OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT **2526**

ELECTRONICS

Foundations of Electronics

TUESDAY 22 MAY 2007 Morning

Time: 1 hour 30 minutes

Additional materials required:
Electronic calculator

Candidate Name

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this Section is **120**.
  (i) the p.d. across a forward-biased silicon diode is 0.70V,
  (ii) the power supplies for operational amplifiers are +15V and –15V,
  (iii) the saturation levels for operational amplifiers are +13V and –13V,
  (iv) logic 1 = 5V and logic 0 = 0V.
- The quality of written communication will be assessed in your answers to all questions.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
QoWC	
Total	

This document consists of **16** printed pages.

1 **(a)** Complete the truth table for a NOR gate.

B	A	Q
0	0	
0	1	
1	0	
1	1	

[1]

(b) The circuit of Fig. 1.1 contains AND and NOR gates.

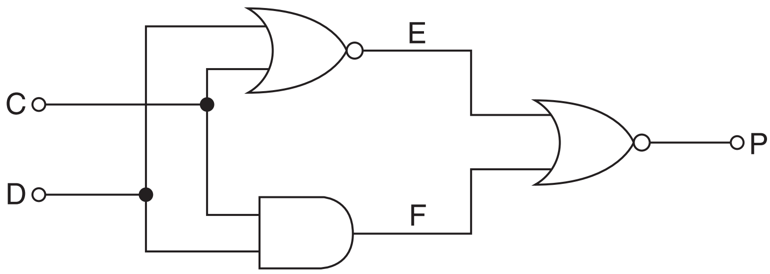


Fig. 1.1

(i) Complete the truth table for the circuit.

C	D	E	F	P
0	0			
0	1			
1	1			

[4]

(ii) The circuit of Fig. 1.1 can be replaced by a single logic gate.
State the name of the logic gate.

....[1]

(c) (i) On Fig. 1.2, draw a circuit to show how the AND gate of Fig. 1.1 can be made from three NOR gates.

[3]

Fig. 1.2

(ii) Use a truth table, with columns for the outputs of each NOR gate, to show that your circuit behaves like an AND gate.

[4]

2 Fig. 2.1 is a block diagram for a low voltage power supply.

Fig. 2.1

(a) Describe the **function** of these blocks.

transformer ....

....

rectifier ....

....

smoother ....

....[6]

(b) In the space below, draw a circuit diagram for a power supply made from a transformer, a single diode and a capacitor.
Label the output terminals, indicating their polarity.

[5]

(c) The power supply operates from the 230 V, 50 Hz mains electricity supply and delivers a current of 250 mA into a load of 27 Ω.

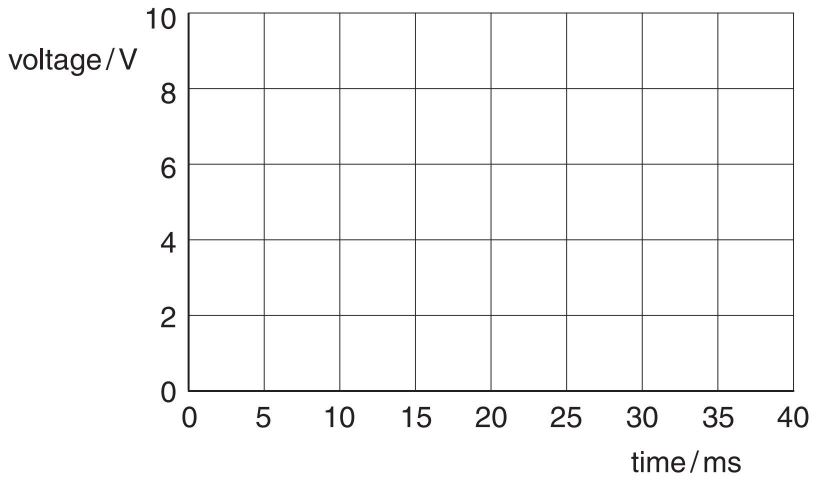
(i) Show that the voltage across the load is about 7 V.

[3]

(ii) Do a calculation to show that the capacitor is charged up at intervals of 20 ms.

[2]

(iii) A 27 Ω load gives a ripple voltage of 0.5 V. On the axes of Fig. 2.2, sketch a graph to show how the voltage across the 27 Ω load changes with time.



[4]

Fig. 2.2

(iv) Calculate a value for the capacitor which will give a ripple of 0.5 V at a current of 250 mA.

capacitor = ... μF [3]

3 Fig. 3.1 shows how a zener diode can generate a steady 5V from a 12V car battery.

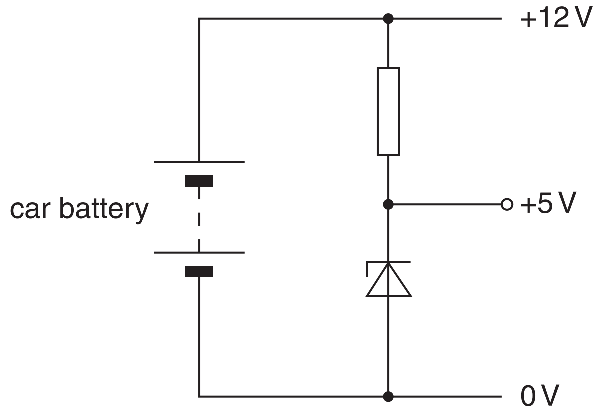


Fig. 3.1

(a) The zener diode has been connected in reverse bias.

(i) Draw an arrow on Fig. 3.1 to show the direction of the current in the zener diode. [1]

(ii) Describe how the current in the reverse biased zener diode depends on the voltage across it.

....

....

....

....[3]

(b) The zener diode is rated at 5V, 1.2W.

(i) Show that the maximum safe current in the diode is about 250mA.

[3]

(ii) How does exceeding this current damage the zener diode?

....

....[1]

(c) The resistor in Fig. 3.1 is chosen to limit the current in the diode to a safe value of 150 mA.

(i) Draw on Fig. 3.1 to show how a voltmeter should be connected to measure the voltage drop across the resistor.

[2]

(ii) State the voltage drop across the resistor.

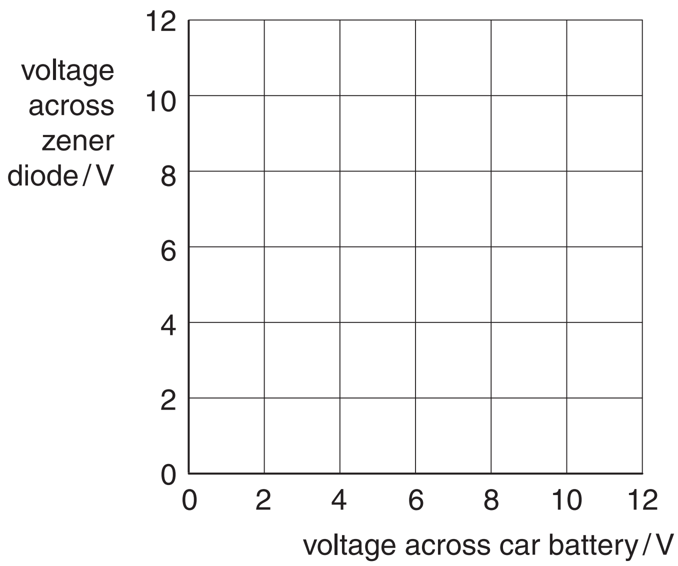
voltage drop = ... V [1]

(iii) Calculate a value for the resistor which limits the diode current to 150 mA.

resistance = ... Ω [3]

(d) The voltage across the car battery can vary from 0 V to +12 V, depending on its state of charge.

Draw on Fig. 3.2 to show how the voltage across the zener diode depends on the voltage across the car battery.



[2]

Fig. 3.2

4 Fig. 4.1 shows a bistable made from a pair of NAND gates.

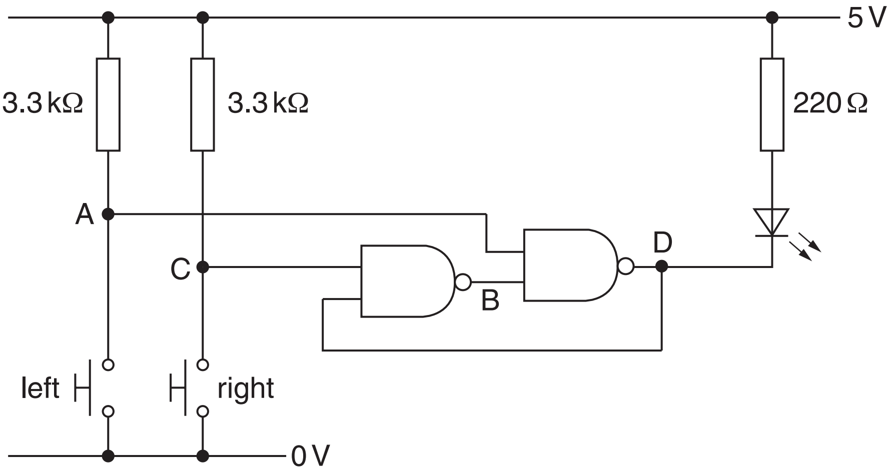


Fig. 4.1

(a) The state of the output D is shown with a green LED.

(i) Draw a ring around the LED. [1]

(ii) State the voltage drop across the LED when it is glowing.

voltage drop = ... V [1]

(iii) Calculate the current in the LED when it glows.

current = ... mA [3]

(b) The point labelled A in Fig. 4.1 is high when the left-hand switch is open and low when the left-hand switch is closed. Explain why.

....

....

....[2]

(c) (i) Complete the truth table for a NAND gate.

A	B	D

[2]

(ii) Explain why pressing the left-hand switch stops the LED from glowing.

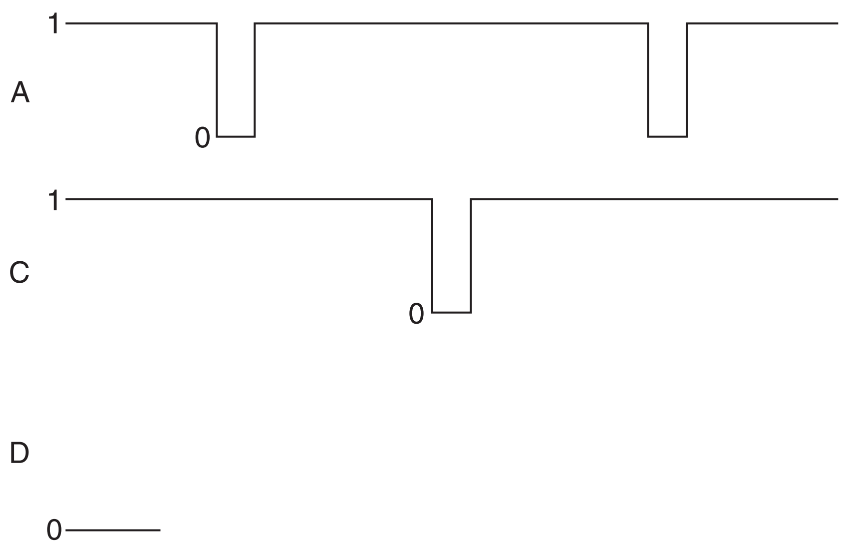
....

....

....

....[3]

(d) Complete the timing diagram of Fig. 4.2 for the bistable shown in Fig. 4.1.



[3]

Fig. 4.2

5 The circuit of Fig. 5.1 switches on the motor when the thermistor gets too hot.

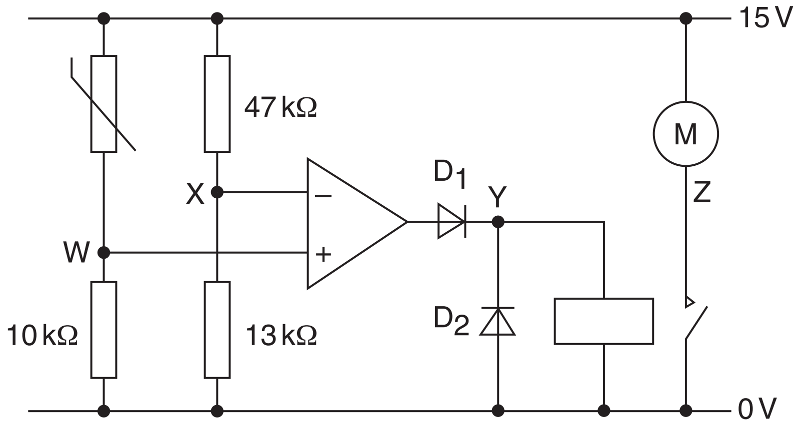


Fig. 5.1

(a) Show that point X is at a constant voltage of about +3V.

[3]

(b) (i) Draw a ring around the thermistor.

[1]

(ii) Explain why the voltage at point W rises as the temperature of the thermistor rises.

....

....

....

....

....[3]

(iii) Explain why the motor turns on when the thermistor gets too hot.

....

....

....

....

....

....[5]

(c) Suggest why the circuit contains a relay.

....

....[1]

(d) The circuit of Fig. 5.1 contains two silicon diodes.

(i) Describe the electrical properties of a silicon diode.

....

....

....

....[3]

(ii) Explain why the diodes have been included in the circuit.

D_1 ....

....

....

D_2 ....

....

....[4]

6 The circuit of Fig. 6.1 includes some logic gates and a D-type flip-flop.

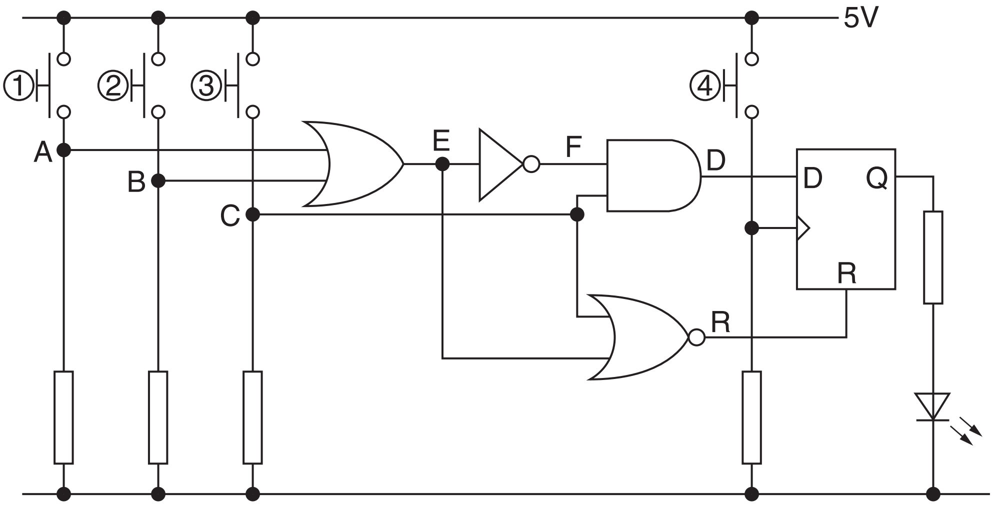


Fig. 6.1

(a) Complete the truth table.

A	B	C	E	F	D	R
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

[7]

(b) Explain why the LED does **not** glow when all four switches are open.

....

....

....

....[3]

(c) State and explain how the switches must be pressed to make the LED glow.

....

....

....

....

....

....[4]

7 The circuit of Fig. 7.1 contains an op-amp arranged as an amplifier.

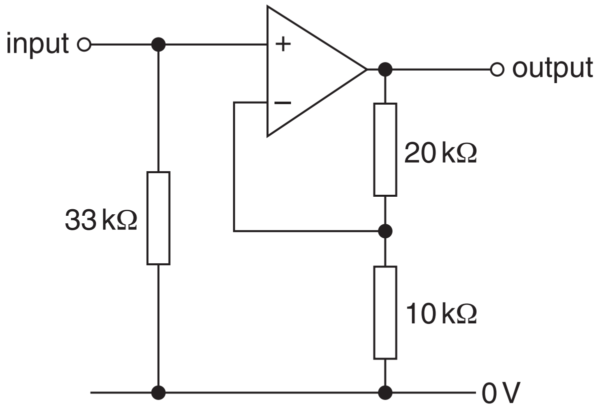


Fig. 7.1

(a) Three types of amplifier are shown below.

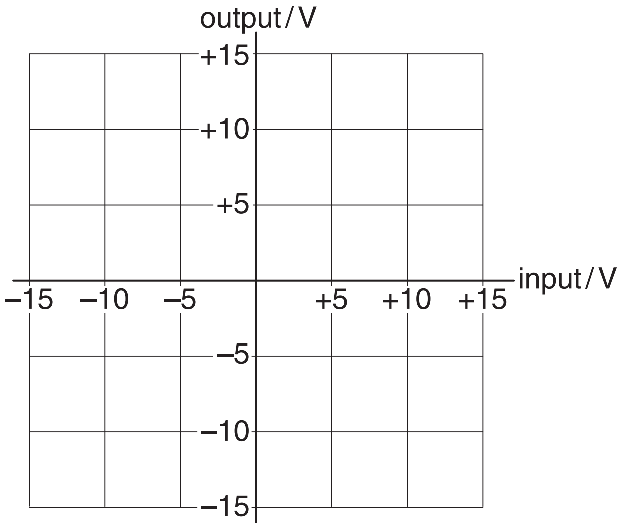
inverting **non-inverting** **voltage follower**

Draw a ring around the type of amplifier shown in Fig. 7.1. [1]

(b) Calculate the voltage gain of the amplifier.

voltage gain = ... [3]

(c) On Fig. 7.2, show how the voltage at the output changes as the voltage at the input is swept from –15V to +15V.



[3]

Fig. 7.2

8 The circuit of Fig. 8.1 includes a buzzer which makes a noise.

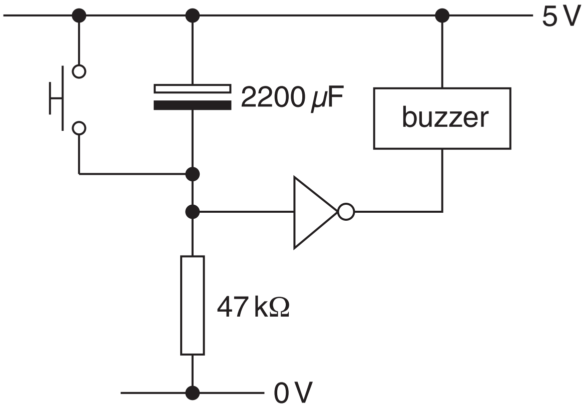


Fig. 8.1

(a) Calculate the time constant of the *RC* network.

time constant = ... s [3]

(b) The sentences (**A** to **I**) describe what happens when the switch is pressed and then released. They are in the wrong order.

A The buzzer makes a noise.
B The buzzer stops making a noise.
C The input of the NOT gate goes low.
D The input of the NOT gate goes high.
E The output of the NOT gate goes low.
F The output of the NOT gate goes high.
G The capacitor discharges quickly through the pressed switch.
H The capacitor charges up slowly through the resistor.
I The switch is released.

Complete the boxes to show the correct order.

G → ☐ → ☐ → ☐ → **I** → ☐ → ☐ → ☐ → ☐ [6]

Quality of Written Communication [3]