

**CAMBRIDGE NATIONALS**

**Examiners' report**

# **SYSTEMS CONTROL IN ENGINEERING**

**J833, J843**

**R113 January 2023 series**

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## 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 is 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.

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## R113 series overview

Most questions were attempted by a high proportion of the candidates. There was evidence of well-prepared candidates who demonstrated their subject knowledge by producing well-structured responses, meeting the requirements of the command verb and confidently using specific and appropriate terminology.

However, in several 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 or explain functions and applications of components, 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.

Few candidates made use of the extra pages this series, suggesting they were able to focus their answers and were guided by the number of lines provided for the answer. It was good practice and very helpful for examiners when candidates put a note at the bottom of their response in the main paper stating that a question had been continued on the extra pages.

In this series there was a decrease in the number of questions to which no response was given. In some cases candidates' handwriting was difficult to read.

In some responses to questions relating to basic electronic principles, candidates seemed to have guessed their responses in order to provide an answer.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
<ul style="list-style-type: none"> <li>performed standard calculations following the given rubric</li> <li>produced clear and concise responses for Level of Response questions</li> <li>completed circuit diagrams placing a resistor and a light dependent resistor (LED) in correct positions</li> <li>applied knowledge and understanding to questions set in a novel context</li> <li>completed tables with accuracy.</li> </ul>	<ul style="list-style-type: none"> <li>found it difficult to apply what they had learnt to unfamiliar situations</li> <li>produced responses that lacked depth and were often rambling and peripheral to what had been asked, sometimes simply repeating information provided</li> <li>showed poor setting out of unstructured calculations</li> <li>produced diagrams and completed circuits that had little or no meaning at all</li> <li>were unable to complete tables with any degree of accuracy.</li> </ul>

### Assessment for learning



For all questions, candidates should always read the question twice and refer back to it when part way through their answer. This will make sure their response is relevant and answers the question.

### OCR support

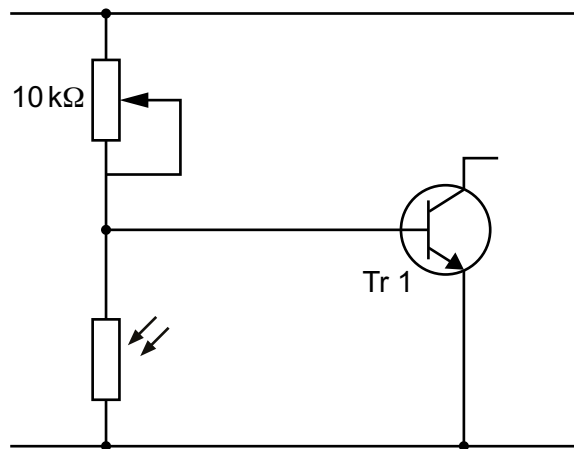


At the beginning of the academic year a sheet should be issued to all students, that contains all of the electronic graphical symbols that are needed for this specification.

## Question 1 (a)

1 Fig. 1 shows a partly completed circuit diagram.

Fig. 1



(a) Complete the circuit diagram in Fig. 1 by adding:

- a light emitting diode (LED) connected to Tr1
- a current limiting resistor for the LED
- +9V and 0V labels for the power supply rails.

[6]

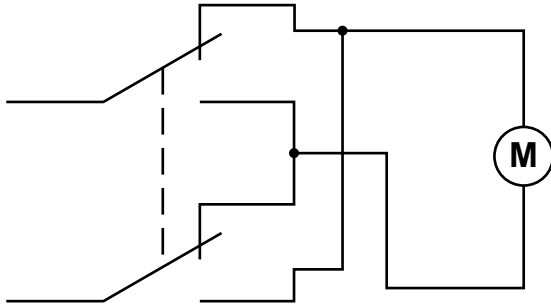
Successful responses to this question completed the circuit diagram correctly using the correct symbol for a resistor and a light dependent resistor (LED) and placed them in the correct positions. The majority of candidates labelled the power rails correctly. Less successful responses produced incorrect symbols and placed them incorrectly.

**Question 1 (b)**

(b) **Fig. 2** shows a switch being used to control the direction of rotation of a motor.

Complete the name of the switch type shown in **Fig. 2** that is being used to control the motor.

**Fig. 2**



Double Pole Double .....

[1]

This was a well-answered question by candidates who stated the correct answer 'throw'. A few candidates used the word 'through' for 'throw'.

**Question 1 (c)**

(c) Calculate the total resistance of three resistors, each of value  $10\Omega$ , connected in series.

Total resistance .....

.....

..... [3]

Generally well-answered by using the correct series formula and manipulating the numbers to give a result of  $30\Omega$ . A few candidates used incorrectly the parallel formula.

### Question 2 (a)

- 2 (a) State how you would identify the difference between a polarised capacitor and a non polarised capacitor when making a connection in a circuit.

.....

.....

..... [2]

Generally well-answered with candidates being able to gain at least 1 mark for this question. Most were able to describe that a polarised capacitor will have different leg lengths, with some knowing specifically which one was +/- . A number of candidates assumed that because they had written about a polarised capacitor having certain characteristics, they didn't have to state the key characteristics of a non-polarised capacitor.

### Question 2 (b) (i)

- (b) A capacitor colour code chart to give values in pF is shown in **Table 1** below.

**Table 1**

Band 1	Band 2	Band 3	Band 4
Black 0	Black 0	Black 0	Black $\pm 20\%$
Brown 1	Brown 1	Brown 1	Brown $\pm 1\%$
Red 2	Red 2	Red 2	Red $\pm 2\%$
Orange 3	Orange 3	Orange 3	Gold $\pm 5\%$
Yellow 4	Yellow 4	Yellow 4	Silver $\pm 10\%$
Green 5	Green 5	Green 5	
Blue 6	Blue 6	Blue 6	
Violet 7	Violet 7		
Grey 8	Grey 8		
White 9	White 9		

- (i) Write down the value of a capacitor colour coded Red, Brown, Orange and Gold. Gold has been completed for you.

Red indicates .....

Brown indicates .....

Orange indicates .....

Gold indicates .....  $\pm 5\%$  .....

The capacitor value is ..... pF  $\pm$  .....

[4]

Most candidates correctly applied knowledge of the capacitor colour code to identify the values of the first two bands. A number of candidates seemed not to be aware that band three was a multiplier, giving the answer as '3' instead of the number of zeros.

**Exemplar 1**

Red indicates ..... 2 .....

Brown indicates ..... 1 .....

Orange indicates ..... 000 .....

Gold indicates .....  $\pm 5\%$  .....

The capacitor value is ..... 21000 ..... pF  $\pm$  ..... 5% ..... [4]

The colour code for a capacitor was well known by a high proportion of candidates resulting in an award of full marks 4/4.

**Question 2 (b) (ii)**

(ii) Calculate the **minimum** and **maximum** value of a 200 pF  $\pm 5\%$  capacitor.

Minimum value .....

.....

Maximum value .....

..... [4]

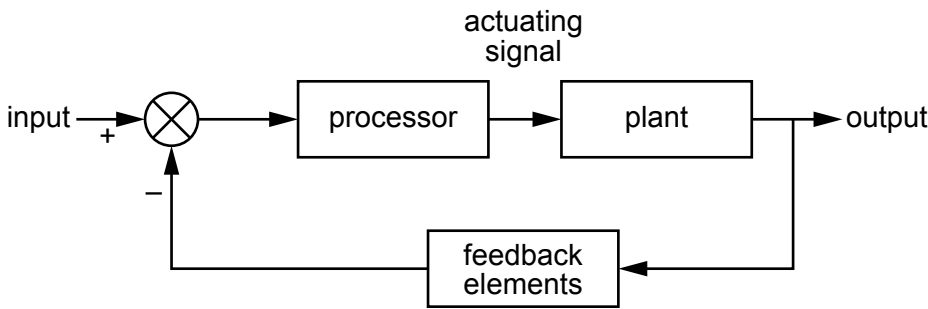
This question was well-answered by candidates. A high proportion of candidates calculated correctly that 5% of 200 is 10 and then calculated correctly the maximum value of 210 pF and a minimum value of 190 pF. A minority of candidates could not calculate correctly 5% of 200.



### Question 3 (a)

3 Fig. 3 is a block diagram of a control system.

Fig. 3



(a) State the type of control loop being used in the diagram shown in Fig. 3.

..... [1]

Generally well-answered with a correct response of 'closed loop'.

### Question 3 (b) (i)

(b) State the purpose of input, output, processor and feedback elements in the system.

(i) Input .....

..... [1]

A proportion of candidates were able to gain 1 mark, linking their response to commands, signals or generating the signal for the processor block.

### Question 3 (b) (ii)

(ii) Output .....

..... [1]

A proportion of candidates were able to gain 1 mark here, linking their response to a signal being sent out of the system from the processor block.

### Question 3 (b) (iii)

(iii) Processor .....  
 .....  
 .....  
 ..... [2]

In general candidates were awarded 1 mark for this question. A number of candidates were unaware of what the processor does in a system.

### Question 3 (b) (iv)

(iv) Feedback elements .....  
 .....  
 .....  
 ..... [2]

In general terms most candidates were not aware of what feedback does in a system.

### Question 3 (c)

(c) Calculate the potential difference across a lamp if its resistance is  $40\ \Omega$  and the current flow is  $0.3\text{A}$ .

.....  
 .....  
 .....  
 ..... V [3]

In general terms a well-answered question. Most candidates were able to select the correct numbers from the question and calculate the answer to gain 2 of the 3 marks available. A number of responses did not give the formula or failed to give the correct formula so were not given a mark.

### Misconceptions



In Question 3 (b) a number of candidates mistook the summing point for a signal lamp at the input section with positive and negative symbols; however, this is the symbol for a summing point. Although the symbols for a lamp and a summing point are similar, the use of a summing point is accurate and appropriate given that it is a block diagram of a control system. Symbols for signal lamps are used in circuit diagrams rather than block diagrams.

### Question 4 (a)\*

4 (a)\* Visual inspection is a technique used to identify potential electrical hazards in electronic circuits.

Discuss the **two** other techniques shown below that are used to identify hazards in electronic circuits:

- portable appliance testing (PAT) compliance
- use of residual current device (RCD).

.....

.....

.....

.....

.....

.....

.....

[6]

A number of candidates answered this question with many giving a reasonable discussion of the use of PAT and an RCD. However less successful responses to this question did not give a very sensible discussion with little or few facts being provided. In general terms it seemed that the use of spelling, punctuation and grammar had slightly improved in this series but in a number of cases the quality of handwriting was low.

PAT – it was generally well known that this test was for safety which included a visual inspection and testing for earth continuity, insulation resistance and lead polarity.

RCD – it was generally well known that this device is a sensitive safety device which monitors imbalance in in the currents of the supply looking for a difference of over 30 mA. A proportion of candidates did mention ‘electric shock’ and ‘electrical fires’. Responses did not refer to the IEE regulations which state that ‘circuits in domestic premises must be RCD protected’.

It is suggested that where equipment is unavailable for this area, students might benefit from YouTube clips to demonstrate these processes.

## Question 4 (b)

(b) List **four** items of electrical test equipment.

- 1 .....
- 2 .....
- 3 .....
- 4 .....

[4]

Generally well-answered with a high proportion of responses giving a correct list of electrical test equipment and a few incorrect responses listing equipment that does not exist.

## Exemplar 2

- 1 Oscilloscope
- 2 ~~the~~ Signal generator
- 3 logic probe
- 4 Power Supply unit

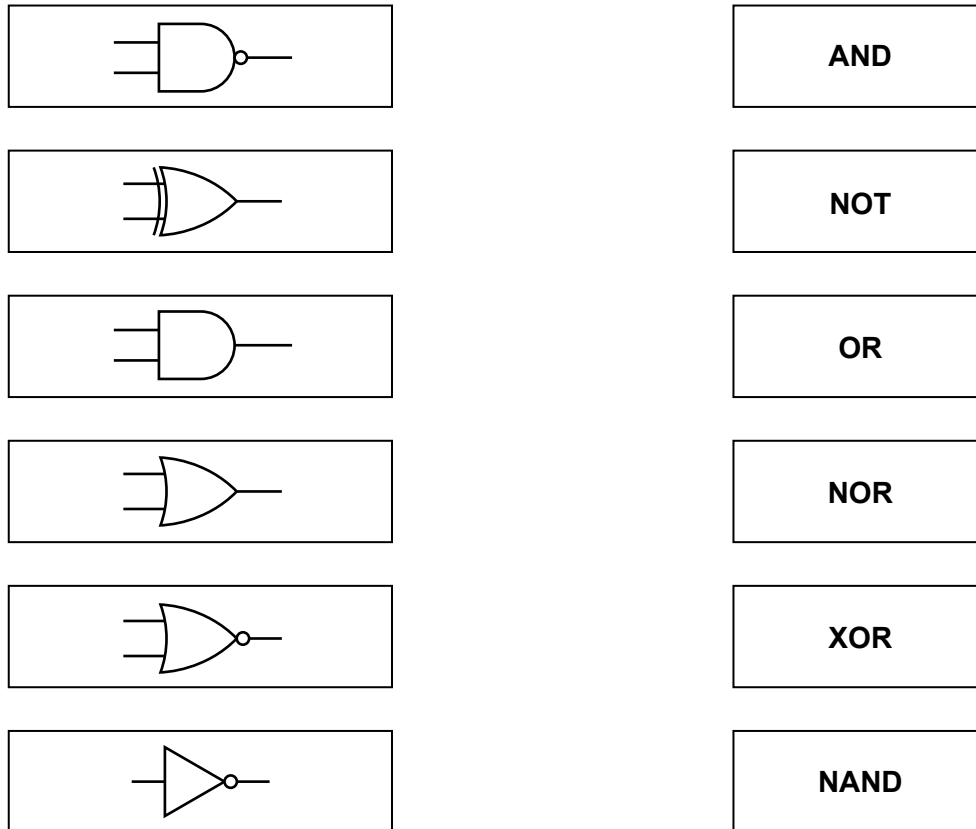
[4]

Generally, a well-answered question, with a high proportion of candidates receiving full marks of 4/4.

## Question 5 (a)

5 Fig. 4 shows **six** logic gate symbols and **six** names of logic gates.

Fig. 4

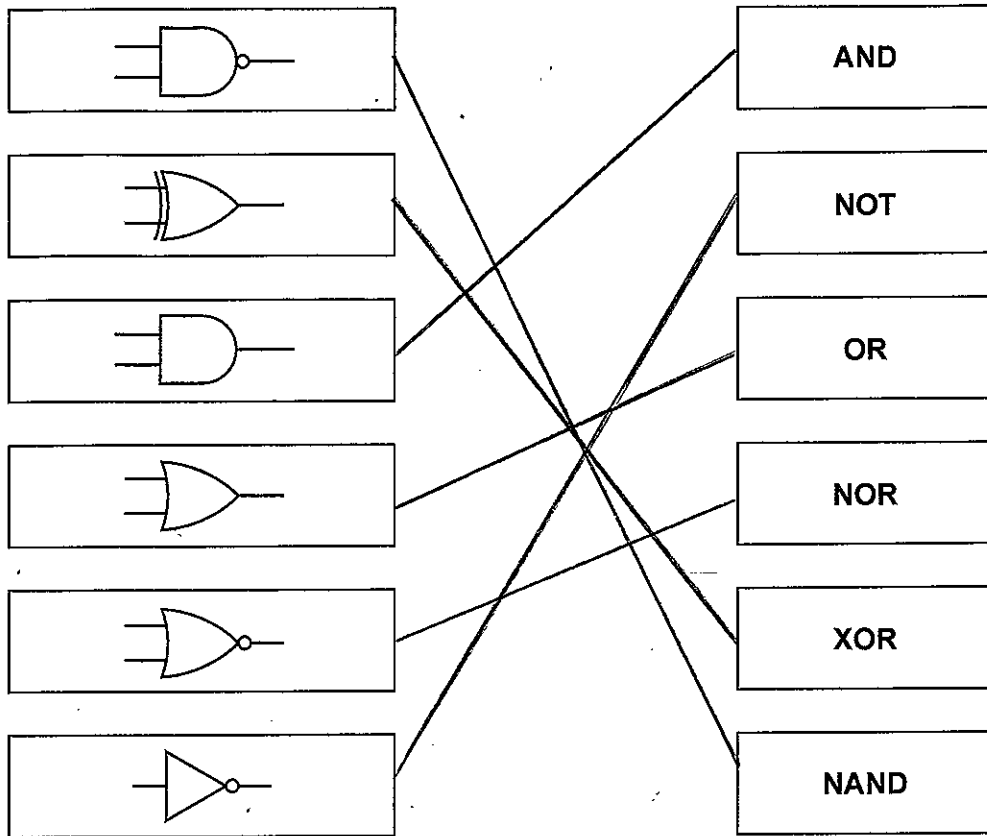


(a) Draw a line between each logic gate symbol and its name.

[5]

A generally well-answered question. It is clear that this cohort has much better knowledge of logic gates than previous cohorts. Most candidates were able to correctly identify all six gates. Many candidates gained at least 3 or 4 of the 6 marks available. A number of candidates used a ruler to draw straight lines linking the logic gate symbol with its name which gave a very professional look to the response. A few candidates supported the lines with a written annotation to identify the gate and ensure they gained as many marks as possible. A number of candidates presented crossed out lines which made the question difficult to mark.

## Exemplar 3



Generally, a well-answered question, with a high proportion of candidates receiving full marks of 5/5.

### Question 5 (b)

(b) Complete the truth table below for each of the **two** input gates listed.

Input A	Input B	AND gate output	OR gate output	NOR gate output	XOR gate output	NAND gate output
0	0					
0	1					
1	0					
1	1					

[5]

Many candidates did not complete the truth table correctly. The majority of candidates were awarded 3 to 4 marks with a number of candidates being awarded zero. The least known response was the output for the XOR gate.

### Question 6 (a)

6 (a) Name **three** manufacturing processes that are used within commercial circuit construction.

1 .....

2 .....

3 .....

[3]

Generally well-answered but with a few incorrect responses.

### Question 6 (b)

- (b) Quality assurance methods are used to check a commercially produced printed circuit board (PCB) with components installed and soldered.

List **five** faults that could be found on a circuit board during a visual inspection.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

5 .....

.....

[5]

A very well-answered question with a high majority of candidates being awarded full marks.

### Question 6 (c)

- (c) Complete the **two** missing values of the preferred E12 resistor series shown below.

	12	15	18	22	27	33		47	56	68	82
--	----	----	----	----	----	----	--	----	----	----	----

[2]

There was a mixed response to this question. It was clear that a large number of candidates were not aware of the E12 series, although it could be assumed that they would have used resistors from this series as part of unit R114. Out of the two responses required, more candidates were able to identify 10 ohms as the first number in the series, with fewer identifying 39 ohms.



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