

**Electronics**

Advanced GCE

Unit **F614**: Control Systems

**Mark Scheme for June 2013**

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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.

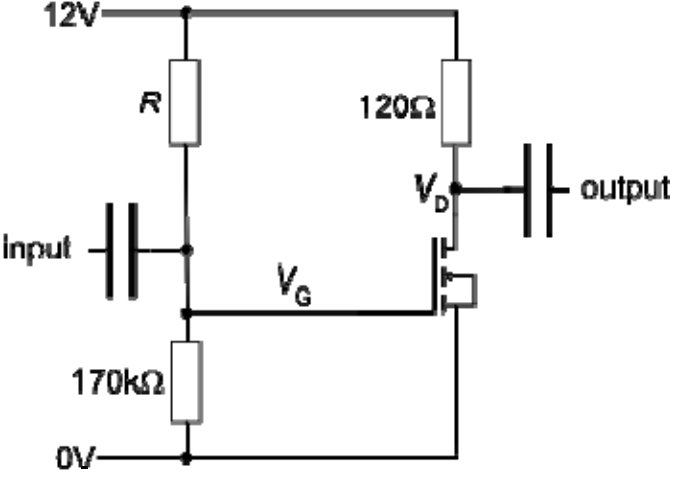
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**Subject-specific Marking Instructions**

**Quality of Written Communication**

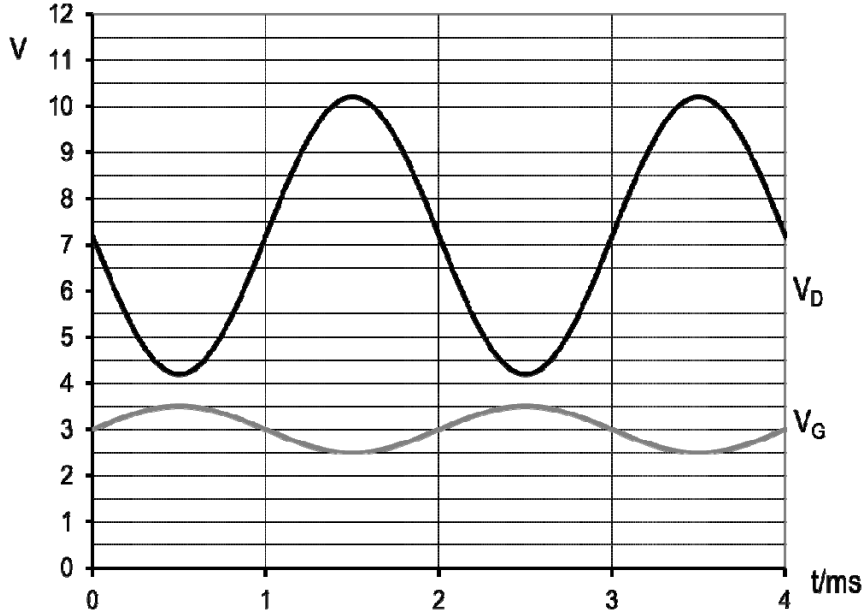
- 3 The candidate expresses complex ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically. Arguments are consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.
- 2 The candidate expresses 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.

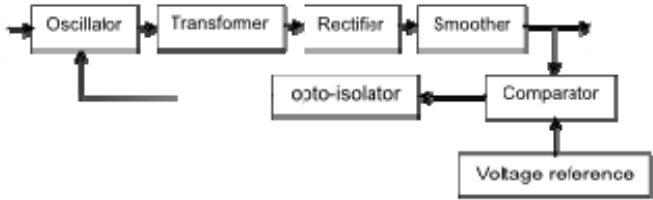
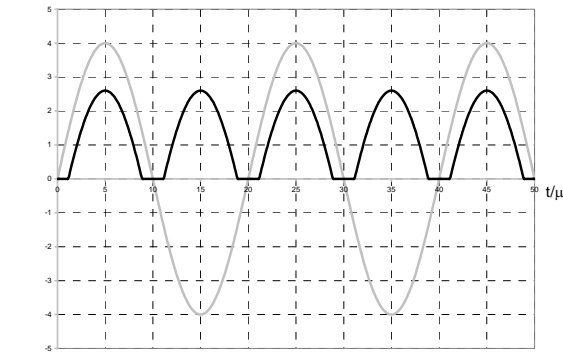
Question	Answer	Marks	Guidance
1 (a)	Capacitors x 2 output to D, input to G 	2	
(b)	calculate current $I = 3/170 \times 10^3 = 1.76 \times 10^{-5}$ calculate voltage across R $V = 12 - 3 = 9 \text{ V}$ calculate $R = 9/1.76 \times 10^{-5} = 5.1 \times 10^5 = 510 \text{ k}\Omega$	3	Could solve by ratios: If incorrect allow 1 mark for correct ratio.
(c) (i)	2.2 V	1	
(ii)	current from graph 40 mA voltage across $120\Omega$ resistor 4.8 V $V_D = 12 - 4.8 = 7.2 \text{ V}$	3	
(iii)	correct units conversion find $\Delta V$ divide change in current by voltage to calculate $g_m = 0.05 \text{ S}$ (ecf)	3	
(iv)	$-g_m$ from 1ciii $\times 120\Omega$	2	

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Question	Answer	Marks	Guidance
(d) (i)	recognisable symbol between D and 0 V	1	
(ii)	sinewave amplitude 3.0 V centred around 7.2 V inverse of input  	3	
(iii)	$1/0.002 = 500 \text{ Hz}$	1	

Question	Answer	Marks	Guidance
2 (a)	<p>one mark to point to max of 6:</p> <ul style="list-style-type: none"> <li>• opto-isolator correct</li> <li>• oscillator correct</li> <li>• transformer correct</li> <li>• rectifier correct</li> <li>• smoother correct</li> <li>• voltage correct</li> <li>• comparator correct.</li> </ul> 	6	
(b)	<p>all positive correct shape peak at ~2.6 V by eye 0V flat around transition</p> <p>voltage/V</p> 	4	
(c)	LED emits light when <u>input high</u> owtte phototransistor <u>conducts</u> when light incident owtte	2	BOD low impedance when light incident
(d)	reduces voltage increases current/energy efficient/power efficient	2	

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Question		Answer	Marks	Guidance
3	(a)	<p>data bus connects cpu, memory, input port and output port  arrows show data going to cpu, memory and output port (optionally data to input port)</p> <p>control bus connects cpu, memory, input port and output port  arrows show control going to memory, output port and input port (optionally cpu)</p> <p>address bus connects cpu and memory (and optionally both input port and output port – not just one)  arrows show data going to memory (and to input port and output port if connected) <u>not cpu</u></p>	6	
	(b)	<p>fetch instruction from memory  EITHER pointed at by program counter  OR store instruction in instruction register  increment program counter  execute instruction (in instruction register)  correct order</p>	5	Allow PC to address bus

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Question		Answer	Marks	Guidance
4	(a)	<pre> MOVI Sn, 04 IN  Sm, I AND Sm, Sn    or    AND  Sn, Sm </pre>	2 1 1	1 mark for 04 n and m different numbers 0-7
	(b)	<pre> showf:  MOVI S2, E2         OUT  Q, S2         RET </pre>	3	
	(c)	<pre> MOVI S5, C8 </pre>	2	1 mark for C8
	(d)	bell sounds turn bell off after 200ms sounds 3 times display does not change	4	
	(e)	<pre> soundb: INC  S2         OUT  Q, S2         RCALL wait200ms         RCALL wait200ms         RCALL wait200ms         DEC  S2         OUT  Q, S2         RET </pre>	8	Turn on bell Without affecting display Wait attempt Long time (>200ms) Exactly 600ms Turn off bell Without affecting display return



Question		Answer	Marks	Guidance																																													
5	(a)	F correct S correct <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>C</th> <th>B</th> <th>A</th> <th>F</th> <th>S</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> </tbody> </table>	C	B	A	F	S	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	1	1	1	0	1	0	0	0	1	1	0	1	1	0	1	1	0	1	0	1	1	1	1	1	2	Not all combinations of CBA [0]
C	B	A	F	S																																													
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	(b) (i)	all clocks connected together to store outputs from Qs Inputs to Ds	3	Qs not connected to anything else Ds not connected to anything else																																													
	(ii)	first four sum digits correct last four sum digits correct carry correct <table border="1" style="margin-left: 20px;"> <tbody> <tr> <td></td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td style="background-color: #cccccc;"></td> </tr> </tbody> </table>		1	1	0	0	1	0	1	0	0	1	1	1	0	1	0	0		3	Must be 0 or 1 in each box																											
	1	1	0	0	1	0	1	0																																									
0	1	1	1	0	1	0	0																																										
	(c)	42 in binary 00101010 all bits correctly inverted 11010101 ecf 1 added correctly 11010110	3	Allow other explained method (eg bit 7 = -128)																																													

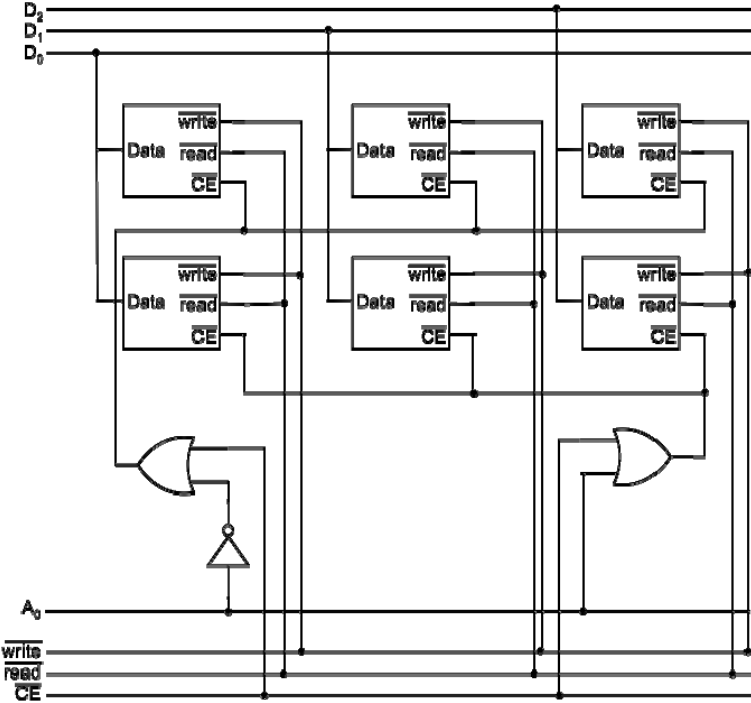
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Question		Answer	Marks	Guidance
6	(a)	reference, difference amp, power amp, motor, position sensor	1	
	(b)	30/47 +1	2	1.64
	(c)	potentiometer	1	
	(d) (i)	$2 - 5 =$ $-3 \text{ V}$	2	subtraction
	(ii)	$-3 \times 1.6 = -4.8 \text{ V}$ ecf from di	1	
	(iii)	to start with $D = -4.8 \text{ V}$ and <u>motor turns</u> (quickly) One from: <ul style="list-style-type: none"> <li>the voltage at P gets smaller as dish turns</li> <li>as P gets small <math>P - R = E</math> gets smaller</li> <li>When <math>P=R</math>, <math>E = 0 \text{ V}</math> and <math>D = 0 \text{ V}</math></li> </ul> so D gets smaller and <u>motor slows</u> when $P = R$ motor stops.	4	None zero D causes motor to turn  Some explanations about calculation of voltages  Motor slows as correct position approached Motor stops at correct position
	(e)	on-off feedback drives at full power until ref so hunts/never settles at one position proportional feedback slows as it approaches ref so gently moves to required position	4	sensible comment distinguishing on-off from proportional

Question		Answer	Marks	Guidance																																													
7	(a)	information lost when power removed	1																																														
	(b)	<table border="1"> <thead> <tr> <th>CE</th> <th>Rēād</th> <th>Write</th> <th>CK</th> <th>E</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table> <p>All combinations of CE , Rēād and Write CK correct E correct</p>	CE	Rēād	Write	CK	E	0	0	0	0	1	0	0	1	1	1	0	1	0	0	0	0	1	1	1	0	1	0	0	1	0	1	0	1	1	0	1	1	0	1	0	1	1	1	1	0	3	
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	(c)	CE , Rēād and Write initially high hold Rēād high throughout make data high make CE low and Write low make Write highand/or CE high.	5	data must be high before CE and Write both low  Allow pulse write/CE low for 2 marks with other held low  Sequence incorrect or no sequence can only get data mark																																													
	(d)	<u>3 cells per address</u> x <u>2 addresses</u> (= 6)	2																																														

Question	Answer	Marks	Guidance
(e)	<p>D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> connected to 2 different cells                      writes and reads all connected                      A<sub>0</sub> decoded to operate different cells when high and low                      A<sub>0</sub> connects through logic to CE                      global CE operates correctly</p> 	5	<p>BOD missing pull-up resistors if tristates/analogue switches used</p>

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