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Examiners' report

SYSTEMS CONTROL IN ENGINEERING

J833, J843

R113 Summer 2019 series

Version 1

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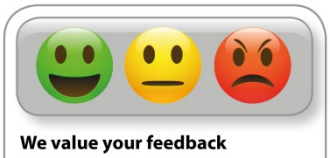

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Introduction

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. 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 can be downloaded from OCR.

Paper R113 series overview

A good proportion of candidates attempted all six questions however knowledge of some sections of the specification appeared to be quite limited in several cases. This was confirmed by a significant increase in the number of questions to which no response was given.

It is also important for candidates to understand that regardless of their knowledge, if their handwriting is illegible, an examiner will be unable to see whether there is evidence in their response to question where they can offer marks.

In a number of 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, 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. Candidates should be advised to read the complete question before providing a response, carefully considering how the command verb is asking them to respond.

In several cases responses to questions relating to basic electronic principles were disappointing, with some candidates apparently resorting to guesswork in order to provide any sort of an answer.

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.

Candidate Performance overview

Candidates who did well on this paper generally did the following;

- Performed standard calculations following the given rubric.
- Produced clear and concise responses for Level of Response questions.
- Completed circuit diagrams placing a thermistor and a signal lamp in correct positions.
- Applied knowledge and understanding to questions set in a novel context.
- Completed tables with accuracy.

Candidates who did less well on this paper generally did the following;

- Found it difficult to apply what they had learnt to unfamiliar situations.
- Produced responses that lacked depth and were often rambling and peripheral to what had been asked, sometimes simply repeating information provided.
- Showed poor setting out of unstructured calculations.
- Produced diagrams and completed circuits that had little or no meaning at all.
- Unable to complete tables with any degree of accuracy.

Question 1 (a)

1 (a) Complete the table using a tick (✓) to identify **three** types of power supply.

Components	Power supply (✓)
Diode	
230 V AC socket	
Operational amplifier	
NPN Transistor	
12 V DC Battery	
Solar Panel	

[3]

This question was generally, well answered with most candidates completing the table correctly with three ticks in accordance with instructions given in the question. However, a few candidates did choose an incorrect power supply such as the diode or the operational amplifier.

Question 1 (b)

(b) Calculate the potential difference, in volts, across a coil if the coil resistance is 15 Ω and the current flowing through the coil is 800 mA.

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

The formula for calculating the potential difference across a coil was generally well known with a high proportion of candidates obtaining high marks.

However, some candidates could not recall V = IR or convert 800 mA to 0.8 A.

Question 1 (c)

(c) Calculate the power input, in watts, to a motor taking a current of 4 A from a 6 V DC supply.

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

The formula for calculating the power input was generally well known with a high proportion of candidates obtaining high marks.

However, some candidates could not recall P = VI to give P = 6 x 4 = 24 W

Question 1 (d)

(d) Calculate the energy, in joules, used by a 50 W lamp in 2 minutes.

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

The formula for calculating energy was generally well known with a high proportion of candidates obtaining high marks.

However, some candidates could not recall W = Pt or convert minutes to seconds to give W = 50 x 2 x 60 = 6000 J.

The symbol W for energy was not well known.

Question 2 (a) (i)

2 **(a)** Fig. 1 shows part of a circuit diagram.

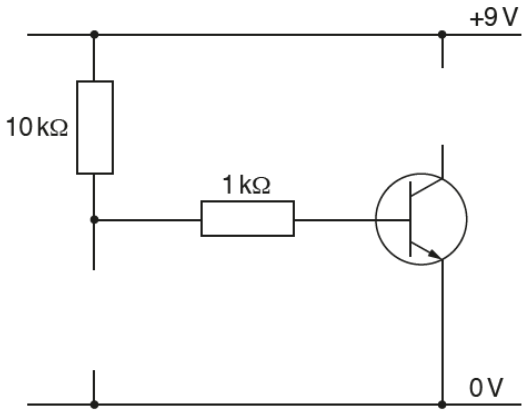

Fig. 1

(i) Complete the circuit diagram in Fig. 1 using an NTC thermistor as an input transducer and a signal lamp as an output transducer. **[2]**

Candidates who did well on this question completed the circuit diagram correctly using the correct symbols for a thermistor and a signal lamp and placed them in the correct positions. A number of candidates used the correct symbols in the incorrect positions.

Candidates who did less well produced incorrect symbols.

Exemplar 1

(a) Fig. 1 shows part of a circuit diagram.

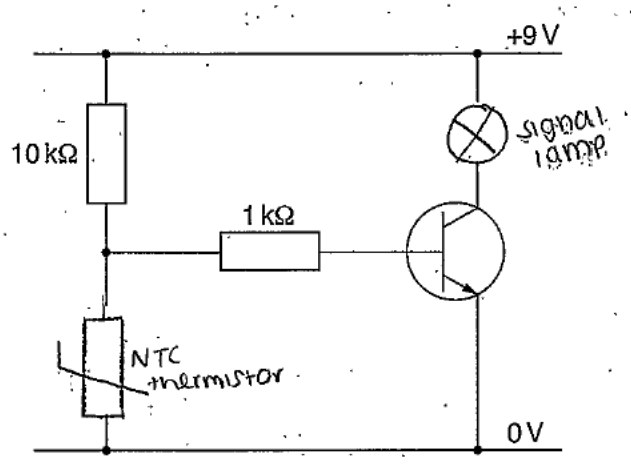

Fig. 1

(i) Complete the circuit diagram in Fig. 1 using an NTC thermistor as an input transducer and a signal lamp as an output transducer. **[2]**

This candidate correctly completed the circuit diagram using the correct symbols for a thermistor and a signal lamp and placed them in the correct positions. They received full marks.

Question 2 (a) (ii)

(ii) Explain in detail how the circuit works.

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..... **[5]**

The concept that with a thermistor, when the temperature drops then its resistance will rise was not well known.

A number of candidates stated correctly that the thermistor and the 10K resistor acted as a potential divider but did not state that the thermistor resistance needed to be higher than the 10K resistor for current to flow to the transistor and subsequently for the signal lamp to light.

In some cases a number of candidates did not understand the difference between current flow, voltage and power surges.

Several candidates demonstrated a lack of knowledge seemingly resorting to guesswork.

Question 2 (b)

(b) State **three** applications for an NTC thermistor.

1 .....

2 .....

3 .....

[3]

Generally, this question was well answered by candidates who stated three correct applications.

Question 3 (a)

3 (a) Explain with the aid of a diagram the function of an operational amplifier being used as a comparator.

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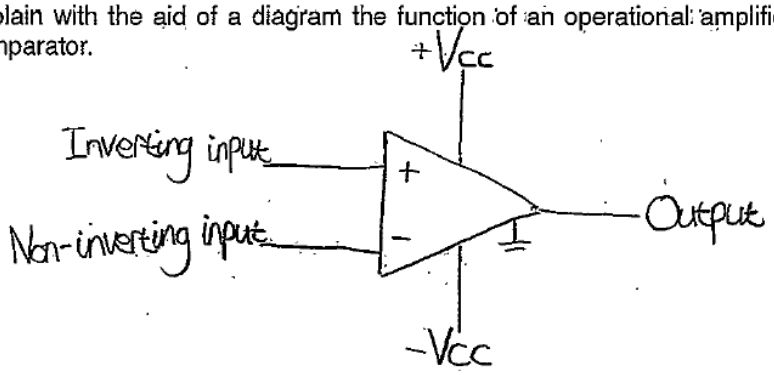
..... **[5]**

The majority of candidates produced diagrams and responses that had very little to do with the function of an operational amplifier being used as a comparator. They lacked knowledge and often provided little or no valid information in their response.

A few candidates did understand the concept that the voltage difference between V_{IN} and V_{REF} gives a result at V_{OUT}.

Exemplar 2

3 (a) Explain with the aid of a diagram the function of an operational amplifier being used as a comparator.



As shown in the diagram drawn (in the test paper), an op-amp has five main pins (plus ground). When used as a comparator, two signals are inputted into the inverting input and the non-inverting input. The op-amp is used to compare the voltages of the two signals, and decide which of the two is higher. Once it has decided this, it will either place the output in positive saturation (the same voltage as the +Vcc input at the top, or negative saturation (the same voltage as the –Vcc input at the bottom), based upon which input is higher. For example, the system may be designed such that if the inverting input has higher voltage than the non-inverting input, the output will be put in positive saturation. Otherwise, the output is put in negative saturation.

This candidate produced a diagram of an operation amplifier but did not add the circuit that was needed for a comparator thus receiving 1 out of 2 marks for this aspect of the question.

The concept that the circuit amplifies the voltage difference between V_{IN} and V_{REF} gives an output at V_{OUT}. was correctly stated. The candidate correctly stated that when V_{IN} is greater than V_{REF} then V_{OUT} is positive and when V_{IN} is less than V_{REF} then V_{OUT} is negative resulting in full marks for this aspect of the question and receiving 4 out of 5 marks overall.

Question 3 (b)

(b) Use notes and sketches to describe the trigger signal and output signal of a monostable integrated circuit.

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.....

.....

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

The majority of candidates produced sketches and notes that had very little to do with the trigger signal and output signal of a monostable integrated circuit. They lacked knowledge and often provided little or no valid information in their response.

However, a few candidates did understand the concept that the single output pulse starts low, goes high for a period of time then returns to low.

Question 3 (c)

(c) Complete the truth table below for the following two-input gates: **OR** and **NOR**.

Input A	Input B	OR gate output	NOR gate output
0	0		
0	1		
1	0		
1	1		

[2]

This question was generally well answered by several candidates who achieved full marks, but some candidates were unable to demonstrate the required knowledge and understanding of how to complete a truth table for a stated gate.

Exemplar 3

Input A	Input B	OR gate output	NOR gate output
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

The candidate neatly and correctly completed the table thus being given full marks.

Question 4 (a)

4 (a) From the following list identify **four** items of test equipment for electronic circuits.

Logic probe **Microphone** **Multimeter**

Power supply unit **Relay**

Residual current device **Signal generator** **Solenoid**

1 .....

2 .....

3 .....

4 .....

[4]

Most candidates correctly identified four items of test equipment for electronic circuits.

However, a number of candidates did choose an incorrect item of test equipment such as the residual current device.

Question 4 (b)

(b) The activities necessary for placing a component on a printed circuit board using a pick and place manufacturing process are shown below, but they are not in the correct sequence.

Complete the table, using numbers 1 to 7, to put the activities in their correct sequence. One has been done for you.

Activity	Sequence
Carry out a quality assurance check	
Check that the components are ready and available	
Check that the robot is switched on and programmed to carry out the manufacturing process	1
Place the component on the printed circuit board	
Check that the vacuum suction cups are working	
Rotate the robotic arm to the correct orientation	
Use the vacuum suction cups to lift the component	

[6]

A number of candidates completed the table correctly using numbers one to seven in accordance with instructions given in the question.

However, some candidates gave a totally incorrect numbering sequence as a likely result of guesswork.

Question 5 (a) (i)

5 (a) (i) Describe how a residual current device (RCD) operates.

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

Most candidates produced responses that had very little to do with the operation of a residual current device, demonstrating a lack of knowledge.

The concept that a residual current device protects by constantly monitoring the current flowing in the active and neutral wires supplying equipment or circuits was understood by a few candidates.

Exemplar 5

A residual current device checks if there is an imbalance of current going from the live to the neutral. If there is it immediately flips a switch and breaks the circuit from the main power. Often the current (bleed) is very small like 30mA.

This candidate was given full marks for referring to residual current device (RCD) checks i.e. monitoring, current flow and when an imbalance is detected the RCD breaks the circuit.

Question 5 (a) (ii)

(ii) Explain why RCDs are compulsory in new electrical installations.

.....

.....

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

Most candidates produced responses that had very little to do with the explanation of why a RCD is compulsory in new electrical installations, demonstrating a lack of knowledge.

Not one candidate referred to the IEE regulations which states 'that circuits in domestic premises must be RCD protected'.

However, a number of candidates did refer to protection against electric shock which could endanger life and protection against electrical fires.

Question 5 (b)

(b) State **four** benefits to a manufacturer of using surface mount components compared to through hole components.

1 .....

2 .....

3 .....

4 .....

[4]

This question was well answered with several candidates stating correctly four benefits of using surface mount components compared to through hole components.

A few candidates clearly lacked knowledge.

Question 6 (a)

6 **(a)*** Discuss the function and application of a solenoid as an output device.

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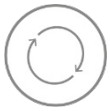
..... **[6]**

Several candidates answered this question, many giving a reasonable discussion of the function of a solenoid. The applications named by candidates were wide ranging. A popular answer for the application of a solenoid was a locking device.

Candidates who did less well on this question did not give a very sensible discussion, often providing few facts incorrect/vague applications.

	**AfL**	In general terms it seemed that the use of spelling, punctuation and grammar has not improved in this series. In a number of cases the quality of handwriting was quite poor. It is important to really emphasise to candidates the importance of writing clearly and in the case of a discussion such as this, planning how to respond before writing out their answer. Those candidates that do plan out their response generally perform well in these higher scoring questions.

Question 6 (b)

(b) Name **four** types of output device that act as a display in electronic equipment.

1 .....

2 .....

3 .....

4 .....

[4]

This question was well answered with several candidates correctly naming four types of output device that act as a display in electronic circuits.

Popular answers included light emitting diodes (LED) and liquid crystal displays (LCD).

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