OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

ELECTRONICS

Simple Systems

F611

Candidates answer on the question paper.

OCR supplied materials:
None

Other materials required:
- Scientific calculator

Tuesday 17 May 2011
Afternoon

Duration: 1 hour 30 minutes

F6267501611

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- 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).
- Answer **all** the questions.
- Do **not** write in the bar codes.

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 your 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.

A scientific calculator may be used for this paper

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	$T = 0.7RC$
relaxation oscillator period	$T = 0.5RC$
frequency	$f = \frac{1}{T}$
Boolean Algebra	$A \cdot \overline{A} = 0$
	$A + \overline{A} = 1$
	$A \cdot (B + C) = A \cdot B + A \cdot C$
	$\overline{A \cdot B} = \overline{A} + \overline{B}$
	$\overline{A + B} = \overline{A} \cdot \overline{B}$
	$A + A \cdot B = A$
	$A \cdot B + \overline{A} \cdot C = A \cdot B + \overline{A} \cdot C + B \cdot C$

BLANK PAGE

TURN OVER FOR NEXT QUESTION

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 Fig. 1.1 shows a logic system.

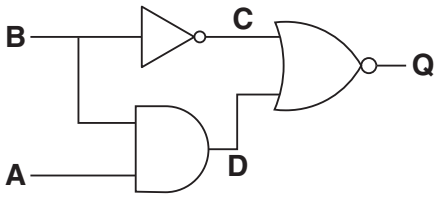


Fig. 1.1

(a) Complete the truth table for this logic system.

B	A	C	D	Q
0	0			
0	1			
1	0			
1	1			

[3]

(b) Use the truth table to write down a Boolean expression for Q in terms of A and B.

Q = ... **[1]**

(c) Draw a diagram to show how the NOT gate can be made from a NAND gate.

[1]

(d) Draw a diagram to show how the AND gate can be made from NAND gates.

[1]

(e) Draw a diagram to show how the NOR gate can be made from NAND gates.

[1]

(f) Draw in the space below a circuit with only NAND gates that replaces the circuit of Fig. 1.1. Label the inputs A and B and the output Q.

[2]

(g) State an advantage of using only NAND gates to build a circuit.

.....

.....

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

[Total: 10]

2 Fig. 2.1 shows an op-amp circuit.

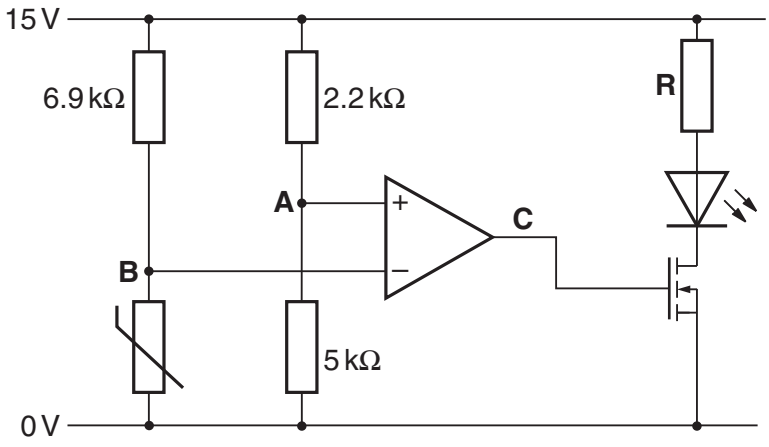


Fig. 2.1

(a) A student decides to build this circuit the only available resistors are 2.2 kΩ, 4.7 kΩ and 10 kΩ.

(i) Draw a diagram to show how the 6.9 kΩ resistor can be replaced by a combination of some of the available resistors.

[2]

(ii) Fig. 2.2 shows a number of resistors connected in parallel.
Put a ring around the resistor combination which could replace the 5 kΩ resistor in Fig. 2.1.

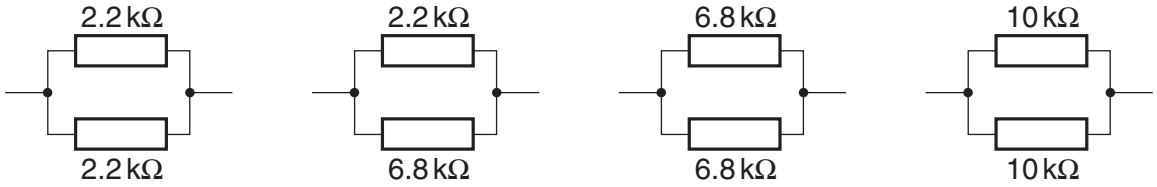


Fig. 2.2

[1]

(b) Calculate the voltage at **A**.

Voltage at A = ... **[3]**

(c) Explain why the connection to the op-amp can be ignored in your calculation of the voltage at **A**.

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

(d) When the output of the op-amp is saturated positive the LED glows.
Calculate the value of R to make the LED operate at 30 mA and 4.5 V.

R = ... Ω **[2]**

(e) Put a ring around the MOSFET on Fig. 2.1. **[1]**

(f) Explain why the MOSFET is needed

.....

.....

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

(g) Draw on Fig. 2.1 to show how a voltmeter can be connected to measure the voltage at the inverting input of the op-amp. **[1]**

(h) Explain why the LED does **not** glow when the thermistor is cold.
Refer to the points **A**, **B** and **C** in your answer.

.....

.....

.....

..... **[4]**

(i) Explain what happens to the state of the LED as the temperature of the thermistor changes slowly from cold to hot.
Refer to the points **A**, **B** and **C** in your answer.

.....

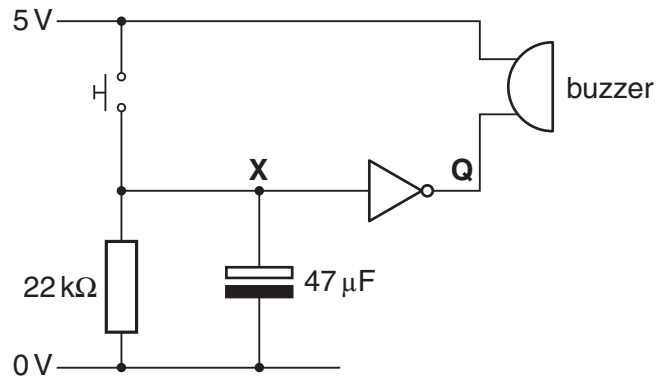
.....

.....

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

[Total: 20]

3 The circuit in Fig. 3.1 allows a switch to control a buzzer.



Voltage at X	Voltage at Q
less than 2.5V	5V
more than 2.5V	0V

Fig. 3.1

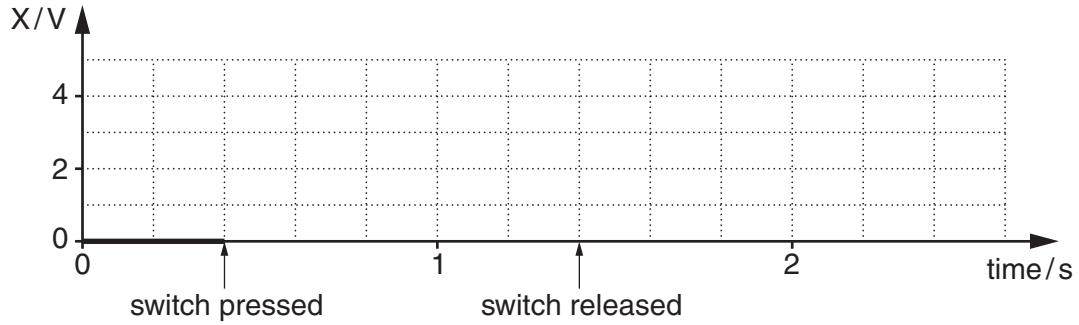
(a) (i) Show that the time constant of the resistor and capacitor network is about 1 s.

[2]

(ii) Calculate the time taken for the voltage at **X** to fall from 5V to 2.5V when the switch is released.

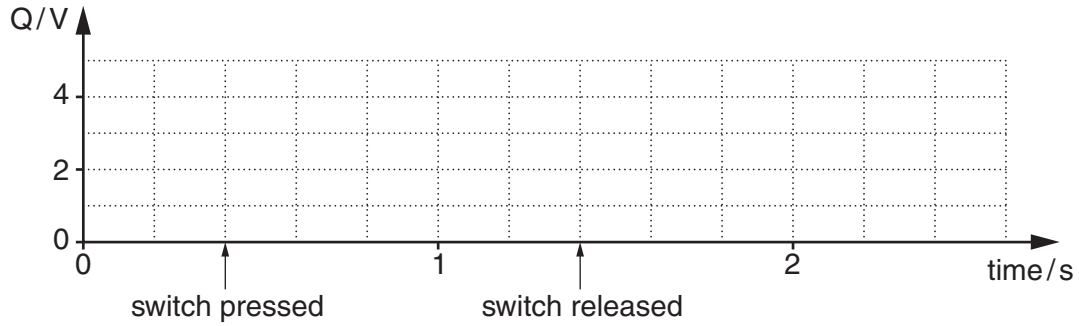
Time = ... s **[1]**

(b) Complete the graph below to show how the voltage at **X** changes with time as the switch is pressed and released.



[4]

(c) Use the data in the table of Fig. 3.1 to draw a graph showing how the voltage at **Q** changes with time as the switch is pressed and released.



[3]

(d) Explain what happens when the switch in Fig. 3.1 is pressed and released.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

[Total: 16]

4 Fig. 4.1 shows an incomplete circuit to produce sound.

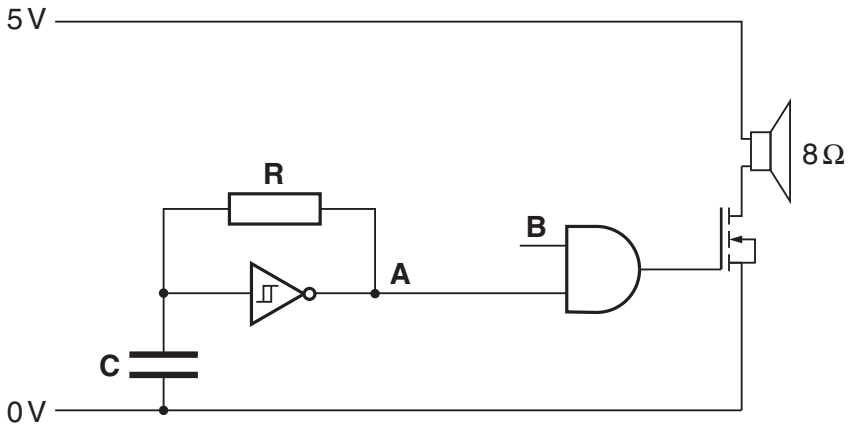


Fig. 4.1

(a) The signal at **A** has a frequency of 440 Hz. Show that the period of the signal at **A** is about 2 ms.

[1]

(b) Calculate suitable values of **R** and **C** to produce a signal with a frequency of 440 Hz at **A**.

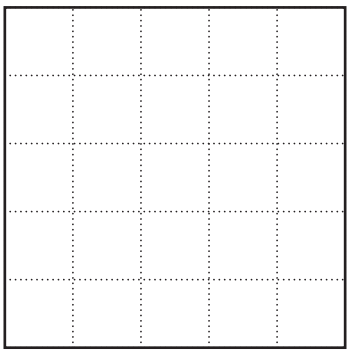
R = ... Ω

C = ... F
[3]

(c) Draw on Fig. 4.1 to show how an oscilloscope can be connected to display the signal at **A**.**[1]**

(d) On the grid below draw the trace you would expect to see on the oscilloscope.

Time base = 0.5 ms / division
Y sensitivity = 2 V / division



[3]

(e) Draw on Fig. 4.1 to show how a resistor and a switch can be connected to point **B** so that the speaker makes a sound when the switch is pressed. **[2]**

(f) Show that the current through the speaker is about 600 mA when the MOSFET is on.

[1]

(g) The following MOSFETs are available for the circuit in Fig. 4.1.

Device	$R_{DS}(on)/\Omega$	Maximum I_D/A	Maximum Power/W
2N7000	5	0.2	0.4
ZVN3306A	5	0.27	0.625
ZVN2106A	2	0.45	0.7
BS170	5	0.5	0.83
ZVN4306A	0.45	1.1	0.85

(i) Write down the most suitable device for the MOSFET in the circuit.

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

(ii) Give a reason for your choice of MOSFET.

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

[Total: 13]

5 Fig. 5.1 shows an incomplete block diagram of an electronic alarm system for a fridge.

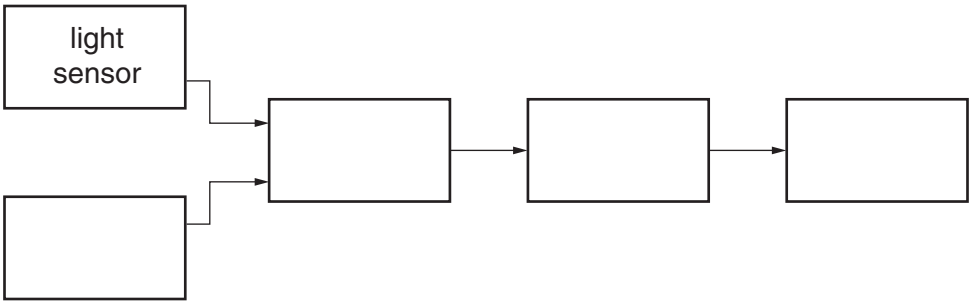


Fig. 5.1

The system sounds an alarm when:
- the fridge gets warm;
- there is light inside the fridge because the door is open.

(a) Complete the block diagram by putting the correct label in each block. Choose from:

buzzer	**driver**	**logic gate**	**position sensor**	**temperature sensor**	**zener diode**

[4]

(b) State what the arrows on a block diagram represent.

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

(c) The circuit of the light sensor is shown in Fig. 5.2.

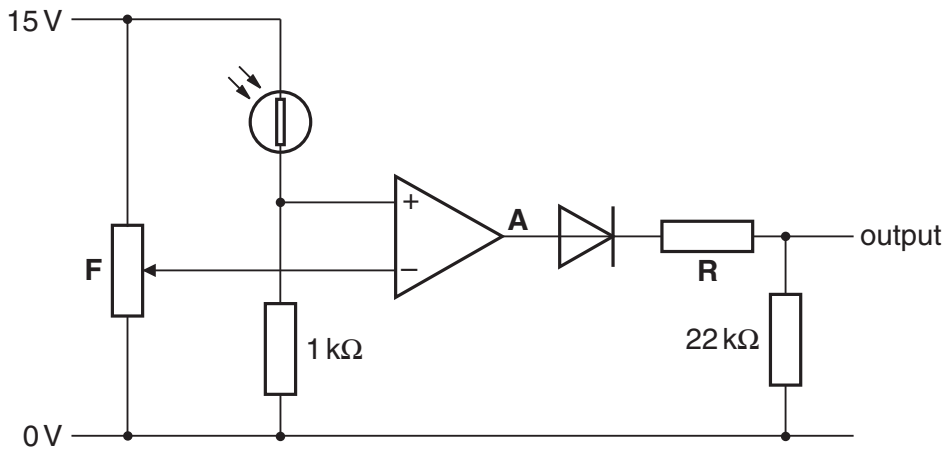


Fig. 5.2

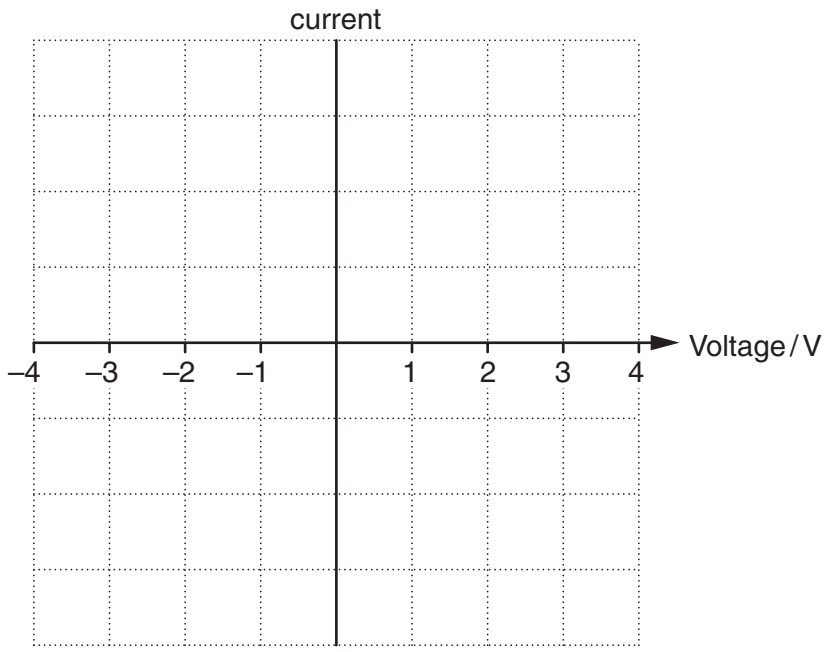
(i) Label the LDR in the circuit of Fig. 5.2. **[1]**

(ii) State the electrical properties of an LDR.

.....

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

(iii) The circuit in Fig. 5.2 contains a diode. Draw a graph on the axes below to show how the current through the diode depends on the voltage across it.



[3]

(iv) Calculate a suitable value for R to make the output of the circuit 5V when the voltage at **A** is 13V.

R = ... **[3]**

(v) Name the component marked **F** in Fig. 5.2.

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

(vi) Suggest why component **F** has been included in the circuit of Fig. 5.2.

.....

.....

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

[Total: 17]

6 The truth table for a logic system is shown below. It has inputs C, B and A, and outputs W and Z.

C	B	A	W	Z
0	0	0	0	
0	0	1	1	
0	1	0	0	
0	1	1	1	
1	0	0	0	
1	0	1	0	
1	1	0	1	
1	1	1	1	

(a) Write a Boolean expression for W.

W = ... **[1]**

(b) Fig. 6.1 shows the circuit for W.

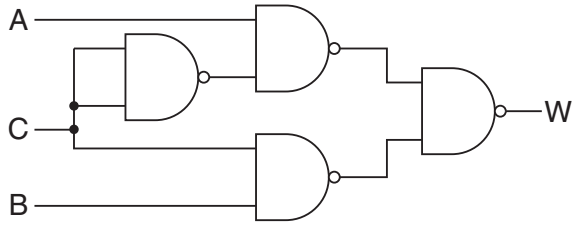


Fig. 6.1

(i) Use Boolean algebra to show that the circuit in Fig. 6.1 is equivalent to your expression for W in part **(a)**.

[4]

(ii) Suggest why the power supply connections for the logic gates are not shown.

.....

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

(c) Fill in column Z in the truth table using the Boolean expression $Z = C \cdot \overline{B} \cdot A + \overline{C} \cdot \overline{A}$ **[2]**

(d) Show in the space below how a circuit for Z can be assembled from NOT, AND and OR gates.

[3]

[Total: 11]

Quality of written communication [3]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE