ENGINEERING PROGRAMMABLE SYSTEMS

Examiners' report

INCLUDED ON THE
KS4 PERFORMANCE TABLES

OCR Level 1/Level 2

Cambridge National in

Engineering Programmable Systems

J824

For first teaching in 2022 | Version 1

R047 Summer 2024 series

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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 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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R047 series overview

This component of the Programmable Systems specification consists of two sections: Section A and Section B.

Section A consists of ten multiple choice questions, with each having one correct answer and three distractors.

Section B of the paper consists of six questions designed to test candidates' knowledge of the wider specification and their ability to respond to key command words.

To do well in this paper, candidates need to have a good understanding of circuit components and their uses, as well as the design, development, and manufacture of printed circuit boards, using various methods and technologies.

A high proportion of candidates attempted all 16 questions, but their knowledge of some sections of the specification appeared to be limited in a number of cases. This was apparent, especially amongst questions linked to industrial manufacturing process, where candidates may have limited first-hand experience.

The standard of presentation and handwriting was sometimes poor, making some responses difficult to follow.

It was good to note that a large proportion of candidates obtained high marks by carrying out calculations correctly, ensuring that all stages of workings were shown, supported by units.

In a number of cases, it was clear that candidates had not read questions carefully enough before giving their answers, resulting in a loss of marks. This was evident in questions where candidates were asked to describe or evaluate circuit production methods.

The mandatory NEA components (R048 and R049) allow candidates to apply some of the knowledge that they will need to recall in R047, as well as doing it in a more practical manner.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• analysed scenarios, leading to the selection of suitable circuit components • accurately explained the function of process devices and output components. • produced clear and well-balanced responses for the Level of Response question. • performed accurate calculations, showing clear workings, supported by units. • accurately applied knowledge of command words to respond to questions set. • applied prior knowledge of test equipment to accurately respond to questions, with supporting justification.	• found it difficult to select specific circuit components, especially in unfamiliar situations. • showed limited knowledge of industrial manufacturing processes. • produced responses to the Level of Response question that lacked depth and understanding of the question set. • were unable to use justification to support responses. • showed limited knowledge of key formulae and their application.

Section A overview

Section A consists of ten multiple choice questions, with each having one correct answer and three distractors. Candidates should be advised to read all available options carefully before selecting an appropriate answer.

Question 1

1 Which power supply converts sunlight into electrical energy?

(a) Battery ☐

(b) Mains adaptor ☐

(c) Photovoltaic cell ☐

(d) Supercapacitor ☐

[1]

The majority of candidates correctly chose 'Photovoltaic cell', with very few selecting the three distractors.

Question 2

2 Which of these is a unit submultiple?

(a) Giga ☐

(b) Kilo ☐

(c) Mega ☐

(d) Pico ☐

[1]

Candidates who did well on this question correctly identified 'Pico' as the correct response.

Some candidates showed limited understanding of the difference between submultiples and multiples, selecting one of the three distractors.

Exemplar 1

2 Which of these is a unit submultiple?

(a) Giga

(b) Kilo

(c) Mega

(d) Pico

[1]

In Exemplar 1, the candidate has highlighted 'sub' within the question, making sure that they have read the question fully.

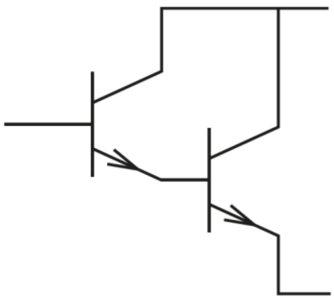
To help eliminate the incorrect answers, they have added crosses next to the responses that they feel are incorrect – in this case, putting crosses next to the three multiples.

Through elimination, this has then left them with the correct response, where a tick has been used in the answer box provided.

This should be seen as good practice.

Question 3

3 What is this the circuit symbol for?



(a) Battery

(b) Darlington driver

(c) Relay

(d) Smart (WiFi-enabled) sensor

[1]

Successful responses to this question identified 'Darlington driver' as the correct answer. 'Relay' on many occasions was incorrectly identified as the correct component.

Question 4

4 What SI unit is power measured in?

(a) hertz ☐

(b) joules ☐

(c) volts ☐

(d) watts ☐

[1]

The majority of candidates correctly chose 'watts', with very few selecting the three distractors.

Question 5

5 Which is a text-based programming language?

(a) using a series of 1s and 0s ☐

(b) using blocks of pre-written code ☐

(c) using characters and words ☐

(d) using flowchart symbols ☐

[1]

Many candidates were able to correctly identify 'using characters and words' as the correct response.

Question 6

6 Which of the following describes electron flow?

(a) from negative to neutral ☐

(b) from negative to positive ☐

(c) from neutral to positive ☐

(d) from positive to negative ☐

[1]

Successful responses identified 'negative to positive' as the correct answer. 'Positive to negative' on many occasions was incorrectly identified as the correct description of electron flow.

Question 7

7 Which item of test equipment would provide waveform signal stimulus for a circuit to test its function?

(a) Continuity tester ☐

(b) Logic probe ☐

(c) Oscilloscope ☐

(d) Signal generator ☐

[1]

Generally this was well answered by candidates with 'signal generator' selected as the correct response.

Some candidates showed limited understanding of 'signal stimulus' and incorrectly selected 'Oscilloscope', seeing the link to waveforms.

Question 8

8 Which part of a block diagram shows the direction of signal flow?

(a) Arrows ☐

(b) Blocks ☐

(c) Inputs ☐

(d) Outputs ☐

[1]

Many candidates were able to correctly identify 'Arrows' as the correct response.

Question 9

9 Which of these is a machine that selects components and positions them on a circuit board?

(a) Automated PCB manufacture ☐

(b) Manual soldering and assembly ☐

(c) Pick and place assembly ☐

(d) PLC programming ☐

[1]

Generally this was well answered by candidates, selecting 'Pick and place assembly'. A number of candidates chose the distractor of 'Automatic PCB manufacture'.

Question 10

10 What type of wiring would be the most appropriate for connecting a door alarm sensor to a printed circuit board (PCB) with wires?

(a) Multi-strand wire ☐

(b) Ribbon cable ☐

(c) Single strand wire ☐

(d) Solid core wire ☐

[1]

Successful responses identified 'Multi-strand wire' as the correct answer. Several candidates chose the distractor of 'Single strand wire'.

OCR support

Further guidance, support and resources for delivering this component can be found on the subject page in Teach Cambridge.

Section B overview

Section B of the paper consists of six questions, designed to test candidates' knowledge of the wider specification and their ability to respond to key command words.

Assessment for learning

A good technique for centres to adopt would be for their candidates to be able to deconstruct the questions, paying particular attention to **command words**, as well as being able to identify **key words** within the question.

Question 11 (a) (i)

11 You are developing a programmable system for a pedestrian road crossing.

- When a person is ready to cross, they must press a button at the side of the road.
- A green light will then visually indicate when it is safe to cross to the other side.
- At this point the system will also make a pulsing sound for those who cannot see the green light.

(a)
(i) Identify **one input** device that could be used as the button for when the user is ready to cross the road.

.... **[1]**

A large proportion of candidates were able to identify a suitable input device, with most selecting a push-to-make switch. Where responses were not awarded marks, they were vague and not specific about the contact arrangements, such as 'switch' or 'button'.

Question 11 (a) (ii)

(ii) Identify **one output** device that could be used as the green light to visually indicate when it is safe to cross the road.

.... **[1]**

Candidates had very good knowledge of output devices that could visually indicate when it was safe to cross the road, with the majority selecting an LED.

A small number of candidates gave responses that could not indicate visually, such as 'buzzer'.

Question 11 (a) (iii)

(iii) Identify **two output** components that could be used to provide the pulsing sound for when it is safe to cross. For **each**, state how it would function to achieve this outcome.

1 ....

How it functions ....

....

2 ....

How it functions ....

....

[4]

A high proportion of candidates were able to identify two suitable output components, with most selecting a combination of buzzer, speaker and piezo sounder.

Candidates did less well when it came to describing the function of the chosen output, with a large proportion giving vague descriptions. Those that did well were able to link the function to current flow.

Assessment for learning

Candidates should be advised to practise applying knowledge of components to various scenarios, supported by justification for component choice.

Question 11 (b)

(b) A motor is being powered by a 12 V power supply. The resistance of the motor has been measured as 60 Ω.

Calculate the current flowing through the motor.

Give your answer using the correct unit.

Show all your working.

Current = ... Unit = ... **[4]**

This was a generally well answered question, with a high proportion of candidates being able to recall Ohm's law and correctly apply it to the values given.

Most candidates showed all stages of working, laying out the response in a logical order.

Question 12 (a) (i)

12

(a)
(i) A 47 μF capacitor is being used to set the time period in a timer circuit.
Give **two** other applications of capacitors in circuits.

1 ....

....

2 ....

....
[2]

A high proportion of candidates were able to identify one other application of a capacitor, with most linking it to storing charge or as a backup power supply.

Some candidates gave responses linked to timing, repeating the example given in the question.

It is suggested that candidates practise recalling applications of a range of electronic circuit components, as shown in the OCR specification.

Question 12 (a) (ii)

(ii) Convert 47 μF into farads.

Answer = ... F **[1]**

Responses to the question were found to be very mixed, with a proportion of candidates showing limited knowledge of converting from μF to F.

It is suggested that candidates practise converting from various units, as shown in the OCR specification.

Question 12 (b)

(b) A 180 Ω, 390 Ω and 1.5 kΩ resistor are connected in a series arrangement.

Calculate the total resistance of this arrangement.

Give your answer in ohms.

Show all your working.

Total resistance = ... Ω **[3]**

As a generally well answered question, a high proportion of candidates achieved 2 of the 3 marks available.

Where candidates did not gain full marks, they did not show all working, missing out the formula for series resistors as the first step.

A small number of candidates gave the formula for a parallel resistor arrangement or were unable to convert from kΩ to Ω.

Exemplar 2

$R_{TOT} = R_1 + R_2 + R_3$

$180 + 390 + 1500 = 2070$

Total resistance = ...2070...... Ω **[3]**

The candidate has correctly stated the formula for calculating resistors in series.

They have then substituted the three resistor values, ensuring that resistor three (R3) is converted into Ohm's.

Although the answer has been written within the working, the candidate has made sure this is also written in the answer box. Full marks were given for this response.

Question 12 (c)

(c) A double sided Printed Circuit Board (PCB) will be made for the system circuit.

Evaluate the use of a double sided PCB instead of a single sided PCB for this application.

....

....

....

....

....

.... **[4]**

Successful responses to this question were able to demonstrate a clear understanding of the differences between double sided PCB and single sided PCB. Most responses focused on the advantages of using one over the other.

Most candidates were able to show some basic understanding of the use of double sided PCB, linking responses to its size and component density.

Question 13 (a)

13
(a) Describe **two** characteristics of the through-hole PCB construction method.

1 ....

....

....

....

2 ....

....

....

....

[4]

A large proportion of candidates were able to gain 1 mark, able to identify one characteristic of through-hole PCB construction.

Most candidates did not go on to 'describe' the characteristic by expanding their point further.

Although candidates have had experience first-hand of though-hole PCB construction in Unit R048, they struggled to compare this to other methods, such as SMT, before formulating an answer.

OCR support

Candidates could be directed to the OCR command words guidance in the Understanding the assessment guide on Teach Cambridge.

Question 13 (b)

(b) Describe the flow soldering process.

....

....

....

....

....

.... **[5]**

This question was generally awarded low marks.

The majority of candidates incorrectly described the 'manual' soldering process instead of the 'flow' soldering process used in industry.

Where candidates did show an understanding of the process, most were able to describe two or three stages correctly.

It is suggested that where equipment is unavailable, candidates might benefit from YouTube clips to demonstrate the process.

Question 14 (a)

14

(a) State **three** safety precautions that should be taken when using an oscilloscope.

1 ....

....

2 ....

....

3 ....

....
[3]

A proportion of candidates were able to state one safety precaution when using an oscilloscope.

Many responses incorrectly referred to the use of goggles and aprons.

It is suggested that candidates practise identifying safety precautions for different test equipment, as shown in the OCR specification.

Question 14 (b)

(b) Discuss the benefits and limitations of using a multimeter to test the functionality of an electronic circuit.

....

....

....

....

....

.... **[6]**

Candidates who did well on this question were able to give a balanced discussion, with at least two benefits and limitations of using a multimeter, supported by good use of technical terms.

A large proportion of candidates were only able to identify one benefit and limitation of the device.

Although it is clear that candidates have previously used these as part of testing in Unit R048, some are unable to recall this knowledge and discuss it in a written format. Candidates may benefit from practising this style of question as they test electronic circuits within centres.

Question 15 (a) (i)

15 You are designing a PCB layout.

(a)
(i) Identify **one** process that could be used to manufacture the PCB.

....

.... **[1]**

Candidates who did well on this question were able to identify a process used to manufacture the PCB, being able to recall CAM milling and photo etching, as shown in the OCR specification.

Candidates who did less well on this question were only able to identify part of the name of the process, such as 'etching' and 'milling'.

Question 15 (a) (ii)

(ii) Explain **two** reasons for using this process to manufacture the PCB.

1 ....

....

....

....

2 ....

....

....

....

[4]

Candidates who did well on this question were able to explain two reasons for using the chosen process fully, with most linking one reason to the accuracy of the process.

A large proportion of candidates were limited by their process choice in part (a)(i), so were unable to access the marks for this part of the question.

Question 15 (b) (i)

(b)
(i) Other than producing a PCB, state **two** methods that could be used to prototype a logic circuit.

1 ....

....

2 ....

....

[2]

The majority of candidates showed excellent knowledge of prototyping methods, with most giving 'beadboard' and 'stripboard' as correct responses.

Some candidates were able to state one correct method, linking the second method to software brands, instead of the specific methods listed in the OCR specification.

Question 15 (b) (ii)

(ii) Complete the truth table below for a logic AND gate.

Input A	Input B	Output
0	0	
0		0
1	0	0
	1	1

[3]

This was a generally well answered question, with a high proportion of candidates being able to complete the truth table accurately for a logic AND gate.

Question 16 (a)

16
(a) Complete the table below by stating the function of each process device and giving an application of each.

Process components and devices	**Function**	**Application**
Latch	Keeps the output signal high/low until it is reset	Alarm circuits
Timer		
Pulse generator		
Amplifier		
Analogue to digital converter		

[8]

Some candidates were able to correctly state the function of at least two of the process devices given, with most giving vague responses that didn't specifically say how it functions.

Many candidates were able to describe the function of the 'Analogue to digital converter', linking comments to its signal/waveform.

'Applications' saw a greater number of correct responses, with most candidates using examples such as stopwatch (timer) and guitar amplifier (amplifier).

A small proportion of candidates achieved no marks, due to repeating the 'Alarm circuits' example given or adding 'circuit' after the name of each process device. For example, 'timer circuit' and 'amplifier circuit'.

Assessment for learning

Candidates should be advised to practise describing the function and applications of various input, process and output components, as listed in the OCR specification.

Exemplar 3

Process components and devices	Function	Application
Latch	Keeps the output signal high/low until it is reset	Alarm circuits
Timer	Keeps the output signal high/low for a set period of time.	Kitchen timer
Pulse generator	Produces an output signal with a continous oscillating signal from high (1) to low (0).	Alarm sounders
Amplifier	Increases the size of a signal	Communication systems
Analogue to digital converter	Converts analogue/sinusoidal waveforms into digital/square wave forms.	Microphone in a mobile phone/Digital sound systems.

In Exemplar 3, the candidate has correctly completed the table, stating the function and application of each process component/device given. The response received full marks.

Question 16 (b)

(b) Explain **one** advantage and **one** disadvantage of using microcontrollers in programmable systems.

Advantage ....

....

....

....

Disadvantage ....

....

....

....

[4]

Many candidates clearly had experience of using microcontrollers from Unit R049 of the specification and many were able to identify an advantage and disadvantage.

Most candidates did not go on to 'explain', for them to be awarded 2 marks for each response.

Most candidates gave responses linked to a microcontrollers small size, its ability to be reprogrammed or the difficulties with learning a programming language.

Where candidates gave comments linked to being expensive, they didn't expand this further by making comparisons against other component types.

Assessment for learning

While teaching Unit R049, it is suggested that classroom discussion is used to discuss the advantages and disadvantages of the microcontrollers used within the centre.

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