OCR
Oxford Cambridge and RSA

Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825/05873

Unit 4: Principles of electrical and electronic engineering

Tuesday 16 January 2018 – Morning
Time allowed: 1 hour 30 minutes

You must have:
- the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
- a ruler (cm/mm)
- a scientific calculator

First Name						Last Name				
Centre Number						Candidate Number				
Date of Birth	D	D	M	M	Y	Y	Y	Y		

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional answer space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Where appropriate, your answers should be supported with working.
- Marks may be given for a correct method even if the answer is incorrect.
- An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- Final answers should be given to a degree of accuracy appropriate to the context.
- This document consists of **12** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/9
2	/12
3	/9
4	/7
5	/12
6	/11
Total	**/60**

Answer **all** the questions.

1 Fig. 1 shows the circuit symbol for an operational amplifier.

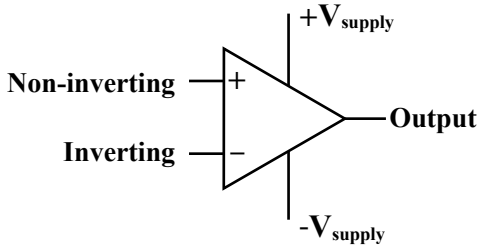


Fig. 1

(a) State, with the aid of the labelled diagram in Fig. 1, **three** key characteristics of an operational amplifier.

1 .....

.....

2 .....

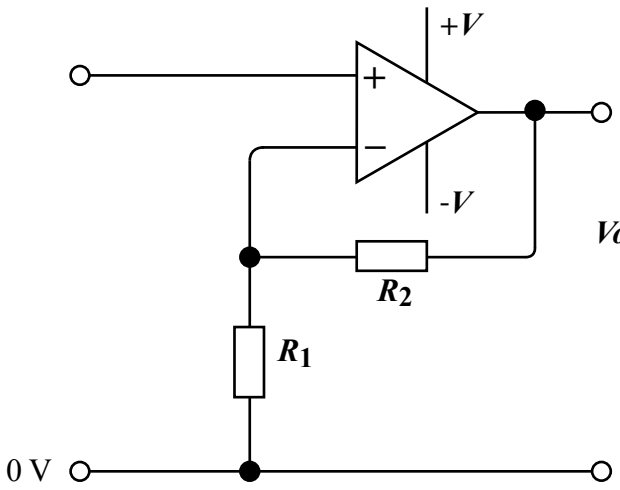
.....

3 .....

.....

[3]

(b) The circuit diagram for an audio amplifier is shown in Fig. 2.



$$\textit{Voltage gain} = A_v = 1 + \frac{R_2}{R_1}$$

Fig. 2

(i) The voltage gain (A_v) of the amplifier is 20 and the value of R_1 is10 kΩ. Calculate a suitable value for resistor R_2.

R_2 = ... kΩ **[3]**

(ii) A voltage of 10 mV is input into the amplifier. Calculate the output voltage (V_{Out}). Indicate the units used in your answer.

V_{Out} = ... **[3]**

2 A simple AC circuit is shown in Fig. 3.

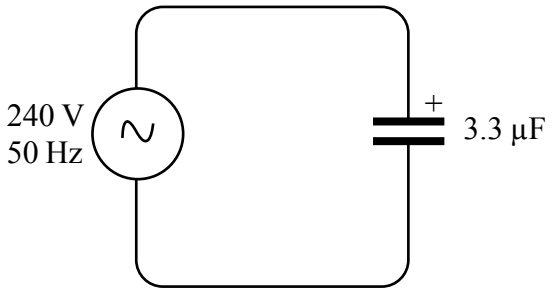


Fig. 3

(a) Calculate the reactance (X_c) of the capacitor.

X_c = ... Ω **[2]**

(b) A 200 Ω resistor is added to the circuit. The updated circuit is shown in Fig. 4.

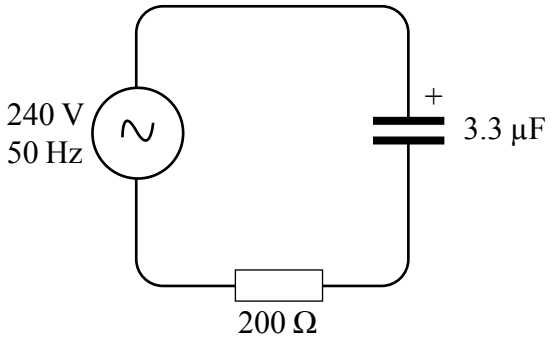


Fig. 4

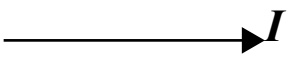
(i) Calculate the total impedance (Z).
Indicate the units used in your answer.

Z = ... **[3]**

(ii) Calculate the phase angle (ϕ).
Indicate the units used in your answer.

Phase angle ϕ = ... **[3]**

(iii) Complete the phasor diagram below for the circuit shown in Fig. 4.
Indicate V_C, V_{Supply} and the phase angle (ϕ) on the diagram.



[4]

3 **(a)** Define Kirchhoff's first law.

.....

.....

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

(b) A four resistor network is shown in Fig 5.

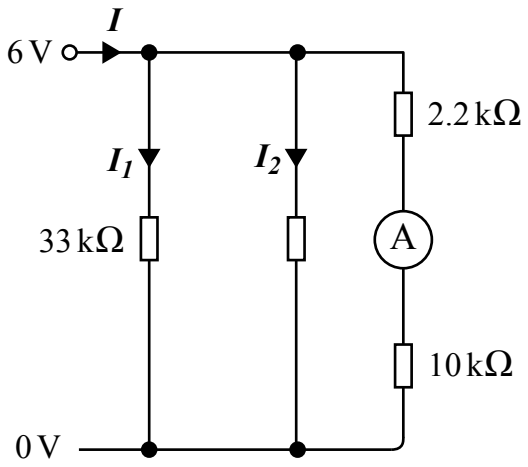


Fig. 5

(i) Calculate the value that will be displayed on the ammeter.

Current = ... mA **[3]**

(ii) Calculate the value of I if I_2 = 1 mA.
Indicate the units used in your answer.

Value of I = ... **[4]**

4 **(a)** A block diagram for an **unstabilised** 12 VDC power supply is shown in Fig. 6.

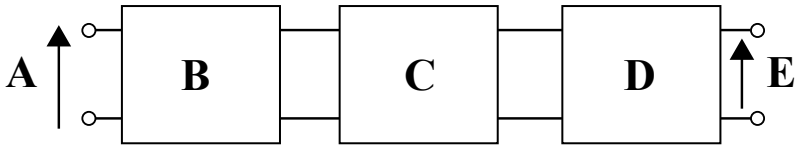


Fig. 6

(i) Identify the following elements of the power supply shown in Fig. 6.
A has been done for you.

A 240 VAC input

B ……..

C ……...

D ……...

E ……

[4]

(ii) The power supply needs to be adapted so that it provides a stabilised output.
Add a block representing a stabilising circuit **to** the diagram in Fig. 6. **[1]**

(b) Explain the benefits of load regulation in a stabilised DC power supply.

.....

.....

.....

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

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Turn over for the next question

5 **(a)** The circuit symbol for a two input logic gate is shown in Fig. 7.

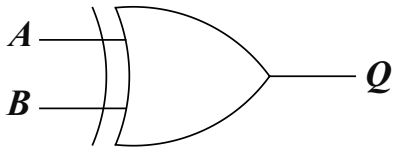

Fig. 7

(i) Complete the truth table for this logic gate.

A	*B*	*Q*
0	0	
0	1	
1	0	
1	1	

[2]

(ii) State the Boolean expression for this logic gate.

..... **[1]**

(b) A combinational logic circuit is represented by the Boolean expression:

$$Q = \overline{(A.B) + C}$$

This forms part of a decoding circuit that opens a door lock mechanism when the correct code is entered into inputs ***A***, ***B*** and ***C***.
The door lock mechanism opens when there is a logic 1 on the output ***Q***.

(i) Draw the combinational logic circuit represented by the Boolean expression.

[4]

(ii) Complete the truth table below to determine the code required to open the door lock mechanism.

A	***B***	***C***	***A.B***	***Q***

Code: ***A*** = …… ***B*** = …… ***C*** = ……

[5]

6 **(a)** Draw a circuit diagram for a series wound self-excited DC generator.

[4]

(b) A separately excited DC generator is connected to a 68 Ω load and a current of 7 A flows. If the armature resistance is 1.5 Ω determine:

(i) The terminal voltage (V).

V = ... V **[2]**

(ii) The generated EMF (E).

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

(c) Identify **one** advantage and **one** disadvantage of a separately excited DC generator over a series wound self-excited DC generator.

Advantage: .....

.....

Disadvantage: .....

.....

[2]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question number(s) must be clearly shown – for example 2(a) or 4(b).