



ADVANCED SUBSIDIARY GCE
ELECTRONICS
 Simple Systems

F611

Candidates answer on the Question Paper

OCR Supplied Materials:
None

Other Materials Required:

- Scientific calculator

Thursday 20 May 2010
Morning

Duration: 1 hour 30 minutes



Candidate Forename		Candidate Surname	
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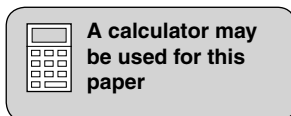
Centre Number							Candidate Number				
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INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You are advised to show all the steps in any calculations.
- This document consists of **16** pages. Any blank pages are indicated.



Data Sheet

Assume, unless otherwise indicated, that:

- all op-amps operate from supply rails at +15V and –15V
- all logic gates operate from supply rails at +5V and 0V.

resistance

$$R = \frac{V}{I}$$

power

$$P = VI$$

series resistors

$$R = R_1 + R_2$$

time constant

$$\tau = RC$$

monostable pulse time

$$T = 0.7 RC$$

relaxation oscillator period

$$T = 0.5 RC$$

frequency

$$f = \frac{1}{T}$$

Boolean Algebra

$$A \cdot \bar{A} = 0$$

$$A + \bar{A} = 1$$

$$A \cdot (B + C) = A \cdot B + A \cdot C$$

$$\overline{A \cdot B} = \bar{A} + \bar{B}$$

$$\overline{A + B} = \bar{A} \cdot \bar{B}$$

$$A + A \cdot B = A$$

$$A \cdot B + \bar{A} \cdot C = A \cdot B + \bar{A} \cdot C + B \cdot C$$

Answer **all** the questions.

- 1 A block diagram for controlling the heated windscreen in a car is shown in Fig. 1.1. When the switch is pressed, the heater turns on for a short while and then turns off again.

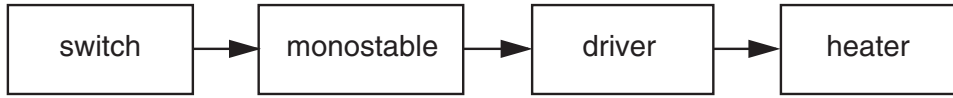


Fig. 1.1

- (a) The heater operates at 12V, 8A. Calculate the power of the heater. Your answer must indicate the correct units.

.....

Power = [2]

- (b) The monostable is constructed from NAND gates. Explain why the driver is needed and the monostable cannot be connected directly to the heater.

.....

[2]

- (c) The table below shows information about some MOSFETs.

MOSFET	maximum drain current / A	maximum drain-source voltage / V	price
IRF510	5.6	100	£0.26
IRF730	6.5	400	£0.64
IRF630	10	200	£0.47
IRF530	17	100	£0.53
IRF540	28	100	£0.74

- (i) State which one of the MOSFETs in the table is most suitable for the driver in the windscreen heater system.

..... [1]

- (ii) Explain your choice

.....

[2]

(d) Fig. 1.2 shows an incomplete circuit diagram of the block diagram in Fig. 1.1.

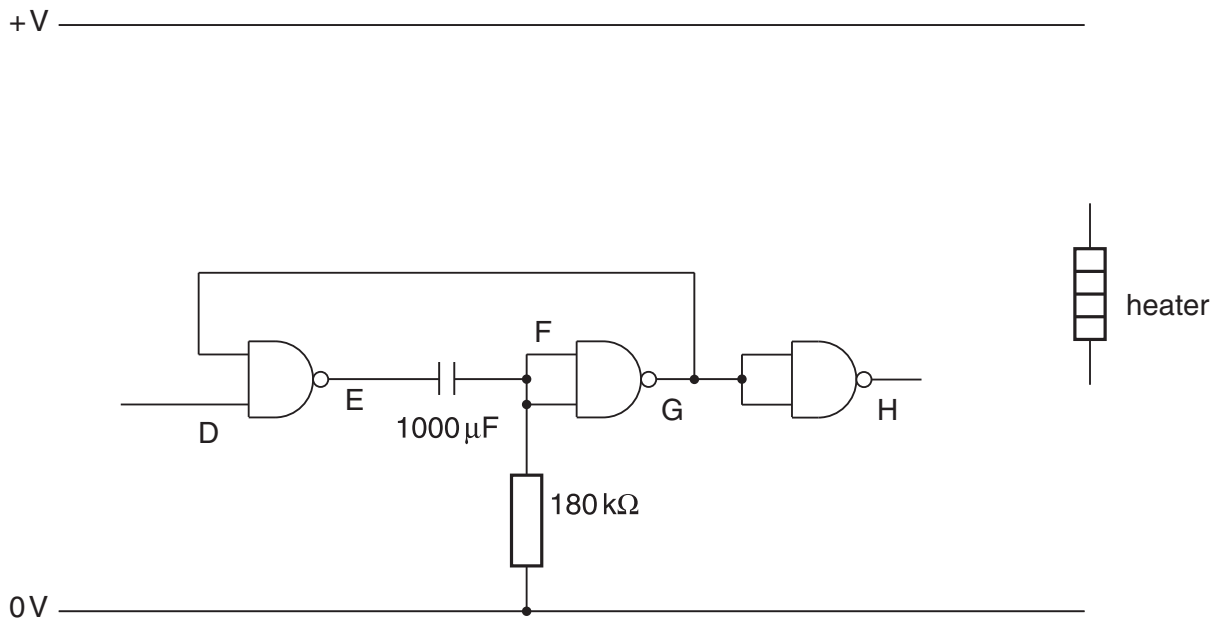


Fig. 1.2

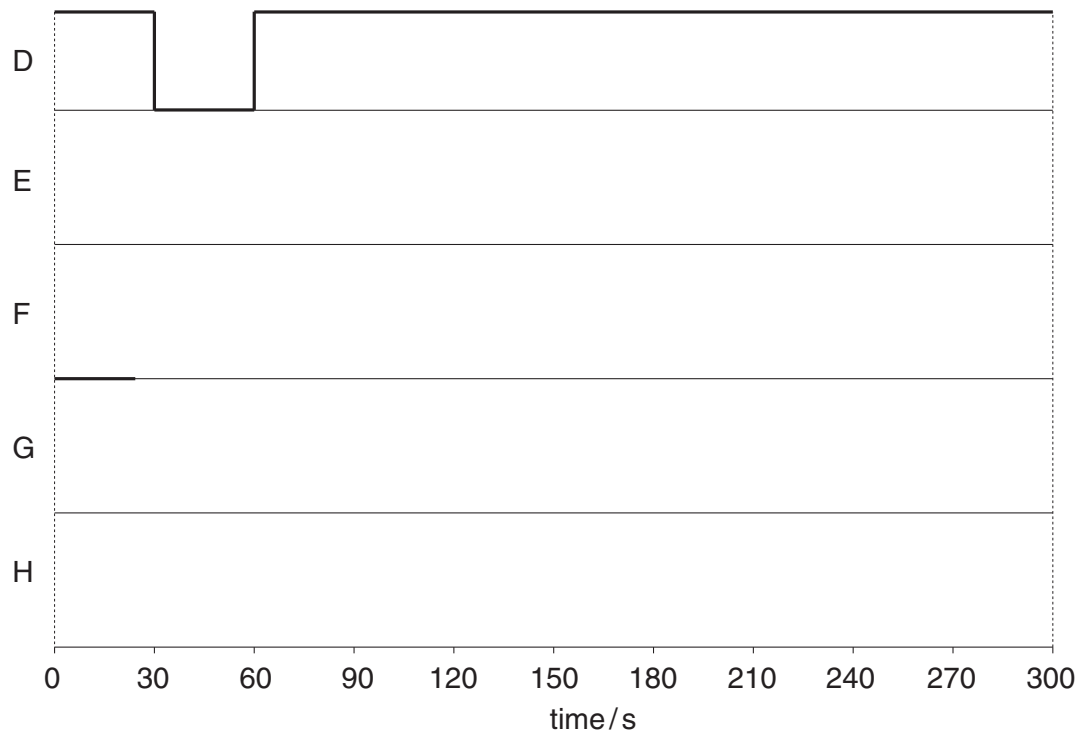
- (i) Draw a MOSFET and other necessary connections on the circuit diagram to make the heater operate when the output H is high. [3]
- (ii) Draw a switch and resistor on the diagram to make the input of the monostable go low when the switch is pressed. [2]
- (iii) State the purpose of the resistor with the switch.

.....
 [1]

(e) Do a calculation to show that the output of the monostable G goes low for about 2 minutes.

[3]

(f) Complete the timing diagram to show the voltages at E, F, G and H in the circuit.



[6]

[Total: 22]

- 2 (a) Fig. 2.1 shows a truth table for a logic gate.

A	B	P
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 2.1

- (i) State the name of this logic gate.

..... [1]

- (ii) Draw the symbol for the logic gate.

[1]

- (iii) Write down a Boolean expression for the output P.

P = [1]

(b) Fig. 2.2 shows a logic gate with inputs C and D and output R.

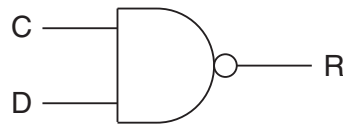


Fig. 2.2

(i) State the name of this gate.

..... [1]

(ii) Complete the truth table for this gate.

C	D	R
0	0	
0	1	
1	0	
1	1	

[1]

(iii) Write down a Boolean expression for the output R.

R = [1]

(c) The circuit in Fig. 2.3 is built from three logic gates

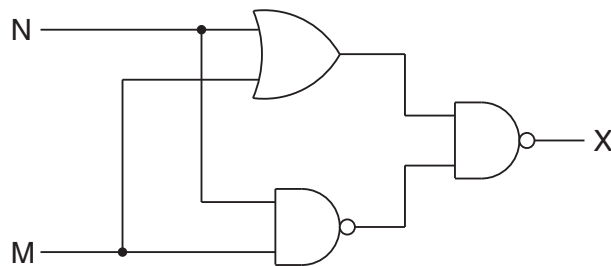


Fig. 2.3

Use Boolean algebra to show that the circuit behaves according to the Boolean expression $X=N.M+\bar{N}.\bar{M}$

.....

 [3]

[Total: 9]
Turn over

3 Fig. 3.1 shows a circuit to turn on a white LED in a garden light when it gets dark.

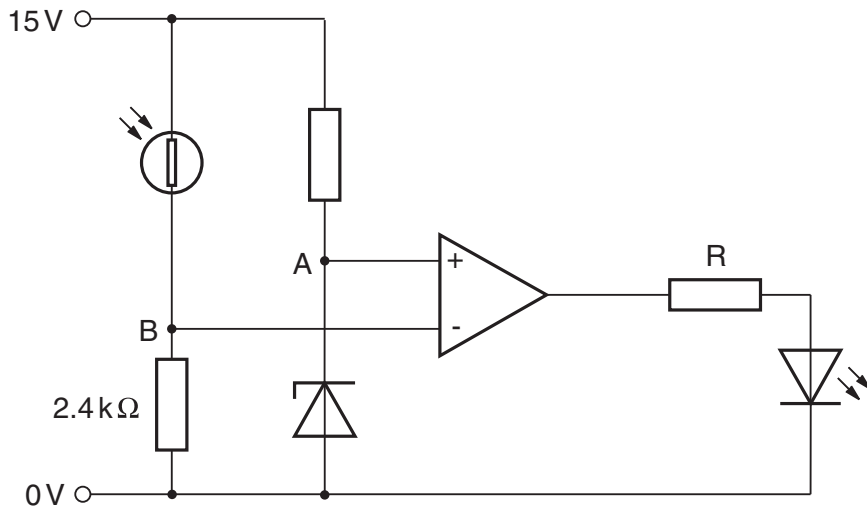


Fig. 3.1

- (a) The LED operates at a forward voltage of 4.2V with a current of 15 mA. Calculate the value of resistor R needed to make the LED glow at its operating current when it gets dark.

R =Ω [5]

- (b) The circuit uses both analogue and digital signals. Explain the difference between analogue and digital signals. Use the circuit to give an example of each type of signal.

.....

.....

.....

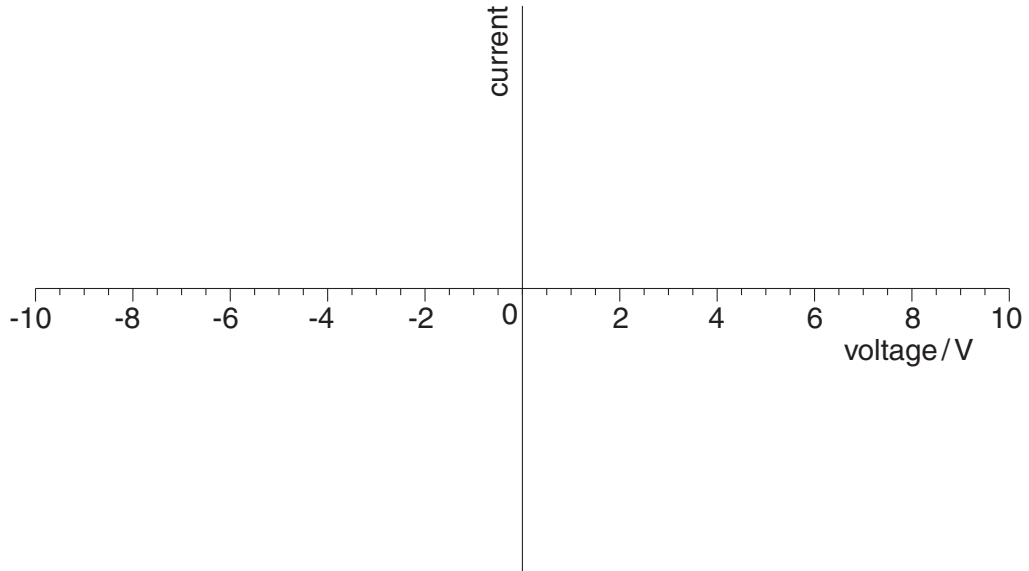
.....

..... [4]

(c) The circuit uses 3.6V zener diode.

(i) Put a ring around the Zener diode on Fig. 3.1. [1]

(ii) Draw a graph on the axes below to show how the current through the Zener diode depends on the voltage across it.

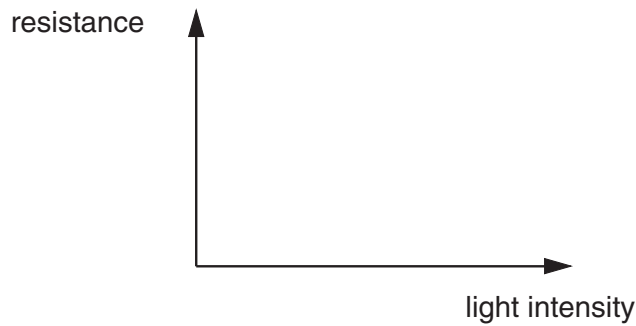


[3]

(iii) State the voltage at A in the circuit.

voltage at A = V [1]

(d) Sketch a graph of resistance against light intensity for the LDR in the circuit on the axes below. You do not need to put values on the axes.



[2]

(e) Show that the voltage at B is about 4V when the resistance of the LDR is 6.8kΩ.

[3]

(f) Using Fig. 3.1 and your answers to (c)(iii) and (e) explain why the LED is off when the resistance of the LDR is 6.8kΩ.

.....
..... [3]

(g) The circuit is designed to turn on the LED when the light level falls to 30 lux. Calculate the resistance of the LDR at 30 lux.

Resistance of LDR at 30 lux =Ω [4]

[Total: 26]

- 4 A logic circuit behaves according to this Boolean expression.

$$P = Q.R.\bar{S} + Q.\bar{S} + \bar{Q}.R.\bar{S}$$

- (a) Complete the truth table for this expression.

Q	R	S	P

[2]

- (b) Use Boolean algebra to show that $P = Q.R.\bar{S} + Q.\bar{S} + \bar{Q}.R.\bar{S}$ can be simplified to $P = \bar{S}.Q + \bar{S}.R$.

[3]

- (c) Draw a circuit diagram which performs the logical function $P = \bar{S}.Q + \bar{S}.R$ using only NAND gates. Label the inputs and output.

[3]

[Total: 8]

Turn over

5 A circuit uses an oscillator and other components to make an LED flash.

(a) An oscilloscope is used to make measurements at the output of the oscillator as shown in Fig. 5.1.

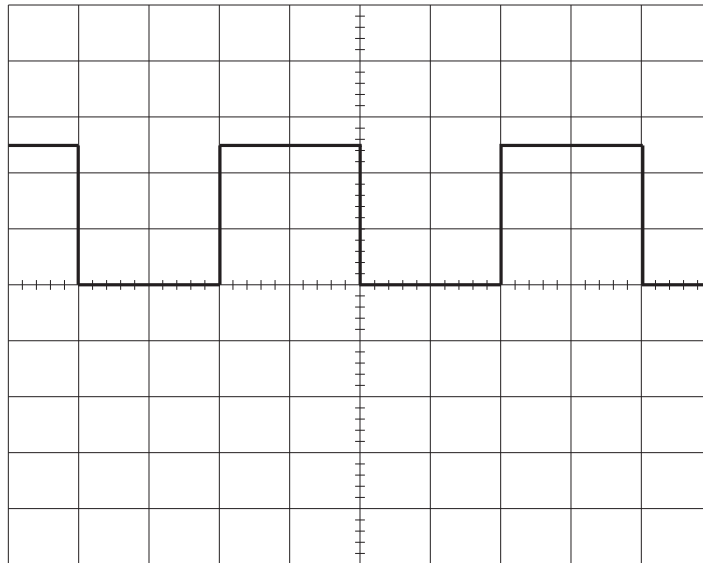


Fig. 5.1

The vertical amplifier is set to 2V per division with 0V at the centre of the screen.
The timebase is set to 200ms per division.

(i) Calculate the period of the oscillator signal.

period = ms [2]

(ii) Calculate the frequency of the oscillator signal.

frequency = Hz [2]

(iii) Calculate the amplitude of the oscillator signal.

amplitude = V [2]

(b) A capacitor and resistor are now added to the output of the oscillator as shown in Fig. 5.2.

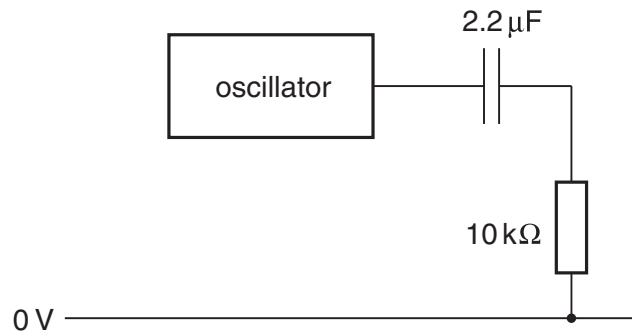


Fig. 5.2

(i) Draw on Fig. 5.2 to show how an oscilloscope should be connected to measure the voltage across the 10 kΩ resistor. [2]

(ii) Calculate the time constant of the resistor and capacitor.

time constant = ms [3]

(iii) Fig. 5.3 shows the screen of the oscilloscope. Draw the new appearance of the oscilloscope trace using the same scale as Fig. 5.1.

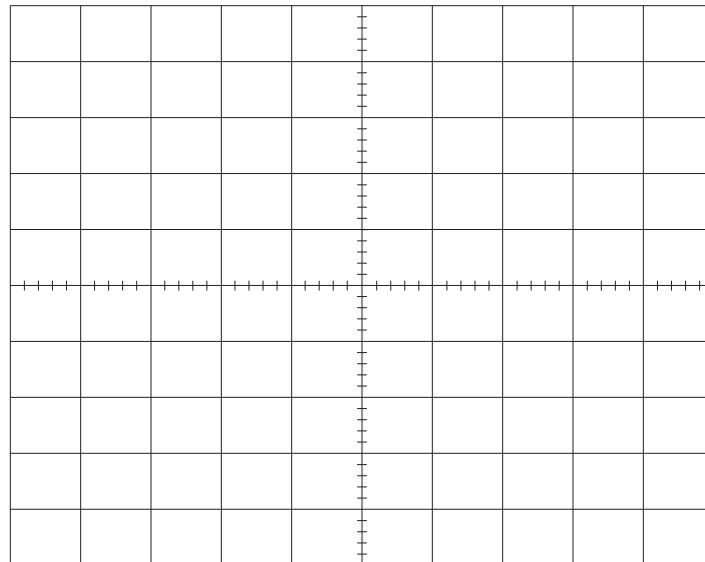


Fig. 5.3

[4]

(c) A NOT gate, resistor and LED are added to the circuit as shown in Fig. 5.4.

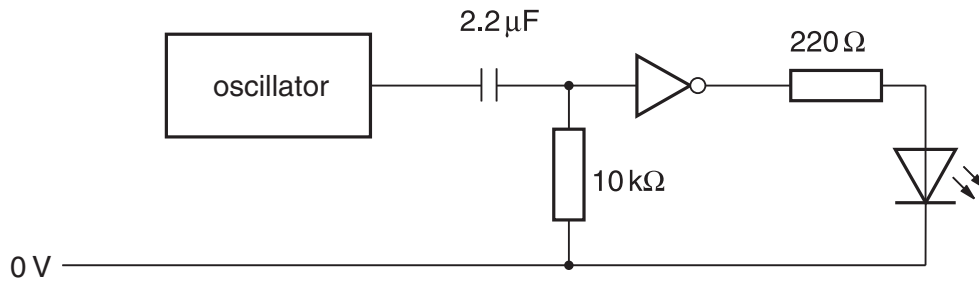


Fig. 5.4

(i) Explain what you now see on the oscilloscope connected across the 10 kΩ resistor.

.....

.....

.....

..... [4]

(ii) Describe the behaviour of the LED. Give approximate values in your answer.

.....

.....

.....

..... [3]

[Total: 22]

Quality of written communication [3]

END OF QUESTION PAPER

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