

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

R113: Electronic principles

Candidates answer on the Question Paper

OCR Supplied Materials:

- None

Other Materials Required:

- A calculator may be used

Duration: 1 hour



Candidate Forename		Candidate Surname	
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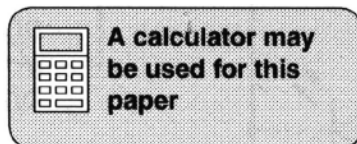
Centre Number						Candidate Number				
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INSTRUCTIONS TO CANDIDATES

1. Use black ink. HB pencil may be used for graphs and diagrams only.
2. Complete the boxes above with your name, centre number and candidate number.
3. Answer **all** the questions.
4. Write your answer to each question in the space provided.
5. Do **not** write in bar codes.

INFORMATION FOR CANDIDATES

1. The total number of marks for this paper is **60**.
2. The number of marks for each question is given in brackets [] at the end of the question or part question.
3. Dimensions are in millimetres unless stated otherwise.
4. This document consists of **12** pages. Any blank pages are indicated.



1 (a) Draw lines to connect each term to the correct unit of measurement.

term	unit of measurement
resistance	farad
power	amp
current	ohm
electromotive force	watt
capacitance	volt

[5]

(b) Products such as an intruder alarm use both mains power and battery power.

(i) Give **one** other example of a product that uses more than one power source.

.....[1]

(ii) Explain, using an example, why it is necessary to include more than one power source for some products.

.....

[2]

(c) Fig. 1 shows a voltage regulator.

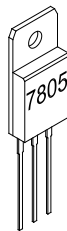


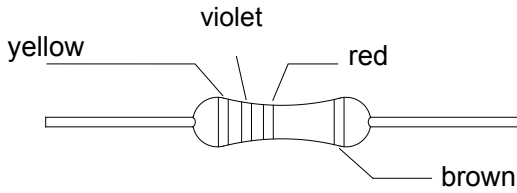
Fig. 1

Describe why a voltage regulator is used in a circuit.

.....

[2]

- 2 (a) (i) Fig. 2 shows a fixed resistor and a resistor colour code chart. State the value and tolerance of the resistor.



Digit 1	Digit 2	Multiplier	Tolerance
black 0	black 0	black 0	brown 0.01
brown 1	brown 1	brown 1	red 0.02
red 2	red 2	red 2	gold 0.05
orange 3	orange 3	orange 3	
yellow 4	yellow 4	yellow 4	
green 5	green 5	green 5	
blue 6	blue 6	blue 6	
violet 7	violet 7	gold 0.1	
grey 8	grey 8	silver 0.01	
white 9	white 9		

Fig. 2

Value

Tolerance [2]

- (ii) State the highest and lowest values that can be expected in a batch of the resistors shown in Fig. 2.

Highest value

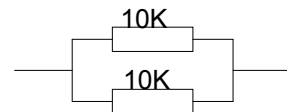
Lowest value [2]

- (b) Two arrangements of resistors are shown in Fig. 3. Complete Fig. 3 to give the total resistance for each arrangement.



Total resistance.....

Fig. 3



Total resistance.....

[2]

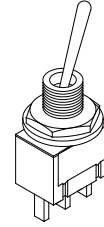
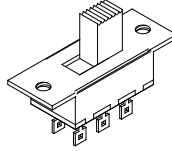
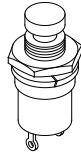
- 3 (a) (i) Three different types of switch are shown in Fig. 5.
Choose from the list below the correct label for each switch.

toggle switch

double pole double throw switch

momentary action switch

reed switch



.....

.....

.....

Fig. 5

[3]

- (ii) Draw the circuit symbol for an SPDT switch.

[2]

- (b) An NPN transistor can be used as an input switch for a logic gate as shown in Fig. 6.

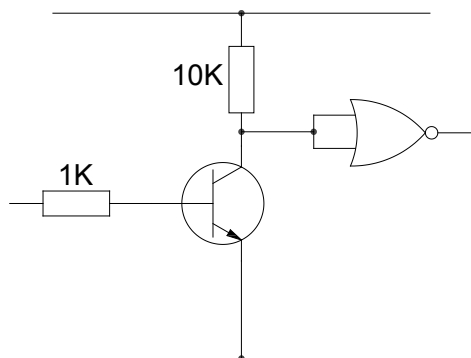


Fig. 6

- (i) State **two** benefits of using a transistor switch rather than a mechanical switch.

1

2 [2]

(ii) Describe the purpose of the 10K resistor in the circuit in Fig. 6.

.....

 [2]

(iii) Draw the circuit symbol for a logic gate that could replace the gate shown in Fig. 6.

[1]

4 (a) An LED circuit and LED are shown in Fig. 7.

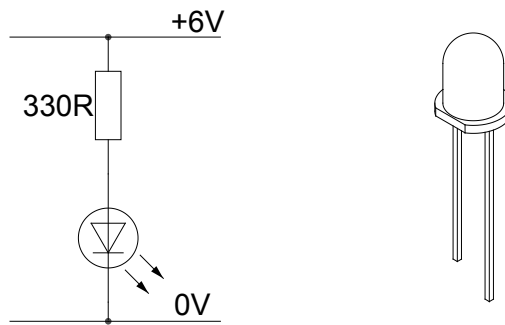


Fig. 7

(i) State **two** methods of identifying the cathode or negative leg of an LED.

1
 2 [2]

(ii) There is a 1.8V drop across the LED.
 Using the formula $V = IR$ calculate the current flow in the circuit.
 Show all workings.

.....

 [3]

5 (a) Fig. 10 shows a mains powered soldering iron.

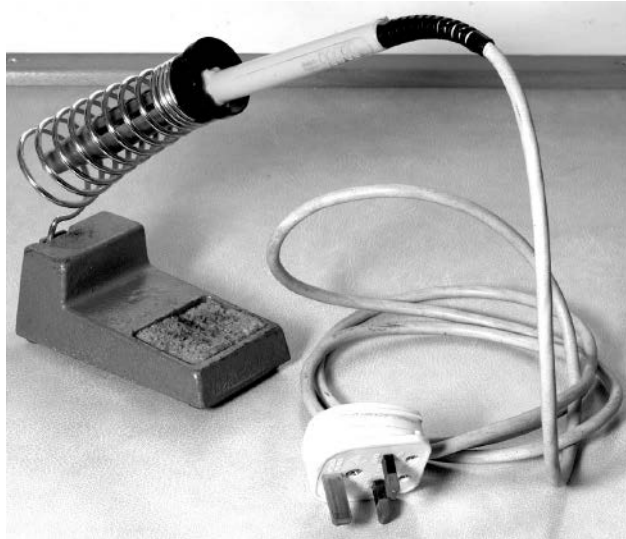


Fig. 10

(i) State **four** safety checks that should be carried out before using a mains powered soldering iron.

- 1
 - 2
 - 3
 - 4
-[4]

(ii) Give **two** benefits of portable appliance testing (PAT) in a school workshop.

-
 -
-[2]

- (b) Fig. 11 shows a PIR sensor from an alarm system. The reverse side of the circuit board has four built-in test points.

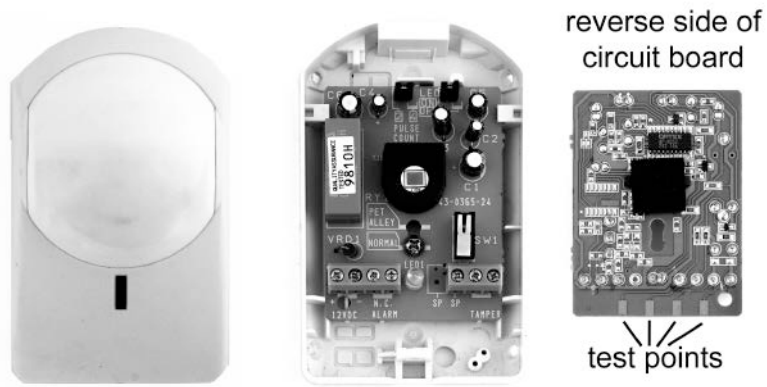


Fig. 11

- (i) Describe how a commercial manufacturer would use built-in test points.

.....
.....
.....
.....[2]

- (ii) The circuit board in Fig. 11 uses surface mount components. State **two** benefits of surface mount components for commercial manufacture.

1

.....

2

.....[2]

- 6 (a) Fig. 12 shows a multimeter being set up to measure current flow in a circuit.

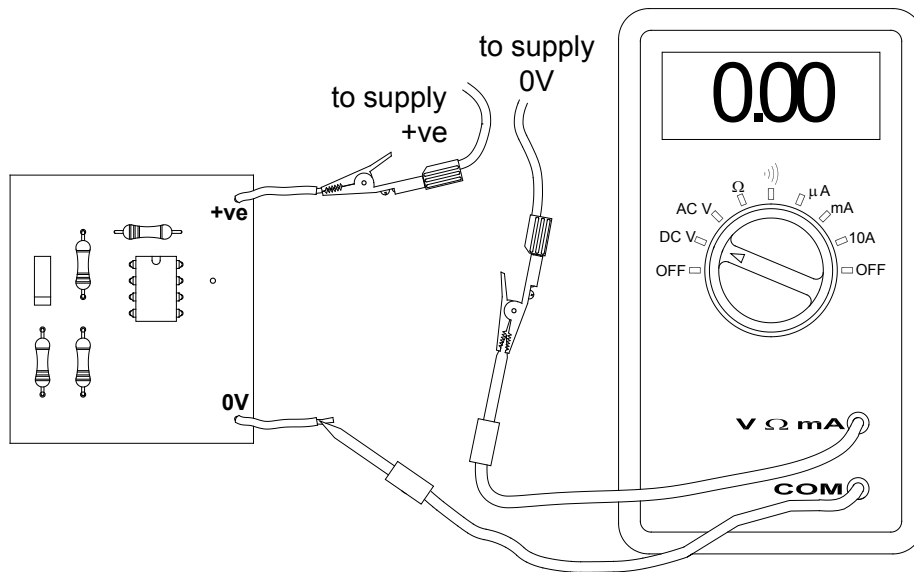


Fig. 12

Describe **two** changes that are needed before an accurate current flow reading can be taken.

.....

.....

.....

.....

[2]

- (b) Many vehicles now give a warning signal if a door, boot lid or bonnet is left open and the car ignition is switched on. A logic circuit for detecting this is shown in Fig. 13.

Complete the truth table below to show the logic level at points X and Y.

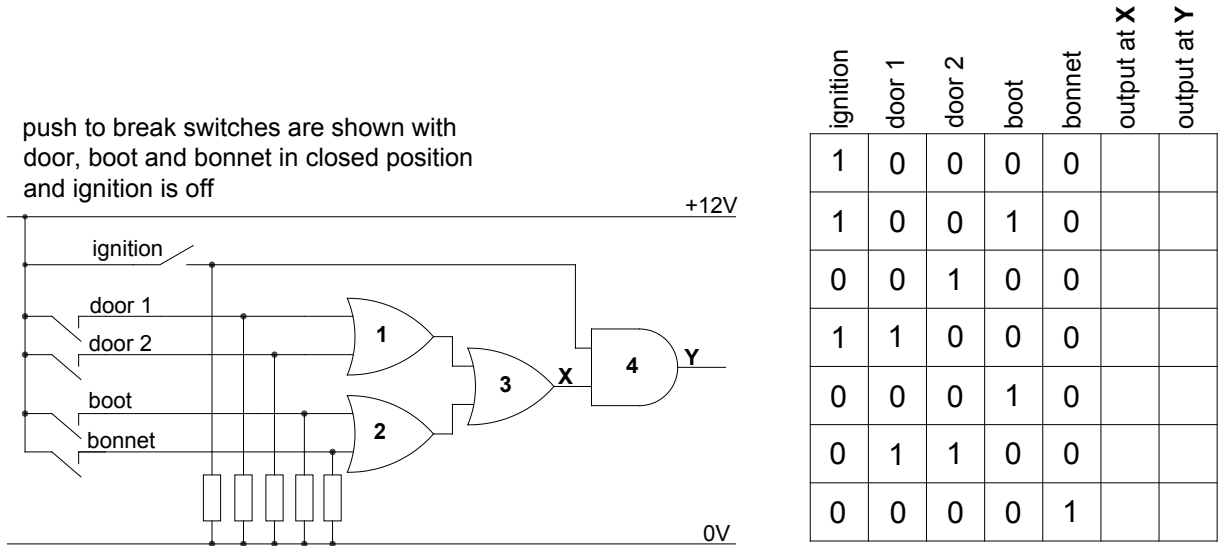


Fig. 13

[2]



SPECIMEN

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

Unit R113 Electronic principles

MARK SCHEME

Duration: 1 hour

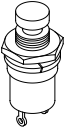
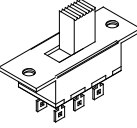
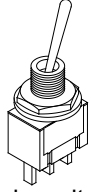
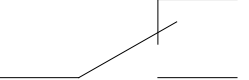
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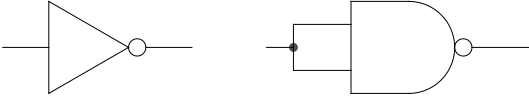
SPECIMEN

This document consists of 8 pages

MARK SCHEME:

Question		Expected Answer(s)	Mark	Guidance
1	(a)	<p>One mark for each correct connection.</p> <p>(5x1)</p>	[5]	No marks for two lines going to same word in either column.
	(b) (i)	<p>One mark for suitable example.</p> <p>Examples could include:</p> <ul style="list-style-type: none"> • calculator • hybrid vehicle • road signs • laptop • generator for back up mains power • any product with a battery and some form of alternative power, solar, mechanical. 	[1]	
	(ii)	<p>Two marks for a clear explanation using an example.</p> <p>Explanation to include detail of why primary power source may fail, allowing back up to take over.</p> <p>(2x1)</p>	[2]	Two marks for clear explanation with example, one mark for valid explanation with no example used.
	(c)	<p>Two marks for a clear description.</p> <p>Voltage regulator is used to: Provide constant stable voltage (1) from a possible varying higher voltage (1) it can provide a smoothing effect with other components (1).</p> <p>(2x1)</p>	[2]	Accept any other valid response relating to voltage requirements.

Question			Expected Answer(s)	Mark	Guidance
2	(a)	(i)	One mark for each correct answer. Value of the resistor 4700 (1) tolerance of the resistor 0.01 or 1% (1) <p style="text-align: right;">(1+1)</p>	[2]	Allow 4.7K 1% tolerance.
		(ii)	One mark for each correct answer. Highest value is $4700 + 4.7 = 4704.7\Omega$ (1) Lowest value is $4700 - 4.7 = 4695.3\Omega$ (1) <p style="text-align: right;">(1+1)</p>	[2]	Ω symbol is not needed for mark.
	(b)		Total resistance for series 48K(1) Total resistance for parallel 5K(1) <p style="text-align: right;">(1+1)</p>	[2]	
	(c)	(i)	Two marks for a clear description of the effect. The resistance across the thermistor will change (1) and decrease (1) <p style="text-align: right;">(2x1)</p>	[2]	
		(ii)	Two marks for a clear explanation. The variable (potentiometer) will allow the voltage at the centre of the potential divider to be set precisely for calibration (1) this allows for accurate control of processing components such as transistor or comparator. (1) <p style="text-align: right;">(2x1)</p>	[2]	Allow one mark for mention of a switching point being adjustable.
3	(a)	(i)	One mark for each correctly labelled switch. <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  momentary action switch </div> <div style="text-align: center;">  double pole double throw </div> <div style="text-align: center;">  toggle switch </div> </div> <p style="text-align: right;">(3x1)</p>	[3]	
		(ii)		[2]	One mark for single pole, One mark for the double throw. Allow variations on the symbol to match those found in simulation software.

Question		Expected Answer(s)	Mark	Guidance
	(b) (i)	<p>One mark for each valid benefit. Benefits of transistor for switching could include:-</p> <ul style="list-style-type: none"> • Reliability and long life • Fast action • No arcing • Generally smaller than a mechanical switch • Lower cost <p style="text-align: right;">(2x1)</p>	[2]	Allow no clamping diode needed for relay switching.
	(ii)	<p>Two marks for a clear description. The 10K resistor is to pull up the input to the NOR gate to level of the positive rail (1) when the transistor is not switched on (1).</p> <p style="text-align: right;">(2x1)</p>	[2]	
	(iii)	 <p>The diagram shows two logic gates. On the left is a Schmitt trigger, represented by a triangle with a small circle at its output. On the right is a Schmitt NAND gate, represented by a D-shaped symbol with a small circle at its output and a dot on its input.</p>	[1]	Allow Schmitt versions of either gate.
4	(a) (i)	<p>One mark for each correct method. LED cathode can be identified by:</p> <ul style="list-style-type: none"> • Observing the flat on body • Observing the shorter connection leg • Using a multimeter <p style="text-align: right;">(2x1)</p>	[2]	Allow mark for any other functional method.
	(ii)	<p>Maximum three marks for correct answer. Use of voltage drop $6V - 1.8V = 4.2V$ (1) Use of $I = V/R$ $I = 4.2 / 330$ (1) $= 12.72mA$ (1)</p> <p style="text-align: right;">(3x1)</p>	[3]	Allow 13 mA for answer.
	(b) (i)	<p>Two marks for a clear description. Common cathode means that the cathodes of each segment are internally joined (1) leaving only one connection to be made (can be two external pins) (1).</p> <p style="text-align: right;">(2x1)</p>	[2]	

Question		Expected Answer(s)	Mark	Guidance
	(ii)	Three marks for a clear explanation. Explanation should include the need for each segment to be the same brightness at all times (1). Each digit displayed uses a different number of segments e.g. 8 requires all segments to be lit, 1 requires only two segments (1). If a single resistor is used the brightness would vary (1). A fault with a single resistor means that all segments would be switched off rather than only losing one segment from the digit (1). (3x1)	[3]	3 x 1 marks, one mark for each point mentioned.
5	(a) (i)	One mark for each safety check. Safety checks will include: <ul style="list-style-type: none"> • Check plug for loose / exposed wires (1) • Check cable for burns / cuts (1) • Check that tip is securely fixed onto the element (1) • Check for PAT test sticker / date on sticker (1) • Check the shaft is secure to the handle (1) • Check the handle is not cracked or broken (1) (4x1)	[4]	One mark each for any four valid checks.
	(ii)	One mark for each valid benefit. Benefits of PAT testing to include: <ul style="list-style-type: none"> • Assurance that appliance has been tested regularly • Less chance of electric shock from faulty appliance • Visual confirmation that a test has taken place • Written details of when test took place 	[2]	Allow any other valid benefits.
	(b) (i)	Two marks for a clear description of how a commercial manufacturer would use built-in test points. Test points allow for automated testing following manufacture (1) reduction in time for setting up manual tests (1). individual boards that form part of a larger circuit can be tested separately (1). (2x1)	[2]	Description should include two valid points. Award two marks for well-developed single point.
	(ii)	One mark for each benefit. Benefits of surface mount components to include: Physically smaller allowing for smaller circuits and smaller casings (1). Less material used in the circuit construction (1). Easier to orientate and place than through hole components (1).	[2]	2 x 1 marks. Allow any other valid benefits.

Question	Expected Answer(s)	Mark	Guidance																																																								
6 (a)	One mark for each change described. Dial on meter should be turned to mA setting (1) Common lead and V Ω mA lead connections should be reversed (1) (2x1)	[2]																																																									
(b)	<table border="1" style="display: inline-table; margin-right: 20px;"> <tr> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">ignition</td> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">door 1</td> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">door 2</td> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">boot</td> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">bonnet</td> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">output at X</td> <td style="writing-mode: vertical-rl; transform: rotate(180deg);">output at Y</td> </tr> <tr> <td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> </tr> <tr> <td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td> </tr> <tr> <td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td> </tr> <tr> <td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td> </tr> <tr> <td>0</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>0</td><td>0</td><td>1</td><td>0</td> </tr> <tr> <td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td> </tr> </table> X column correct, 1 mark Y column correct, 1 mark (2x1)	ignition	door 1	door 2	boot	bonnet	output at X	output at Y	1	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	1	0	0	1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1	1	0	[2]	
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(c)*	<p>Level 3 (5–6 marks)</p> <ul style="list-style-type: none"> Detailed discussion showing a thorough understanding of the implications for a manufacturer when considering changing from through hole to surface mount production. Makes reasoned judgments about both benefits and drawbacks of surface mount solutions compared with traditional solutions, supported using relevant examples. Information is presented clearly and accurately, with correct use of appropriate technical language and engineering terminology. Accurate use of spelling, punctuation and grammar. <p>Level 2 (3–4 marks)</p> <ul style="list-style-type: none"> Adequate discussion showing some understanding of the implications for a manufacturer when considering changing from through hole to surface mount production. Makes some appropriate judgments about both benefits and drawbacks of surface mount solutions compared with traditional solutions, supported using some relevant examples. Information is presented clearly and with some accuracy. Appropriate technical language and engineering terminology is used on some occasions. Occasional errors in spelling, punctuation and grammar. 	[6]	Implications for manufacturer could include: <ul style="list-style-type: none"> New machinery / equipment needed e.g. purchase of pick and place machinery, solder mask equipment, ovens Purchase of testing equipment Cost of new equipment compared to outsourcing manufacture Workforce training Fewer assembly workers needed Greater difficulty in re-working faulty boards Comparison should be made with traditional methods.																																																								

Question	Expected Answer(s)	Mark	Guidance
	<p>Level 1 (1–2 marks)</p> <ul style="list-style-type: none"> • Basic discussion showing limited understanding of the surface mount process. • Makes some basic statements about surface mount solutions compared with traditional solutions, supported using limited examples. • Information presented is basic and may be ambiguous or disorganised. There will be little or no use of technical language and engineering terminology. • Errors of spelling, punctuation and grammar may be intrusive. <p>0 = a response that is irrelevant and/or not worthy of a mark. Annotate with 'Seen' at end of response.</p> <p style="text-align: right;">(6`x1)</p>		
	Total marks for paper	60	

Question number			Content Area			
			LO1	LO2	LO3	LO4
1	a	i	5			
1	b	i	1			
1	b	ii	2			
1	c		2			
2	a	i		2		
2	a	ii		2		
2	b		2			
2	c	i		2		
2	c	ii		2		
3	a	i		3		
3	a	ii		2		
3	b	i		2		
3	b	ii		2		
3	b	iii		1		
4	a	i		2		
4	a	ii	3			
4	b	i		2		
4	b	ii		3		
5	a	i			4	
5	a	ii			2	
5	b	i			2	
5	b	ii				2
6	a				2	
6	b				2	
6	c*					6
Total Marks			15	25	12	8