



## **Cambridge National**

### **Science**

Unit **R113**: Electronic principles

Level 1/2 Cambridge National Award/Certificate in Systems Control in Engineering

## **Mark Scheme for January 2015**

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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.

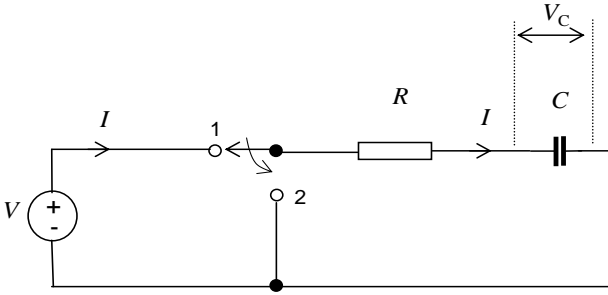
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Question		Answer	Mark	Guidance
1	(a)	Signal lamp or lamp or bulb Bell Loudspeaker Thermistor Motor	5	One mark for each correct component.
	(b) (i)	$I = V/R$ $= 2/10$ $= 0.2 \text{ A}$	1 1	Award one mark for a correct formula. Award one mark for a correct answer with or without working. Award two marks for a correct answer with or without units.
	(ii)	$P = V^2/R$ $= 2^2/10$ $= 0.4 \text{ W}$	1 1	Award one mark for a correct formula. Award one mark for a correct answer with or without working. Award two marks for a correct answer with or without units. Accept the use of other correct methods and formulae.
	(c)	Resistor value = 4400 $\Omega$	1	Accept 4K4 and 4.4k $\Omega$ for one mark.

Question			Answer	Mark	Guidance
2	(a)	(i)	npn transistor.	1	Accept bipolar transistor for one mark
		(ii)	Darlington Pair.	1	
		(iii)	Accept any other suitable switch e.g. Push button switch – normally open Single pole single throw (SPST) toggle switch.	1	Accept any correct response for one mark
		(iv)	The 470Ω resistor is a current limiting resistor to protect the LED from an overload of current.	1 1	
		(v)	The variable resistor (potentiometer) will allow the voltage at the centre of the potential divider to be set precisely for calibration this allows for accurate control of processing components such as the transistors.	1 1	
2	(b)		When the contacts are closed a current flows if the variable resistor is set to a high value.  The Darlington pair is a two transistor circuit connected together so that the current amplified by the first transistor is amplified further by the second transistor. The overall current gain is equal to the two individual gains multiplied together.  The LED lights up but is protected by the 470 Ω resistor from an overload.	1  1  1	

Question			Answer	Mark	Guidance
3	(a)	(i)	2.2pF.	1	
		(ii)	2.2F.	1	
	(b)		An electrolytic capacitor is polarized which means that it must be connected into a circuit the correct way round. If a voltage is applied to a capacitor in the reverse direction the capacitor will be damaged.	1	
	(c)			3	Award two marks for a correct circuit diagram. Award one mark for at least three labels
	(d)		In an RC charging circuit the time constant determines how quickly $V_R$ and $V_C$ approach their final values.	1 1	.

Question		Answer	Mark	Guidance
	(e)	$R = 100\text{K} = 100 \times 10^3 \Omega$ $C = 47\mu\text{F} = 47 \times 10^{-6} \text{ F}$ Time Constant = $RC$ $= 100 \times 10^3 \times 47 \times 10^{-6}$ $= 4.7\text{s}$	1 1	Award one mark for a correct formula. Award one mark for a correct answer with or without working. Award two marks for a correct answer with or without units.

Question		Answer	Mark	Guidance
4	(a)	<ol style="list-style-type: none"> <li>1 Check that the soldering iron bit is clean and shiny. Clean the surfaces that are to be soldered.</li> <li>2 Check that leads and wires are mechanically strong and pre-tinned.</li> <li>3 Dry fit all components through the holes on the PCB. Secure the components.</li> <li>4 Solder into position and allow to cool..</li> <li>5 Examine the joint. Cut components lead off just above the soldered joint.</li> </ol>	4	Award one mark for each correct response up to a maximum of four.
	(b)	<p><b>Level 3 (5–6 marks)</b></p> <ul style="list-style-type: none"> <li>• Detailed discussion showing a thorough understanding of the implications for a manufacturer when considering quality assurance methods used during commercial printed circuit board (PCB) production.</li> <li>• Makes reasoned judgments about quality assurance methods e.g. visual inspection and automatic testing, supported by relevant examples.</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> <p>Adequate discussion showing some understanding of the implications for a manufacturer when considering quality assurance methods used during commercial printed circuit board (PCB) production..</p> <ul style="list-style-type: none"> <li>• Makes some appropriate judgments about quality assurance methods e.g. visual inspection and automatic testing, supported by relevant examples.</li> </ul> <ul style="list-style-type: none"> <li>• Information is presented clearly and with some accuracy. Appropriate technical language and engineering terminology is used on some occasions.</li> <li>• Occasional errors in spelling, punctuation and grammar.</li> </ul>	6	<p>Implications for manufacturer could include:</p> <p>Selection of method of QA i.e. visual inspection or automatic test</p> <p>Prevention of mistakes or defects in manufactured products and avoiding problems when delivering solutions or services to customers</p> <p>Applied to physical products in pre-production to verify what will be made meets specifications and requirements, and during manufacturing production runs by validating lot samples meet specified quality controls</p> <p>Refer to administrative and procedural activities implemented in a <a href="#">quality system</a> so that requirements and goals for a product, service or activity will be fulfilled</p> <p>Systematic measurement, comparison with a standard, monitoring of processes and an associated feedback loop that confers error prevention</p>

Question	Answer	Mark	Guidance
	<p><b>Level 1 (1–2 marks)</b></p> <ul style="list-style-type: none"> <li>• Basic discussion showing limited understanding of the implications for a manufacturer when considering quality assurance methods used during commercial printed circuit board (PCB) production.</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.</li> <li>• 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. Annotate with 'Seen' at end of response.</li> </ul>		<p>Principles included in QA are: "Fit for purpose", the product should be suitable for the intended purpose; and "Right first time", mistakes should be eliminated.</p>



Question			Answer	Mark	Guidance
5	(a)	(i)	Sine wave.	1	
		(ii)	Frequency (X control) The X gain allows the signal to be contracted or expanded horizontally about the centre of the screen.	1 1	Award marks for understanding shown.
		(iii)	Amplitude (Y control) The Y shift moves the signal vertically About the centre of the screen.	1 1	Award marks for understanding shown.
	(b)	(i)	Test equipment items: Multimeter Voltmeter Ammeter Ohmmeter Logic probe for logic levels Signal generator	3	Award one mark for each correct item of test equipment.
		(ii)	Select a point about halfway along the circuit. Test for voltage. If voltage is present you have not found the area of the break fault. The fault is then in the other half circuit.  You would then repeat with half way of every subsequent half until you had located the break.	1  1	

Question			Answer	Mark	Guidance
6	(a)	(i)	Z.	1	
		(ii)	X.	1	
		(iii)	Y	1	
6	(b)	(i)	The process block acts on the input and feedback to provide an output	1 1	
		(ii)	Closed Loop Control.	1	
		(iii)	The control system shown is closed loop because it has a feedback block.	1	
	(c)		Applications are: Oven control Central heating control Plant watering system Fire alarm ABS braking Controlling the thickness of sheet steel produced by a rolling mill Controlling the volume of water supplied to a tank in order to maintain a constant level Motor car cruises control Torque control – to wind /unwind cables Control of lifts.	3	Application "closed-loop process control" is used wherever any process variables (pressures, temperatures, speeds, forces, flow rates, mixing ratios and filling levels etc.) must be maintained constant.  Award one mark for each correct application.

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