CAMBRIDGE NATIONALS

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Examiners' report

SYSTEMS CONTROL IN ENGINEERING

J833, J843

R113 January 2022 series

Version 1

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Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

R113 series overview

Some candidates attempted all six questions but, in many cases, knowledge of some sections of the specification appeared to be limited. This was confirmed by a significant increase in the number of questions to which no response was given.

In many cases, it was apparent that candidates had not read questions carefully enough before giving their answers, resulting in a loss of marks. In questions where candidates are asked to describe and explain, it should be noted that justified responses need to be presented in order to gain the higher marks available. One word or overly simplistic answers are not suitable responses to this type of question.

Some candidates needed to read the question fully and went on to provide a response that was not always relevant to the question. Candidates should be advised to read the complete question before providing a response.

There were instances where candidates did not address the command verbs in the question. When a question command verb is 'describe', candidates gave one word responses, which limits their ability to access the full range of marks available.

In a number of cases, responses to questions relating to basic electronic principles showed that learning had not taken place, with some candidates guessing answers.

Candidates should be advised not to use the additional lined space unless absolutely necessary because sufficient space for an answer has been provided on the examination paper.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• Applied knowledge and understanding to questions set in a novel context. • Produced clear and concise responses to Level of Response questions. • Performed standard calculations following the given rubric. • Completed diagrams correctly. • Completed tables with accuracy.	• Struggled to apply what they had learnt to unfamiliar situations. • Produced responses that lacked depth, and were often peripheral to what had been asked, sometimes repeating the information provided. • Showed poorly structured calculations. • Produced diagrams that had little or no meaning at all. • Were unable to complete tables with any degree of accuracy.

Question 1 (a) (i)

1 (a) (i) Complete the table by using words from the list below.
Each word may be used once or not at all.

Automatic

Continuous

Portable

Sustainable

Unsustainable

Power Source	Type of Power Source
6 V Battery	
1 kW Solar Panel	
230 V AC Mains	

[3]

Generally well answered with the majority of candidates completing the table correctly with three words in accordance with instructions given in the question. However a few candidates were unaware of what was meant by sustainability, with some choosing automatic instead of continuous for the 230 V AC mains.

Question 1 (a) (ii)

(ii) Give **one** drawback of using a sustainable power source.

.....

..... **[1]**

Generally well answered with candidates giving one drawback of using a sustainable power source. The majority of candidates linked their answer to cost or reliability when compared to other power sources.

Question 1 (a) (iii)

(iii) Give **one** example of a combined power source for portable equipment.

.....

.....

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

Generally well answered with candidates giving one example of a combined source. But a number of candidates only gave one power source, for example, 'Battery and Solar' was awarded 2 marks but 'Battery' by itself was only awarded 1 mark. A few candidates gave a product instead of a power source.

Question 1 (b)

(b) Calculate the potential difference across a heating element if its resistance is 70 Ω and the current flowing through it is 3.3A.

.....

.....

.....

.....

..... **[4]**

A majority of candidates were awarded full marks. A few candidates could not correctly recall the formula V = IR or carry out the correct numerical sequences to obtain an answer of 231 V.

Exemplar 1

(b) Calculate the potential V difference across a heating element if its resistance is 70 Ω and the current flowing through it is 3.3A.

V = IR

B V = 3.3 × 70

V = 231V

..... **[4]**

In this response, the formula V = IR was correctly applied giving a numerical answer of 231 V.

Question 2 (a)

2 **Fig. 1** shows part of a circuit diagram with an LED rated at 2 V 20 mA.

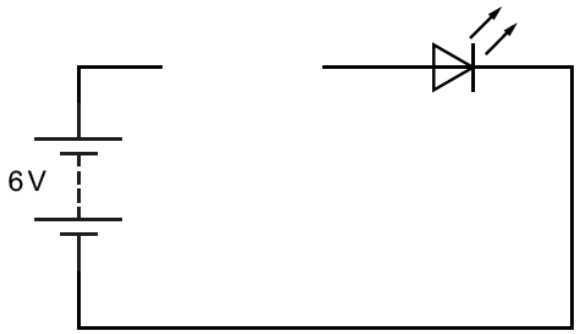


Fig. 1

(a) Complete the circuit diagram in **Fig. 1** by drawing a resistor in the space provided. **[1]**

Generally well answered by the majority of candidates by drawing a correct symbol for a resistor. A few candidates drew incorrect symbols for a resistor.

Question 2 (b)

(b) Calculate the potential difference across the resistor.

.....

.....

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

This question was generally awarded low marks. The term 'potential difference' did not seem to be well known. A number of candidates did not take into account that the LED was rated at 2 V resulting in a potential difference across the resistor of 4 V.

Question 2 (c)

(c) Give **two** reasons for having a resistor in the LED circuit.

1 .....

2 .....

[2]

A straightforward question but not all candidates were given full marks. The expected responses were 'protect the LED' and 'limit the current through the LED'. Some candidates were awarded a mark for using alternative words.

Question 2 (d)

(d) Describe the operation of an LED.

.....

.....

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

The majority of candidates were able to explain that LEDs emit light, with most being able to link this to the point at which current is flowing through the resistor. Overall, key terms were known by most candidates, with responses showing a good understanding of component function.

Question 2 (e)

(e) Calculate a suitable value for the resistor if the current flow required is 20 mA.

.....

.....

.....

..... **[3]**

There were mixed responses to this question. The good responses were given high marks. Others appeared to be guessing and gave incorrect calculations.

Some candidates could not correctly covert 20 mA to amperes (A). This error in conversion resulted in many incorrect numerical answers.

The formula, R = V/I, for calculating the resistor was generally not well known and a high proportion of candidates used 6 V instead of 4 V.

Question 3 (a)

3 **(a)** Complete the table, using a tick (✓) against **three** techniques that can be used to identify potential electrical hazards.

Techniques	Tick (✓)
Portable appliance testing	
Power supply unit	
Truth tables	
Use of residual current device	
Visual inspection of equipment	

[3]

Generally well answered by candidates ticking three techniques correctly. But some candidates could only give two correct responses. 'Use of residual current device' was the most frequently used incorrect response.

Question 3 (b)

(b) The half split method is a fault finding procedure for electronic circuits.

Describe how this works.

.....

.....

.....

.....

.....

..... **[3]**

Generally, candidates produced a mixture of responses and were awarded low marks.

A number of candidates were clearly aware of the half split method, but only a few were able to describe the full procedure. A number of responses described the need to split the circuit into two and test, but did not continue with a description of the need for additional circuit splitting.

Exemplar 2

(b) The half split method is a fault finding procedure for electronic circuits.

Describe how this works.

This method works by when a fault is detected in a circuit, the circuit is split in halfs. One half works fine, while the other has the fault. This is continued until the fault has been found. ~~the~~ The area with the fault shrinks each time a test is carried out. **[3]**

The candidate gave a very good response clearly showing that the concept of dividing a circuit into halves resulted in a final half that would contain the fault. A maximum mark of 3/3 was awarded.

Question 3 (c)

(c) State **two** benefits of using a virtual signal generator for testing a simulated circuit.

1 .....

.....

2 .....

.....

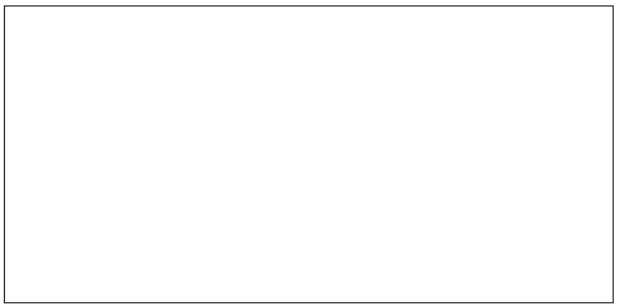
[2]

Generally well answered with a number of candidates being awarded two marks. A popular response was 'The circuit does not need to be physically constructed and the simulation can be saved'.

In some cases, alternative words were used in responses, and were awarded marks.

Question 3 (d)

(d) In the space provided below, draw the shape of a signal that could be provided by a virtual signal generator.



[2]

Generally well answered by the majority of candidates who could accurately draw a wave form. The most popular response was a sine wave and a square wave.

Question 4 (a)*

4 **(a)*** Discuss the benefits to a manufacturer of using surface mount components in electronic circuits, compared to using through hole mounted components.

.....

.....

.....

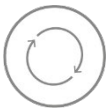
.....

.....

..... **[6]**

Many candidates gave a reasonable discussion of the benefits to a manufacturer of using surface mount components in electronic circuits. The discussions by the candidates were wide ranging. A popular response included 'smaller components are used, fewer holes need to be drilled, both sides of the circuit could be used, lower initial costs and time of setting up for mass production'.

Candidates who did less well on this question gave a less sensible discussion, providing few facts and incorrect or vague benefits.

	**AfL**	The use of spelling, punctuation and grammar could be improved and in some responses to this six mark question, the quality of handwriting was low.

Exemplar 3

4 (a)* Discuss the benefits to a manufacturer of using surface mount components in electronic circuits, compared to using through hole mounted components.

Surface mounted components are much smaller than through hole mounted components. This means that more of them are able to be fitted on the same size PCB, they can also be fitted to both sides of a PCB. This means that money can be saved as less PCB is needed and the components cost less as they are smaller. Money can also be saved as less people are needed when using surface mounted components as they can all be placed on the PCB by a pick and place machine, unlike through hole components which might need to be manually placed on the board. + Surface mount components are also much more durable under vibrational force which means that they are much less likely to come off the board once they are attached which would mean the manufacturer might have to give refunds. + Due to more of the process being done by machines, lots more PCBs can be made in the same space of time when using surface mounted components as through hole components so more can be sold, making more money. * Because the manufacturer would have to pay more staff meaning that [6]

The response was given the maximum of 6/6 marks for presenting a very clear and correct response to this question. The benefits to a manufacturer of using surface mount components in an electronic circuit were clearly stated from the very beginning of the response. The sentence construction was good and the handwriting reasonable.

Question 4 (b)

(b) State the names of **three** manufacturing processes used within commercial circuit construction.

1 .....

2 .....

3 .....

[3]

Generally well answered with a number of candidates correctly naming three manufacturing processes used within commercial construction.

A few candidates lacked knowledge and their responses provided little or no information. Popular responses included flow solder wave process, pick and place robot and manual component placement.

Question 4 (c)

(c) Name **one** item of test equipment which is used for testing electronic circuits.

..... **[1]**

Generally well answered by the majority of candidates. Popular answers included multimeter, voltmeter and ammeter.

Question 5 (a)

5 (a) Identify **two** smart modern materials.

1 .....

2 .....

[2]

Generally well answered by a number of candidates who were awarded 2 marks. Popular answers included Quantum tunnelling composite and shape memory alloys. A few candidates lacked knowledge and their responses gave little or no information.

Question 5 (b)

(b) **Fig. 2** shows part of a circuit diagram for an astable circuit using a 555 timer.

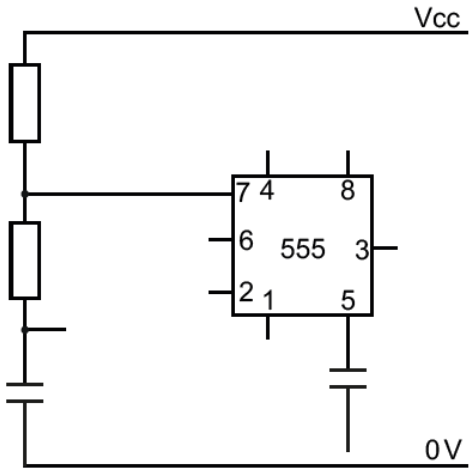


Fig. 2

Complete the circuit diagram in **Fig. 2** by drawing in the connections for pins 1, 2, 4, 5, 6, 8. **[4]**

The responses appeared to be split, one group clearly completing the circuit diagram correctly and the other group not completing the circuit diagram correctly.

Question 5 (c)

(c) Draw a label on the circuit diagram in **Fig. 2** to show what pin 3 is used for. **[1]**

The responses appeared to be split with one group clearly identifying that pin 3 was the 'output' and the other group completing the circuit diagram with a range of components.

Question 5 (d)

(d) Complete the sentence using words from the list below:
Each word may be used once or not at all.

external

internal

irregular

regular

sawtooth

square

An astable circuit will produce a ..... signal in the form of

a ..... wave, without needing an ..... trigger. **[3]**

Generally well answered by the majority of candidates giving a correct response of regular, square, and external.

Question 6 (a) (i)

6 **(a)** The block diagram in **Fig. 3** shows an alarm system for heat and smoke.

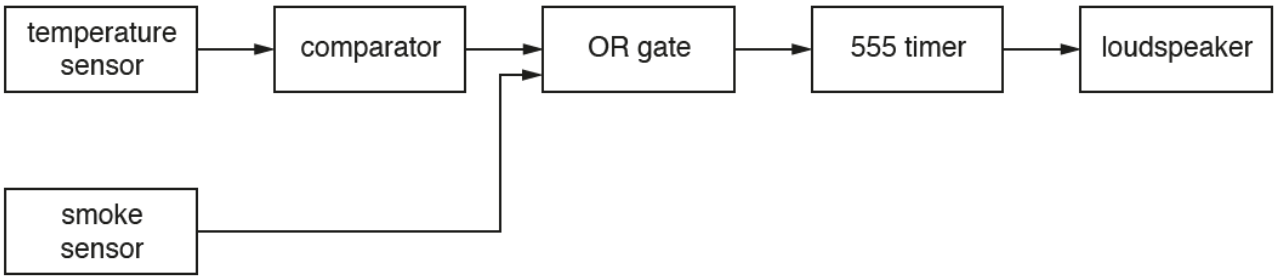


Fig. 3

(i) State the names of the **two** blocks that will give an input to the system.

.....

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

Generally well answered by the majority of candidates correctly stating temperature sensor and smoke sensor.

Question 6 (a) (ii)

(ii) State which block of the system represents the output stage.

..... **[1]**

The majority of candidates who answered correctly stated loudspeaker.

Question 6 (a) (iii)

(iii) State in which block an operational amplifier is used.

..... **[1]**

The responses appeared to be split, with some candidates clearly identifying that the operational amplifier is used as a comparator. A large proportion of candidates incorrectly identified the OR gate of the 555 timer as an operational amplifier.

Question 6 (a) (iv)

(iv) State in which block a thermistor is used.

..... **[1]**

Generally answered by the majority of candidates correctly stating temperature sensor.

Question 6 (b)

(b) Describe what is meant by the term 'capacitor voltage rating'.

.....

.....

.....

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

Some candidates could clearly identify the term 'capacitor voltage rating' as the maximum amount of voltage that it can safely be exposed to. The rest were not able to answer this meaningfully.

Question 6 (c)

(c) Calculate the maximum and minimum value a capacitor will have if it is rated at 120 µF ± 10%.

Maximum value .....

.....

Minimum value .....

.....

[3]

Generally well answered with the majority of candidates being awarded full marks. This majority correctly calculated that 10% of 120 is 12 and then added or deducted 12 giving a correct answer of a maximum value of 132 and a minimum value of 108.

A small number of candidates struggled to calculate 10% of the given number, which resulted in a loss of marks.

Exemplar 4

(c) Calculate the maximum and minimum value a capacitor will have if it is rated at 120 µF ± 10%.

Maximum value ..... 132 µF ..... 120/10 = 12 = 10%

..... 120 + 12 = 132 .....

Minimum value ..... 108 µF ..... 120/10 = 12 = 10%

..... 120 - 12 = 108 .....

[3]

The candidate was given the maximum mark of 3/3. The response clearly shows that the candidate understood the concept of tolerance by correctly calculating that 10% of 120 was 12 leading to a maximum value of 132 µF and a minimum value of 108 µF.

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