…day … Month Year – Morning/Afternoon

OCR Level 1/Level 2 Cambridge Nationals in Engineering Programmable Systems

Unit R047: Principles of electronic and programmable systems

SAMPLE ASSESSMENT MATERIAL (SAM)

Time allowed: 1 hour 15 minutes

You can use:
• A scientific or graphical calculator

Write clearly in black ink. **Do not write in the barcodes.**

Centre number ☐☐☐☐☐   Candidate number ☐☐☐☐

First name(s) _____

Last name _____

INSTRUCTIONS
• Use black ink.
• Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
• Answer **all** the questions.

INFORMATION
• The total mark for this paper is **70**.
• The marks for each question are shown in brackets **[ ]**.
• This document has **16** pages.

ADVICE
• Read each question carefully before you start your answer.

Section A

Put a tick (✓) in the box next to the **one** correct answer for each question.

1   Which of these is the unit of measurement for frequency?

(a)   Amp ☐

(b)   Farad ☐

(c)   Hertz ☐

(d)   Watt ☐

[1]

2   Which of these is best described as the flow of electrons around a circuit?

(a)   Capacitance ☐

(b)   Current ☐

(c)   Resistance ☐

(d)   Voltage ☐

[1]

3   How many ohms is 1.5 megaohms (MΩ)?

(a)   1 500 Ω ☐

(b)   15 000 Ω ☐

(c)   150 000 Ω ☐

(d)   1 500 000 Ω ☐

[1]

4 Which of these is the correct formula for calculating the power in a circuit?

(a) $P = I / V$

(b) $P = I V$

(c) $P = I^2 V$

(d) $P = V / I$

[1]

5 Which of these best describes the purpose of an output block in a system?

(a)   Changes an electronic signal into a physical signal.

(b)   Changes a signal from the physical environment into an electronic signal.

(c)   Increases the size of an electronic signal.

(d)   Processes an electronic signal, such as by latching it on for a period of time.

[1]

6 Which of these components is used as an interface device in a circuit?

(a)   Buzzer

(b)   Diode

(c)   Relay

(d)   Thermistor

[1]

7 A system with feedback is called a:

    (a)   Closed process system

    (b)   Closed loop system

    (c)   Open loop system

    (d)   Open process system

[1]

8 Which of these best describes what a logic probe is used for?

    (a)   To check the signal state of a digital circuit.

    (b)   To measure the value of an analogue signal.

    (c)   To produce analogue signal waveforms.

    (d)   To produce digital signal waveforms.

[1]

9 What component does this circuit symbol represent?

    (a)   Push-to-break switch

    (b)   Push-to-make switch

    (c)   Reed switch

    (d)   Single pole single throw (SPST) switch

[1]

10 You are developing a system that boosts an audio signal to a speaker.

What type of process device would be the most appropriate for this application?

(a) Amplifier ☐

(b) Analogue to digital converter ☐

(c) Latch ☐

(d) Pulse generator ☐

[1]

Section B

11 You are developing a child's night light system.

The system must automatically produce a low level of lighting when it is nighttime.
The light must be off during the day.

(a) (i) Identify **one** suitable input component for use in this system.

....

[1]

(ii) Explain **one** reason why this component is suitable**.**

....

....

....

....**[2]**

(b) Identify **two** output components that could be used to produce light in this system.

1 ....

2 ....

[2]

(c) You are prototyping the night light system using a breadboard.

(i) Explain **two** reasons for using a breadboard to prototype this system.

1 ....

....

....

....

2 ....

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....

....

[4]

(ii) State **one** drawback of using a breadboard to prototype this system.

....

....**[1]**

12 A resistor arrangement is shown below.
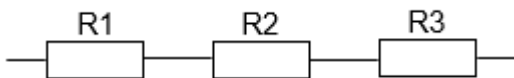
(a) (i) Identify the type of resistor arrangement shown.

....**[1]**

(ii) The value of each of the resistors is:

R1 = 100 Ω
R2 = 1.2 kΩ
R3 = 4.7 kΩ

Calculate the total resistance of the resistor arrangement.

Give your answer in ohms and show all your working.

Total resistance = ... Ω

[3]

(iii) The current flowing through the resistor arrangement is 2 mA.

Using Ohm's Law calculate the potential difference across the arrangement.

Give your answer using the correct unit and show all your working.

....Potential difference =………………..Unit =…………..

[4]

(b) One application of resistors is to protect an LED from damage.

Identify **two** other applications where fixed or variable resistors can be used in electronic circuits.

1 ....

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2 ....

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[2]

13 (a) Describe **two** differences between analogue and digital signals.

1 ....

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....

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2 ....

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[4]

(b) (i) Describe the function of a logic OR gate.

....

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....

....**[2]**

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

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

[2]

Turn over

(c)   A central heating system is one application of a logic AND function.

Identify **two** other applications of a logic AND function.

1 ....

....

2 ....

....

[2]

14 **(a)** You are testing a single strand wire in a circuit to make sure that it is still capable of conducting electricity.

    (i) Identify **two** pieces of test equipment that you could use to do this.

1 ....

2 ....

[2]

    (ii) Describe how you would use **one** of the pieces of test equipment named in **(i)** to do this.

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....**[5]**

(b) Multi-strand wire can be used to connect batteries to circuit boards.

Explain why multi-strand wire is suitable for this.

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[3]

15 **(a)** State **three** characteristics of surface mount technology (SMT).

1 ....

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2 ....

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3 ....

....**[3]**

(b) Describe how a pick and place machine is used to assemble a circuit.

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....**[3]**

(c) Describe the steps to fit and solder components to a PCB using the through-hole construction method.

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....**[4]**

16 A company designs and manufactures home security systems using non-programmable circuitry.

The company is considering changing to microcontroller-based systems.

(a) Discuss the advantages and disadvantages to the company of changing from non-programmable circuitry to microcontroller-based systems.

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....**[6]**

(b) The company could use a block-based editor to program their new systems.

(i) State **two** features of block-based programming editors.

1 ....

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2 ....

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[2]

(ii) State **two** drawbacks of using block-based editors to program microcontroller systems.

1..

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2..

....

[2]

END OF QUESTION PAPER

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Sample Assessment Material (SAM)

Cambridge Nationals in Engineering Programmable Systems
R047 Principles of electronic and programmable systems.

MARK SCHEME
DRAFT

Duration: 1 hour 15 minutes

MAXIMUM MARK 70

Version: 2
Last updated: 14/07/21

(FOR OFFICE USE ONLY)

This document consists of 10 pages

Crossed Out Responses
If a student has crossed out a response and written a clear alternative response, then the crossed out response is not marked. If no alternative is given, examiners will give students the benefit of the doubt and mark the crossed out response if it is legible.

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a student gives two responses (even if one of these responses is correct), no mark will be awarded, as it is not possible to determine which was the first response selected.

Contradictory Responses
When a student provides contradictory responses, no mark will be awarded, even if one of the answers is correct.

Short Answer Questions (usually worth only **one mark per response**)
If a student needs to give a set number of short answer responses, but gives more, only the set number of responses will be marked. The response space will be marked from left to right on each line and then line by line until the required number of responses have been marked. The remaining responses will not be marked.

Short Answer Questions (worth **two or more marks**)
If a student is required to provide a description of, say, three items or factors and four items or factors are provided, then marking will be similar to the above example (but downwards).

Longer Answer Questions
If a student provides two (or more) responses to a medium or high tariff question which only needs a single (developed) response, and does not cross out the first response, the first response will be marked.

Levels of response marking
a.   **To determine the level** – examiners will start at the highest level and work down until they reach the level that matches the answer
b.   **To determine the mark within the level**, they will consider the following:

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

Subject Specific Marking Instructions

Reference to SOI in mark scheme means seen or implied.

Question			Answer	Mark	Guidance
1			**(c)** Hertz	1	
2			**(b)** Current	1	
3			**(d)** 1500000 Ω	1	
4			**(b)** P = I V	1	
5			**(a)** Changes an electronic signal into a physical signal	1	
6			**(c)** Relay	1	
7			**(b)** Closed loop system	1	
8			**(a)** To check the signal state of a digital circuit.	1	
9			**(d)** Single pole single throw (SPST) switch	1	
10			**(a)** Amplifier	1	

Question			Answer	Mark	Guidance
11	(a)	(i)	**One** from: • Light dependent resistor/LDR • Photodiode **Award credit for any other appropriate response.**	1	1 mark for suitable input device that can automatically detect changes in light level. Do **not** accept: • Types of manual switch • Any input device that cannot automatically detect changes in light level • Light sensor (must be a named component)
11	(a)	(ii)	Up to **two** marks for one reason explained e.g.: • An LDR's resistance changes with the light level therefore 　○ it can be used to sense when it has gone dark **Award credit for any other appropriate response.**	2	1 mark for any valid reason given. 1 mark for explaining the reason. Marks may be awarded for a valid reason and explanation even if the answer to **11 (a) (i)** is incorrect.
11	(b)		Any **two** from: • Lamp • Light emitting diode/LED **Award credit for any other appropriate response.**	2	1 mark each for suitable output devices that can produce light.
11	(c)	(i)	Up to **two** marks for each reason explained e.g.: • The night light system has few components and interconnections 　○ breadboards are more suitable for simpler designs • Breadboarding uses physical components therefore 　○ it allows accurate checking of sensor/output function • Changes/improvements to the system can be made easily because 　○ breadboarding does not require any soldering **Award credit for any other appropriate response.**	4	1 mark for each valid reason given up to a maximum of 2 marks. 1 mark for explaining each reason given up to a maximum of 2 marks.

Question			Answer	Mark	Guidance
11	(c)	(ii)	**One** mark for any valid drawback given e.g.: • Only produces a temporary circuit • Component/wire connections can easily become loose **Award credit for any other appropriate response.**	1	
12	(a)	(i)	Series	1	
12	(a)	(ii)	Total resistance = **6000** (Ω) Workings: $R_{tot} = R_1 + R_2 + R_3$ $R_{tot} = 100 + 1200 + 4700$	3	Correct answer seen award **3** marks. Otherwise mark workings: 1 mark for correct formula/method. (SOI) 1 mark for conversion of the units for R2 and R3.
12	(a)	(iii)	Potential difference = **12** Unit = V Workings: 2 mA = 0.002 A V=IR / 0.002 x 6000	4	Correct answer seen award **3** marks. Correct unit 1 mark. Otherwise mark workings: 1 mark for conversion of 2 mA to 0.002 A 1 mark for correct formula (SOI) Allow ecf from **12 (a) (ii)** for their resistance value.
12	(b)		Any **two** from: • To create a potential divider/sensor circuit • To create a parallel resistor arrangement • To adjust the volume of an amplifier **Award credit for any other appropriate response.**	2	1 mark for each appropriate reason up to maximum of 2 marks.

Question			Answer	Mark	Guidance
13	(a)		Any **two** from: • Analogue signals can have an infinite number of possible values (1) whereas digital signals have discrete/0 and 1 values (1) • Analogue signals are shown as continuous waveforms (1) whereas digital signals are shown as square waves (1) **Award credit for any other appropriate response.**	4	1 mark for each valid point. Maximum of 2 marks for only describing analogue or digital signals.
13	(b)	(i)	Up to two marks for a description, e.g.: • The output is high when either or both of the inputs are high (1) • The output is low when both inputs are low (1).	2	1 mark for each valid point. Accept 1 instead of high and 0 instead of low.
13	(b)	(ii)	<table><tr><th>Input A</th><th>Input B</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	2	2 marks for all outputs correct. 1 mark for 3 outputs correct.
13	(c)		Any **two** from: • Lift systems • Burglar alarm systems • Machine safety systems **Award credit for any other appropriate response.**	2	Do **not** allow: central heating system (as it is given in the question).

Question			Answer	Mark	Guidance
14	(a)	(i)	One mark for each correct answer: • Continuity tester • Multimeter **Award credit for any other appropriate response.**	2	
14	(a)	(ii)	Up to five marks from: e.g.: • Connect the black and red probe terminals to the correct sockets on the multimeter/continuity tester • Move the dial on the multimeter to the continuity setting or ohms range/switch the continuity tester on • Place the black terminal on one end of the wire • Place the red terminal on the other end of the wire • Listen for the beep indicating continuity/read the result from the digital screen **Award credit for any other appropriate response.**	5	1 mark for description of each valid step. Maximum 5 marks. Marks may be awarded for an appropriate description even if the answers to **14 (a) (i)** are incorrect.
14	(b)		Up to three marks for relevant points of explanation e.g.: • Multi-strand wire is flexible (1) • It is less likely to break due to mechanical stress/when the battery is moved (1) • Reducing the likelihood of power loss to the circuit (1) • Reducing the cost of maintenance/replacement (1). **Award credit for any other appropriate response.**	3	1 mark for each valid point or additional marks for points that are explained further.

Question			Answer	Mark	Guidance
15	**(a)**		Any **three** from: • Components are placed/soldered on the surface of the PCB/not placed through drilled holes • Components are very small/allows miniaturisation • Solder paste/flow soldering used to make joints • Components can be placed on both sides of the PCB • Allows for high volume manufacture of PCBs **Award credit for any other appropriate response.**	3	1 mark for each valid characteristic.
15	**(b)**		**Three** from: • Machine is programmed with the instructions for assembly • The robot arm picks up the appropriate components from trays/reels • The arm then automatically places these in the correct positions on the PCB **Award credit for any other appropriate response.**	3	1 mark for description of each valid step.
15	**(c)**		**Four** from: • Place component legs into the holes in the PCB • Place the tip of a hot soldering iron on the joints to be made • Apply solder to the joints • Allow solder to cool/solidify **Award credit for any other appropriate response.**	4	1 mark for description of each valid step.

	Question		Answer	Mark	Guidance
16	**(a)**		Points of discussion might cover areas such as: • Programmable systems reduce the amount of hardware/components needed and hence reduce circuit size and cost of materials • Programs can be simulated before they are downloaded onto the microcontroller so errors can be found/corrected before download to hardware • Access would be required to programming software and extra training may be required for staff in using it • Microcontrollers are usually more expensive to purchase than non-programmable components • If the function of the security system needed to be upgraded or changed in the future the PCB circuitry would not need to be changed, just the programming **Other relevant points should be credited.**	6	**Level 3 (high) 5-6 marks** A thorough discussion. A good understanding with a range of advantages and disadvantages being clearly identified and developed. Consistently uses appropriate terminology. **Level 2 (mid) 3-4 marks** An adequate discussion which shows some understanding, with some advantages and disadvantages identified and limited development. Uses some appropriate terminology. **Level 1 (low) 1-2 marks** A basic discussion which shows limited/poor understanding. Some advantages or disadvantages identified but no development. Little or no use of appropriate terminology. **0 marks** Response is not worthy of credit.
16	**(b)**	**(i)**	Any **two** from: • Visual programming method • Uses pre-written groups of code/functions • Simple to learn and understand **Award credit for any other appropriate response.**	2	1 mark for each valid feature.
16	**(b)**	**(ii)**	Any **two** from: • Not as flexible • Limitations in functionality • Programs can end up being more complex than they need to be **Award credit for any other appropriate response.**	2	1 mark for each valid drawback.