

**Cambridge National**

**Systems Control in Engineering**

**R113/01: Electronic principles**

Level 1/2 Cambridge National Certificate/Award

**Mark Scheme for January 2021**

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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.

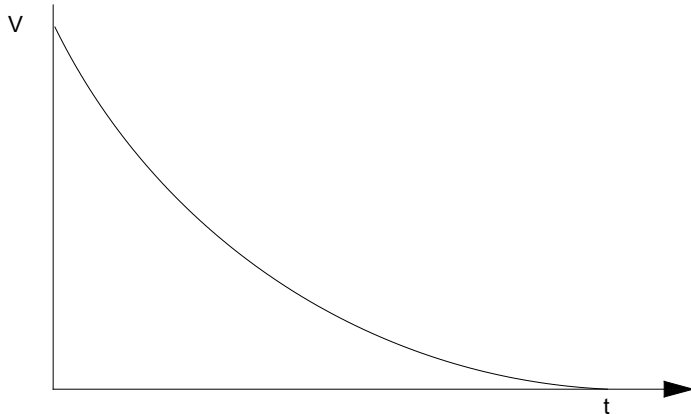
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## Annotations

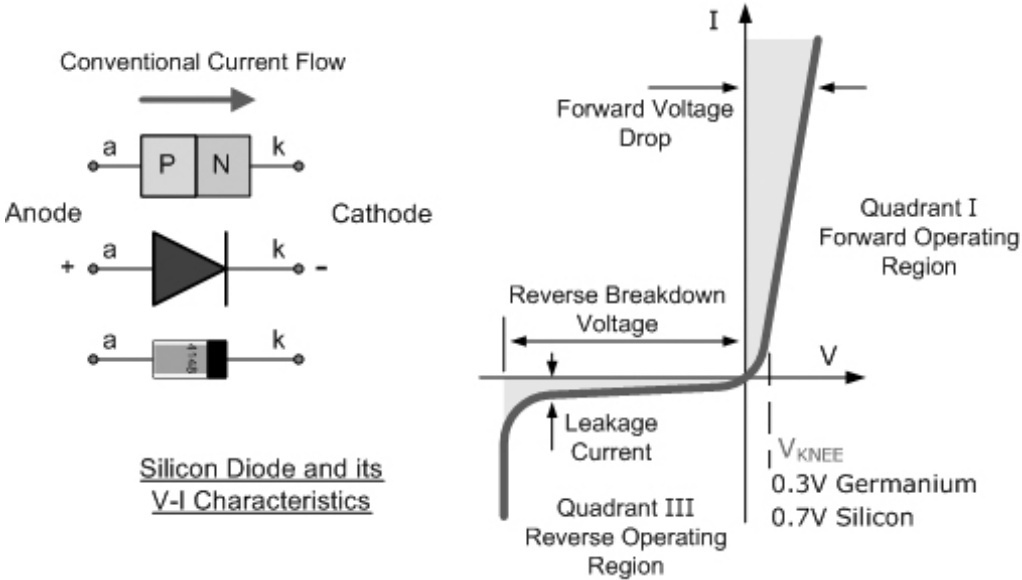
Annotation	Meaning
	Blank page
	Vague
	Tick
	Noted but no credit given
	Repeat
	Knowledge
	Example/Reference
	Development
	Benefit of doubt
	Unclear
	Level 3
	Level 2
	Level 1

Question			Answer	Mark	Guidance
1	(a)		<b>A</b> Resistor <b>B</b> Potentiometer / Variable resistor <b>C</b> Light Dependent Resistor	3	Award one mark for each correct component.
1	(b)	(i)	Light Emitting Diode	1	
1	(b)	(ii)	The LED will emit light [1] when it is forward biased [1] or a limited current is passed through it [1]. Voltage drop across the terminals of the LED [1]. 1 mark for each valid point in description, allow 2 marks for one fully justified point.	2	Allow 'when connected the correct way round'. 1 mark for each valid point in description, allow 2 marks for one fully justified point.
1	(c)		npn or bipolar	1	Award one mark for a correct response
1	(d)		Bell Buzzer Signal lamp	3	Award one mark for each correct device.
<b>Total</b>				<b>10</b>	

Question		Answer	Mark	Guidance
2	(a)	Contacts <b>e</b> and <b>d</b> must be connected.	1	
2	(b)	$I = V/R$ $= 12/200$ $= 0.06 \text{ A}$	3	Award one mark for $I = V/R$ . Award one mark for 12/200. Award one mark for 0.06 A or 0.06. Award full marks for correct answer with no working.
2	(c)		2	Award one mark for correct shape. Award one mark for correct starting and finishing point.
	(d)	$R = 0.2 \times 10^6 \Omega$ $C = 10 \times 10^{-6} \text{ F}$ $T = RC$ $= 0.2 \times 10^6 \times 10 \times 10^{-6}$ $= 2 \text{ s}$	4	Award one mark for $R = 0.2 \times 10^6 \Omega$ . Award one mark for $C = 10 \times 10^{-6} \text{ F}$ . Award one mark for $0.2 \times 10^6 \times 10 \times 10^{-6}$ . Award one mark for 2 s or 2. Award full marks for correct answer with no working.
<b>Total</b>			<b>10</b>	

Question			Answer	Mark	Guidance
3	(a)	(i)	$1/R = (1/R_1) + (1/R_2)$ $= (1/3) + (1/2)$ $= (2 + 3)/6$ $= 5/6$ So $R = 6/5$ $= 1.2 \Omega$	3	Award one mark for $(1/3) + (1/2)$ Award one mark for $(2 + 3)/6$ or $5/6$ . Award one mark for $R = 6/5 = 1.2 \Omega$ or 1.2. Award full marks for correct answer with no working.
3	(a)	(ii)	$P = V^2/R_2$ $= 12^2/2$ $= 144/2$ $= 72 \text{ W}$	3	Award one mark for $12^2/2$ or $144/2$ . Award one mark for 72. Award one mark for W. Award full marks for correct answer with no working.
3	(b)		$V_{\text{out}} = V_{\text{in}} R_2 / (R_1 + R_2)$ $V_{\text{in}} = V_{\text{out}} (R_1 + R_2) / R_2$ $= 2(2 + 1)/1$ $= 6 \text{ V}$	4	Award one mark for $V_{\text{out}} = V_{\text{in}} R_2 / (R_1 + R_2)$ . Award one mark for $V_{\text{in}} = V_{\text{out}} (R_1 + R_2) / R_2$ . Award one mark for $2(2 + 1)/1$ Award one mark for 6 V or 6. Award full marks for correct answer with no working.
<b>Total</b>				<b>10</b>	

Question	Marks	Mark	Answer
4 (a)*	<p><b>Level 3 (5–6 marks)</b></p> <ul style="list-style-type: none"> <li>Detailed discussion showing a thorough understanding of the function and applications of a signal diode in electronic circuits.</li> <li>Information is presented clearly and accurately, with correct use of appropriate technical language and engineering terminology.</li> <li>Accurate use of spelling, punctuation and grammar.</li> </ul> <p><b>Level 2 (3–4 marks)</b></p> <ul style="list-style-type: none"> <li>Adequate discussion showing some understanding of the function and applications of a signal diode electronic circuits.</li> <li>Information is presented clearly and with some accuracy.</li> <li>Appropriate technical language and engineering terminology is used on some occasions.</li> <li>Occasional errors in spelling, punctuation and grammar.</li> </ul> <p><b>Level 1 (1–2 mark)</b></p> <ul style="list-style-type: none"> <li>Basic discussion showing limited understanding of the function and applications of a signal diode in electronic circuits.</li> <li>Information presented is basic and may be ambiguous or badly presented.</li> <li>There will be little or no use of technical language and engineering terminology. Errors of spelling, punctuation and grammar may be intrusive.</li> </ul> <p><b>Level 0 ( 0 marks)</b></p> <ul style="list-style-type: none"> <li>A response that is irrelevant and/or not worthy of a mark.</li> <li>Annotate with 'Seen' at end of response.</li> </ul>	6	<p>Signal Diode The function of a signal diode is to allow an electric current to pass in one direction i.e. called the diode's forward direction, while blocking it in the opposite direction i.e. the reverse direction.</p> <p>The signal diode is a non-linear semiconductor device which can be considered to be an electronic version of a check valve.</p> <p>Applications Rectifier – turning ac into dc Protection device Voltage regulator Signal limiter Isolating a signal from a supply Controlling the size of a signal Use in logic gates Use in high voltage power conversion circuits Switching and clipping Radio and TV</p> <p>Accept any other correct responses.</p> <p>(Markers are reminded to use K and DEV for marking this question)</p>

Question	Answer	Mark	Guidance
	<p>For information only:</p>  <p><u>Silicon Diode and its V-I Characteristics</u></p>		
<p>4 (b)</p>	<p>A Input                      B Feedback                      C Output                      D Control or Process</p>	<p>4</p>	<p>Award one mark for each correct response.</p>
	<p><b>Total</b></p>	<p><b>10</b></p>	



Question		Answer	Mark																																				
5	(a)	Visual inspection Half split method	2	Award one mark for each correct response																																			
5	(b)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A</th> <th>B</th> <th>Q1</th> <th>Q2</th> <th>Q3</th> <th>Q4</th> <th>Q5</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <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>1</td> <td style="text-align: center;">/</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td style="text-align: center;">/</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> </tr> </tbody> </table>	A	B	Q1	Q2	Q3	Q4	Q5	0	0	0	0	1	1	1	0	1	0	1	/	1	0	1	0	0	1	/	1	0	1	1	1	1	0	0	0	5	One mark for each correct column in the truth table. Accept Q3 1 1 0 0
A	B	Q1	Q2	Q3	Q4	Q5																																	
0	0	0	0	1	1	1																																	
0	1	0	1	/	1	0																																	
1	0	0	1	/	1	0																																	
1	1	1	1	0	0	0																																	
5	(c)	The OR gate is used to detect when the set values of pressure or temperature are exceeded. The OR gate produces the command for the system to correct the detected faults.	3	Award one mark for “detect”. Award one mark for “set values of pressure or temperature are exceeded”. Award one mark for “produces the command for the system to correct the detected faults”. Award one mark for ‘safety’.  Accept other correct responses.																																			
<b>Total</b>			<b>10</b>																																				

Question		Answer	Mark	Guidance
6	(a)	Flow or wave solder process Manual component placement Through hole technology	2	Award one mark for each correct response up to a maximum of two marks
6	(b)	Functions of pick and place robot: <ul style="list-style-type: none"> <li>• Picking up the correct component</li> <li>• Orientating</li> <li>• Placing on correct spot on circuit.</li> <li>• Consistent</li> <li>• Repetitive tasks taken away from humans</li> <li>• Monotonous tasks taken away from humans</li> <li>• Can have advanced vision systems</li> <li>• Vision system can inspect and monitor products – finds faults</li> <li>• Works faster than humans</li> <li>• Deals with large/small/heavy/hard to handle component</li> </ul>	3	Award one mark for each correct response up to a maximum of three marks.
6	(c)	Reasons for surface mounted components will include: <ul style="list-style-type: none"> <li>• Components are usually smaller and easier to replace</li> <li>• Not so many holes need to be drilled</li> <li>• SMT parts are often cheaper than equivalent through hole parts i.e. cheaper</li> <li>• More components can be used in the same area as through hole method</li> <li>• Both sides of the circuit board can be used</li> <li>• Self-correcting system in operation for small errors in placement</li> <li>• Lower initial costs - cheaper</li> <li>• Less time is taken in setting up procedures for mass production i.e. faster</li> <li>• The automatic system is generally simpler and faster</li> <li>• Many SMT parts cost less than equivalent through-hole parts</li> <li>• Copes better under shock and vibration conditions</li> </ul>	5	Award one mark for each correct reason up to a maximum of five.
<b>Total</b>			<b>10</b>	

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