1	Accept <u>ramp generator</u> not in other systems
4bi	-2V	1	
4bii	2V ecf from i	1	
4c	Use of $[\pm]13\text{ V}$ , $2.5\text{ V}$ and $0.33\text{ V/s}$ in ramp generator formula $R1C = 7.6\text{ s}$ $R2 = R3$ $R2, R3$ in k	1 1 1 1	Alternatively allow for $\text{gain} \neq -1$ compensating for different ramp rate
4d	Positive Increasing Increasing Increasing Zero Unchanging Unchanging Unchanging	1 1 1 1 1 1 1 1	

Question	Expected Answer	Mark	Additional Guidance
5a	MOVI Sn, 7E OUT Q, Sn RET	2 1 1	1 mark for 7E
5b	MOVI Sm, 40 IN Sp, I AND Sm, Sp / AND Sp, Sm	2 1 1	1 mark for 40 p≠m Do not allow SUB
5c	Maximum 6 from: S7 set to zero initially S2 mask for sensor S4 mask for oscillator S3 holds input value S7 increases by one each time sensor goes high Returns to main program when relaxation oscillator low S7 returns number of pulses to main program	6	
5d	Turn on dp Without changing rest of display [need to use S0] Wait 200ms Turn off dp (or toggle) Do it for 10s	1 1 1 1 1 1	flash: MOVI S6, 01 MOVI S4, 32 repeat: EOR S0, S6 OUT Q,S0 MOVI S5, C8 delay: RCALL wait1ms DEC S5 JNZ delay DEC S4 JNZ repeat RET



Question	Expected Answer	Mark	Additional Guidance
6a	Information retained when power switched off (wtte)	1	
6b	<p>X Continues high until first write transition</p> <p>X Goes low at falling edge on write</p> <p>X Stays low until next falling edge on write</p> <p>Output inverse of X [digital]</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	 <p>The diagram consists of four vertically stacked timing plots sharing a common horizontal time axis. Each plot has a vertical axis labeled from 0 to 5. The top plot, labeled 'input/V', shows a signal that is high (at level 5) until the first falling edge of the 'write/V' signal, then drops to low (at level 0) and remains low until the second falling edge of 'write/V', after which it returns to high. The second plot, labeled 'write/V', shows a signal that is high, then drops to low, then returns to high, then drops to low again, and finally returns to high. The third plot, labeled 'X/V', shows a signal that is high until the first falling edge of 'write/V', then drops to low and remains low until the second falling edge of 'write/V', after which it returns to high. The bottom plot, labeled 'output/V', shows a signal that is low until the first falling edge of 'write/V', then drops to high and remains high until the second falling edge of 'write/V', after which it returns to low.</p>

Question	Expected Answer	Mark	Additional Guidance
6c	Tristate connected to drain of MOSFET [through NOT gate] and read to control of tristate Tristate connected correct way around NOT gate to read tristate [or from output] Data needs to connect to input of write tristate and output of read tristate (ecf)	1  1  1  1	 <p>Accept answers with one NOT gate producing active low read or inverting either input or output of memory</p>

Question	Expected Answer	Mark	Additional Guidance
7a	General purpose register in CPU Store/memory For results/data needed for processing/calculations	1 1 1	
7b	Collection of wires For moving information <u>to and from</u> CPU to/from memory/ports	1 1 1 1	
7c	1. Address of next instruction/contents of PC stored on stack 2. Stack pointer incremented/decremented 3. PC loaded with called address 4. Subroutine executed 5. When return executed PC loaded from top of stack 6. Stack pointer decremented/incremented 7. Program continues with main program	1 1 1 1 1 1	Sequence should be in correct order but allow swapping order of 1 & 2 provided 5 & 6 swapped      6 <sup>th</sup> mark for point 4 or 7 provided no incorrect elements added to sequence

**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](mailto:general.qualifications@ocr.org.uk)

[www.ocr.org.uk](http://www.ocr.org.uk)

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

**Oxford Cambridge and RSA Examinations**  
**is a Company Limited by Guarantee**  
**Registered in England**  
**Registered Office; 1 Hills Road, Cambridge, CB1 2EU**  
**Registered Company Number: 3484466**  
**OCR is an exempt Charity**

**OCR (Oxford Cambridge and RSA Examinations)**  
**Head office**  
**Telephone: 01223 552552**  
**Facsimile: 01223 552553**

© OCR 2016

