CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

Unit 4 January 2019 series

Version 1

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. 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.

Unit 4 series overview

Unit 4 paper assesses understanding of the principles of electrical engineering and digital and analogue electronic control systems. There was a marked improvement in performance in this examination relative to previous occasions. This was evidenced, not least, by confidence in the use of the correct equations and formulae to deduce the right answers to calculations.

Most successful topics	***Least successful topics***
• Questions on digital electronics, Question 6, for instance, continue to be answered well, with a good knowledge of logic gates, Boolean algebra and truth tables. • Candidates are demonstrating a greater confidence with scientific units. In general these are indicated in the answer line, or highlighted in the question text if candidates need to provide them. • There was a notable decrease in 'No Response' and nearly all candidates had attempted all questions. Candidates should, of course, be encouraged to attempt all questions where time permits. • The best results were only possible by a combination of careful calculation and a sound grounding in the principles involved.	• The operational amplifier circuits and motors, Questions 3 and 5, exemplifying simple systems rather than fundamental principles were not handled so well. • Of particular note was the challenge posed by Q1(b). Not for the first time a question exploring candidates' familiarity with the multimeter found many wanting, even amongst the most able. • Many responses showed a lack of familiarity with common circuit symbols, leading to a lack of clarity in drawing or interpreting diagrams. It would seem that more time spent early on embedding these ideas would avoid ambiguity and lost marks. • Unit prefixes, ms, μF, kΩ, etc. still pose challenges for some.

Question 1 (b) (i)

(b) The power supply on a boat operates at about 24 V DC.

(i) Fig. 2a shows a multimeter with the dial in the off position.

Draw an arrow on Fig. 2b showing the correct position of the dial to accurately measure the voltage of the power supply on the boat.

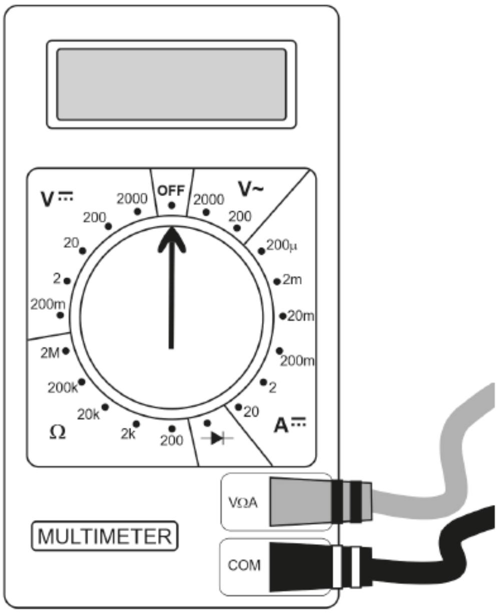

Fig. 2a

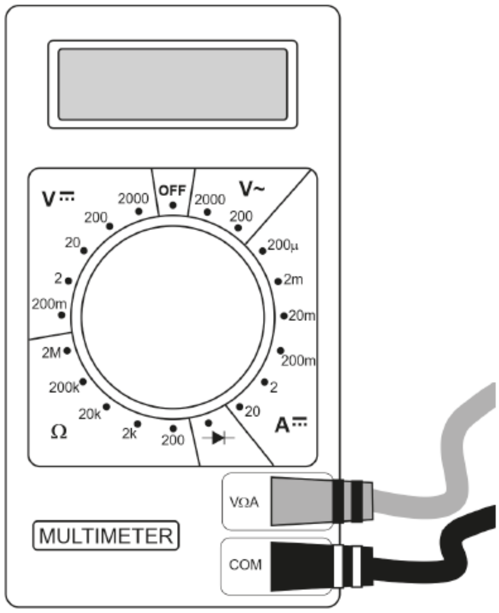

Fig. 2b

[1]

(ii) State why the dial position you have chosen for your answer will produce the most accurate measurement.

....

....**[1]**

The diagram is a simple depiction of an instrument that should be familiar to all candidates, and nearly all responded. Success with the two parts to the question depended on familiarity with the various modes of operation, and their purpose:

- Select the mode of operation – DC voltage
- Select the voltage range that is large enough to include the expected reading of 24 V
- Select the smallest acceptable range that will give the most precision/decimal places.

The question was not well answered. The commonest response being 20V 'because it is closest to 24V' coupled with less than adequate justifications for the choice. Reference to precision or decimal places was essential in order to secure the second mark.

Question 1 (c) (i)

(c) A network of resistors is shown in Fig. 3.

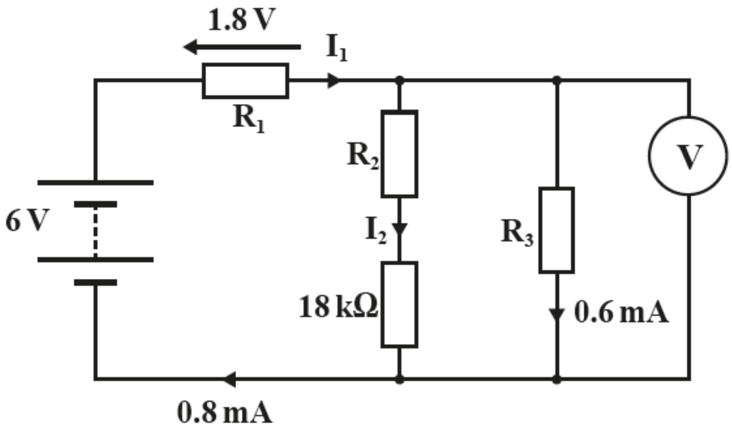

Fig. 3

(i) Calculate the voltage shown on the voltmeter.

V = ... V **[1]**

This question concerns Kirchoff's Voltage Law and is calculated by subtracting the Potential Difference (PD) across R_1 from 6V. Many candidates did so successfully. Many others answered with 6V.

Question 1 (c) (ii)

(ii) State the value of I_1.

I_1 = ... mA **[1]**

This question concerns Kirchoff's Current Law. Most candidates used this to identify the correct answer on the circuit diagram, no calculation being necessary.

Question 1 (c) (iii)

(iii) Calculate the value of I_2.

I_2 = ... mA **[1]**

This question concerns Kirchoff's Current Law, the answer being the difference between the current through R_1 and the current through R_3. Most candidates managed this.

Question 1 (c) (iv)

(iv) Calculate the value of R_1.

R_1 = ... Ω **[1]**

This question was not well answered, most commonly associated with the conversion of mA to A

Question 1 (c) (v)

(v) Calculate the value of R_2.

R_2 = ... Ω **[1]**

As in Q1(c)(iv) this question was not well answered, most commonly for not converting mA to A

Question 2 (a)(i)

2 **(a)** A sine wave is shown in Fig. 4.

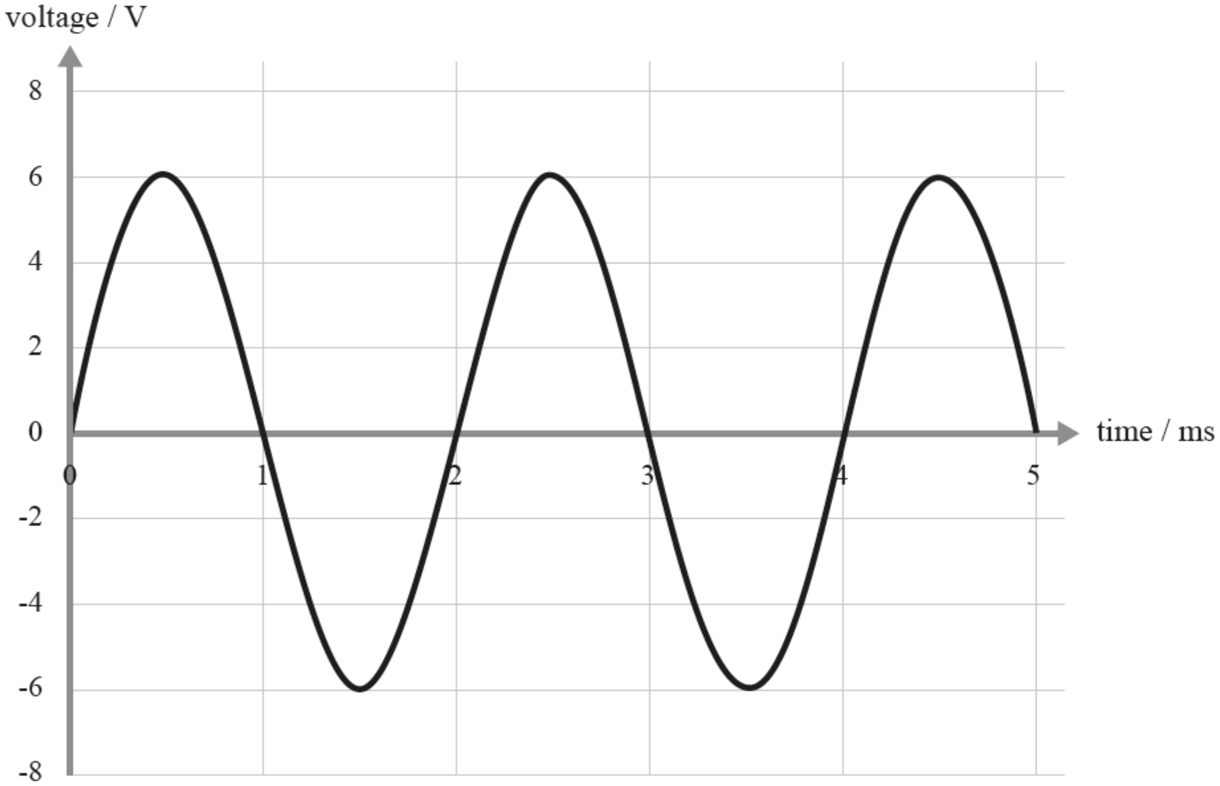

Fig. 4

(i) State the amplitude of the signal in Fig. 4.

amplitude = ... V **[1]**

This question was generally answered well. A minority confused amplitude with peak-to-peak voltage.

Question 2 (a) (ii)

(ii) State the period of the signal in Fig. 4.

period = ... ms **[1]**

The period could be read from the graph. This question was generally answered well.

Question 2 (a) (iii)

(iii) State the peak to peak voltage of the signal in Fig. 4.

peak to peak voltage = ... V **[1]**

This question was generally answered well. A minority responded with '±6V' which was not accepted.

Question 2 (a) (iv)

(iv) Calculate the frequency of the signal in Fig. 4.
Show your working. Give the units for your answer.

frequency = ... **[3]**

A majority of candidates achieved full marks. A significant minority omitted to convert the time period to seconds and/or to find the frequency by the inverse of the time period.

Question 3 (a)

3 This question is about series-wound DC motors.

(a) Complete the paragraph below using the most appropriate word in each gap.

Choose words from the following list.

Each word may be used once, more than once or not at all.

high	**infinite**	**low**	**slow**	**zero**

A series-wound DC motor is used to start a car engine. When a voltage is first applied to the motor it is not turning and so the EMF generated by the motor is .... and the torque provided by the motor is .... After a short time the motor has reached high speed and so the EMF generated by the motor is .... and the torque provided by the motor is ....

[4]

Some candidates demonstrated familiarity with this type of question, recalled what they had learned about this type of motor and secured 3 or 4 marks, while three quarters of candidates did less well. It did not appear that candidates were unfamiliar with the form of the question, but rather that they found it difficult to differentiate some of the optional words, e.g. low, slow and zero.

Question 3 (c) (i)

(c) In a series-wound DC motor the resistance of the armature (R_a) is 0.16 Ω and the resistance of the field windings (R_f) is 0.04 Ω.

(i) Calculate the total resistance (R_t) of the series-wound DC motor.

R_t = ... Ω **[1]**

This question was about combination of series resistors was widely answered well.

Question 3 (c) (ii)

(ii) The motor is used with a supply voltage (V) of 12 V.

When the motor is turning quickly the current in the armature (I_a) is 20 A.

Calculate the EMF (E) generated by the motor.

Give the units for your answer.

E = ... **[3]**

This question required the use of the equation $V=E+I_aR_t$. All the necessary data was provided in the question. The commonest omissions, in approximately equal measure, were:

- Use of the wrong formula
- Incorrect rearrangement to find E
- No Volts symbol in the answer.

Question 4 (b)

(b) Draw on Fig. 6 to show how alternating current (AC) can be converted to half-wave direct current (DC) of the correct polarity using a **single** diode.

Fig. 6

[3]

Full marks could be earned simply by directly connecting one pair of leads and connecting the other pair through a correctly-drawn diode. Inclusion of a transformer and/or a load resistor had to be correctly connected and gained no additional marks. A significant minority of responses showed the AC and/or the DC supply shorted out. One mark was awarded for the diode symbol, however it was connected.

Question 4 (c)

(c) State the meanings of the terms *direct current* and *alternating current.*

direct current: ....

....

alternating current: ....

....

[2]

This question was not well answered by many candidates. It was clear that for many definitions in terms of either current flow or voltage polarity have not been learned.

Question 4 (d) (i)

(d) The DC output of the power supply is protected with a 2 A fuse.

(i) Draw the wires on Fig. 7 to show how all the parts should be connected.

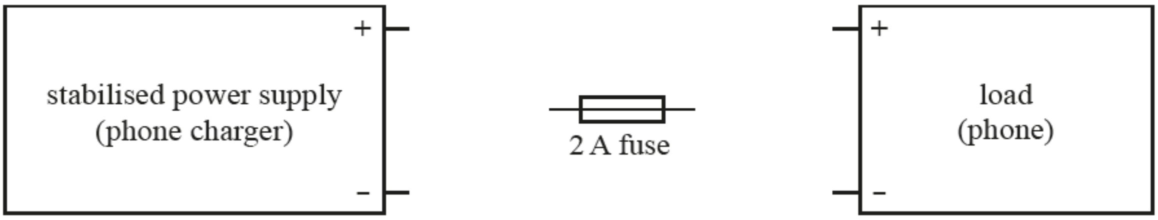

Fig. 7

[1]

A majority shorted out either the power supply or the load, or both.

Question 4(d) (ii)

(ii) Explain how the fuse works to protect the output of the power supply.

....

....

....

....

.... **[3]**

Most candidates could explain that a fuse was a strip of thin metal which heated up to melting point ('blew') when the specified current was exceeded. Relatively few explained how this protected the output.

Question 5 (b) (i)

(b) A summing amplifier circuit is used to combine two different signals, $V_1 = 1.2\,V$ and $V_2 = -2.5\,V$

The feedback resistor of the summing amplifier (R_f) has a value of 220 kΩ and the input resistors (R_{in}) both have a value of 110 kΩ.

(i) Draw the circuit diagram for the summing amplifier.

Label all the resistors and inputs with their values.

[2]

There was a varying degree of understanding of the function and set up of a summing amplifier. One mark was effectively for the arrangement of the input resistors, the other for the setup of the inverting amplifier, as introduced in Q5(a). Understanding of both was relatively uncommon.

Question 5 (b) (ii)

(ii) Calculate the output voltage of the summing amplifier.

Use the formula $V_{out} = -\frac{R_F}{R_{in}}(V_1 + V_2)$

V_{out} = ... V **[1]**

A slim majority succeeded in substituting the correct values in the formula. Many did not pick up on the double negative in the workings.

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