OCR
RECOGNISING ACHIEVEMENT

Tuesday 14 May 2013 – Morning

AS GCE ELECTRONICS

F611/01 Simple Systems

F/6280/5061/3

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- Scientific calculator

Duration: 1 hour 30 minutes

F 6 1 1 0 1

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. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- 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).
- 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**.
- Quality of Written Communication will be assessed in this paper.
- 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	$A \cdot \overline{A} = 0$
	$A + \overline{A} = 1$
	$A \cdot (B + C) = A \cdot B + A \cdot C$
	$\overline{A \cdot B} = \overline{A} + \overline{B}$
	$\overline{A + B} = \overline{A} \cdot \overline{B}$
	$A + A \cdot B = A$
	$A \cdot B + \overline{A} \cdot C = A \cdot B + \overline{A} \cdot C + B \cdot C$

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1 Fig. 1.1 shows part of a circuit for controlling a lamp.

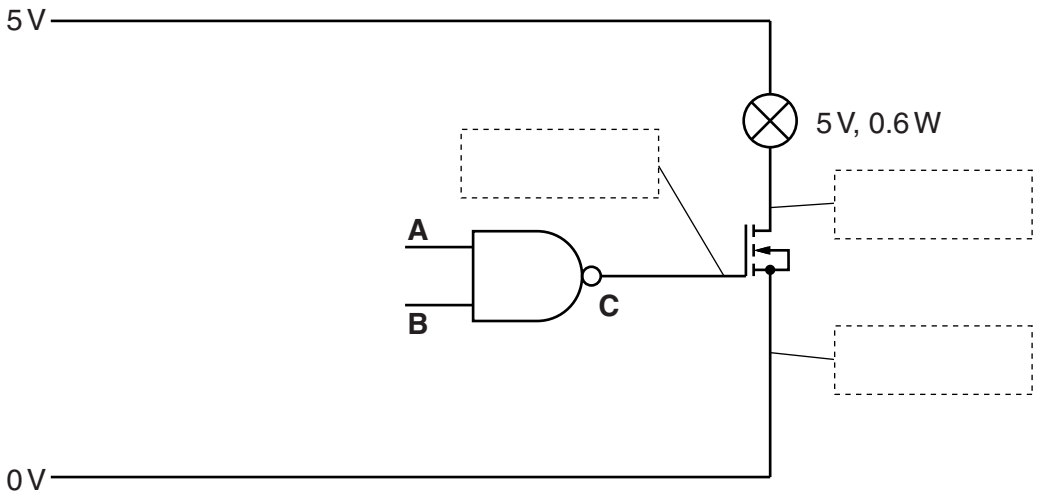


Fig. 1.1

(a) Name the logic gate in Fig. 1.1.

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

(b) Complete the truth table for the logic gate in Fig. 1.1.

A	B	C

[2]

(c) Write a Boolean expression for **C** in terms of **A** and **B**.

C = ... **[1]**

(d) Draw on Fig. 1.1 to show how a resistor and a switch should be connected to make **A** low when the switch is closed and to make **A** high when the switch is open. **[2]**

(e) Label the terminals of the MOSFET in Fig. 1.1. Use the boxes provided. **[3]**

(f) Explain how the MOSFET in Fig. 1.1 works by filling in the gaps using the words below.

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

falling high infinite low oscillating rising steady

The output of the logic gate can only operate …… power devices. The MOSFET acts as a driver sinking a …… current from the lamp.

The lamp is off when the output of the logic gate is …… which makes gate-source voltage …… and so the drain-source resistance is …… .

The lamp is on when the output of the logic gate is …… which makes gate-source voltage …… and so the drain-source resistance is …… . **[8]**

(g) Calculate the current in the MOSFET when the 0.6W, 5V lamp is on.

current = ...A **[1]**

(h) The table shows a list of available MOSFETs for the circuit in Fig. 1.1.

Device	Maximum V_{DS} / V	Maximum Drain Current / A	Maximum Power / W	Price / £
2N7002	60	0.11	0.225	**0.04**
2N7000	60	0.2	0.4	**0.09**
ZVN3306A	60	0.27	0.625	**0.27**
ZVN2106A	60	0.45	0.7	**0.45**
BS170	60	0.5	0.83	**0.15**

State the most suitable device in the list.

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

[Total: 19]

2 Fig. 2.1 shows a temperature sensing circuit.

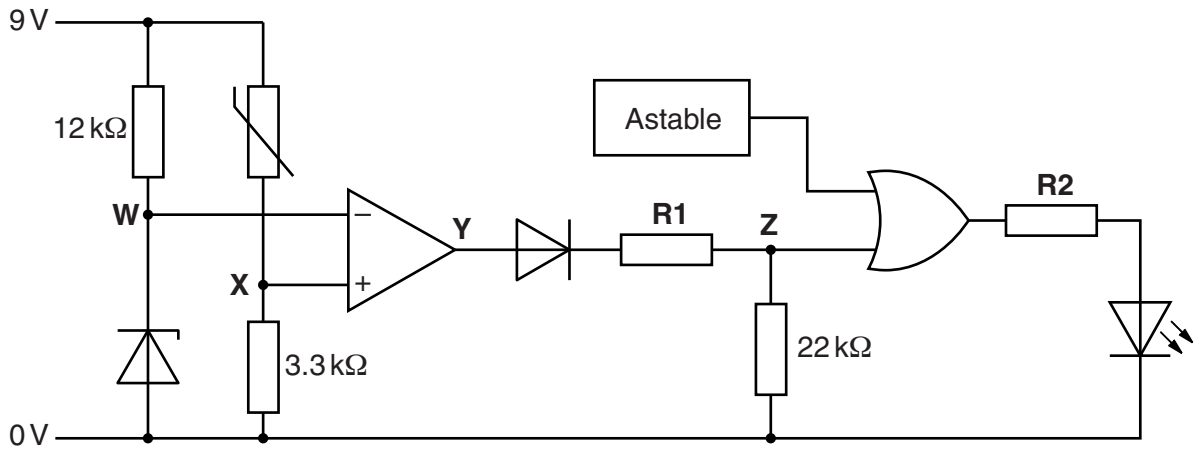
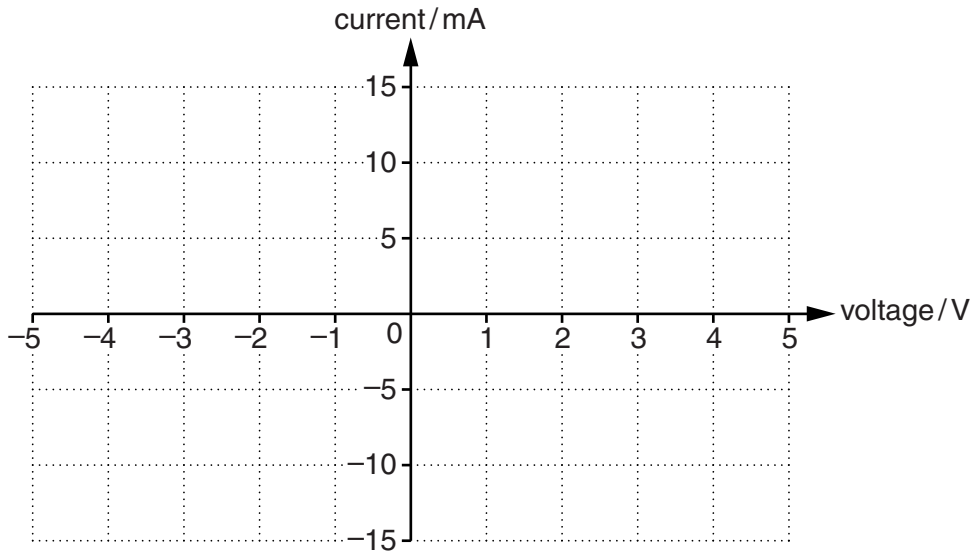


Fig. 2.1

(a) Put a ring around the zener diode in Fig. 2.1. **[1]**

(b) The zener diode is rated at 3.6 V.
Draw a graph of the current-voltage characteristics of the zener diode on the axes in Fig. 2.2.



[3]

Fig. 2.2

(c) When the temperature of the thermistor is 25 °C it has a resistance of 8.3 kΩ.
Calculate the voltage at **X** when the temperature is 25 °C.

Voltage at **X** = ... V **[3]**

(d) Explain why the voltage at **Z** is 0V when **Y** is at –13V.

.....

.....

.....

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

(e) Calculate the value of **R1** to make the voltage at **Z** equal to 5V when the voltage at **Y** is +13V.

R1 = ... kΩ **[3]**

[Total: 12]

3 Fig. 3.1 shows a circuit that controls an LED.

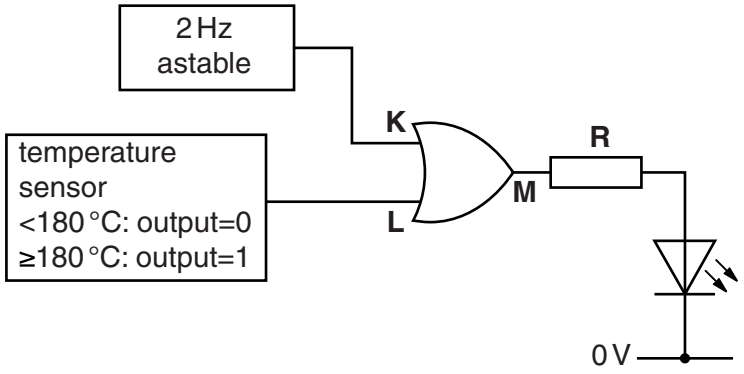


Fig. 3.1

(a) The LED in Fig. 3.1 has a forward voltage of 2.1 V at a current of 4 mA. Calculate the value of **R** to limit the current through the LED to 4 mA.

R = ... Ω **[3]**

(b) The astable has a frequency of 2 Hz. Calculate the period of the astable.

period = ... s **[1]**

(c) State and explain what happens to the output of the LED as the temperature sensor slowly warms up from 100 °C to 190 °C.

.....

.....

.....

.....

.....

..... **[5]**

(d) Complete the circuit of Fig. 3.2 to show the astable of Fig. 3.1.
Label the output.
Include all component values.

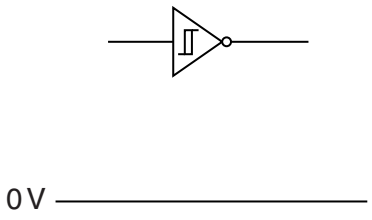


Fig. 3.2

[5]

(e) The logic gate in Fig. 3.2 has thresholds at 2V and 3V.
Draw the transfer characteristics on the axes in Fig. 3.3.

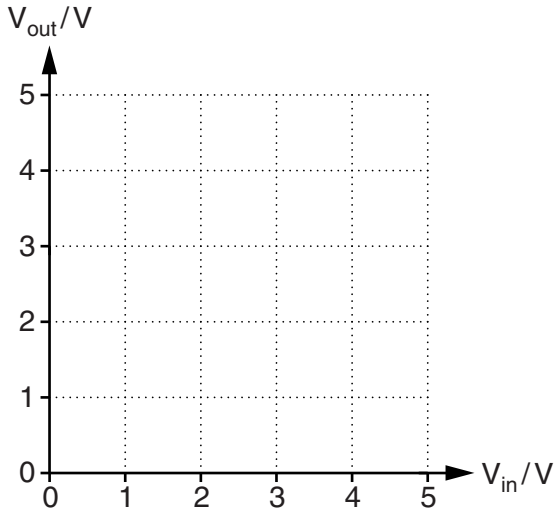


Fig. 3.3

[2]

[Total: 16]

4 This question is about using the rules of Boolean algebra.

(a) Put a ring around the Boolean expression which matches the truth table.

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

$Q = \overline{A \cdot B}$ $Q = \overline{A} + \overline{B}$ $Q = \overline{A + B}$ $Q = A + B$ **[1]**

(b) Put a ring around the Boolean expression which matches the truth table.

C	D	P
0	0	0
0	1	1
1	0	0
1	1	0

$P = \overline{C} + D$ $P = \overline{C \cdot \overline{D}}$ $P = (\overline{C + D}) \cdot D$ $P = (C + D) \cdot \overline{C}$ **[1]**

(c) Put a ring around the Boolean expression which matches the truth table.

E	F	R
0	0	0
0	1	1
1	0	1
1	1	0

$R = (\overline{E} + F) + (E + \overline{F})$ $R = (\overline{E} \cdot F) + (E \cdot \overline{F})$ $R = (\overline{E} \cdot F) \cdot (E \cdot \overline{F})$ $R = (\overline{E} + F) \cdot (E + \overline{F})$ **[1]**

(d) Put a ring around the Boolean expression which matches the truth table.

G	H	S
0	0	1
0	1	0
1	0	1
1	1	1

$S = G \cdot \overline{H}$ $S = \overline{G} + H$ $S = \overline{\overline{G} + H}$ $S = G + \overline{G + H}$ **[1]**

[Total: 4]

5 Fig. 5.1 shows a part of a logic circuit.

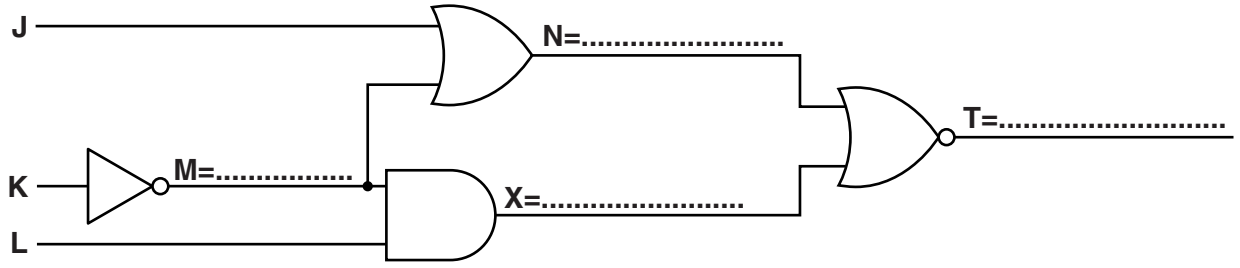


Fig. 5.1

(a) Using only the letters **J**, **K**, **L**, write the Boolean expression for the output of each gate on Fig. 5.1. **[4]**

(b) Complete the truth table for the circuit in Fig. 5.1.

J	K	L	M	N	X	T
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

[4]

(c) Draw a diagram below of the circuit in Fig. 5.1 with each gate replaced by its 2-input NAND gate equivalent. Label the points **J**, **K**, **L**, **M**, **N**, **X** and **T**.

[4]

[Total: 12]

6 A heater turns on for 5 minutes when a switch is pressed.

(a) Using the words below complete the block diagram in Fig. 6.1 for the system which operates the heater.

driver **heater** **monostable** **switch**

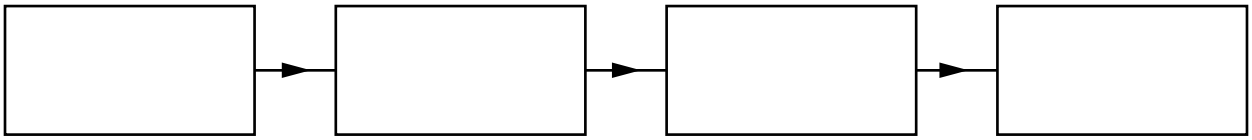


Fig. 6.1 **[1]**

(b) State why block diagrams are used as well as circuit diagrams.

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

(c) Fig. 6.2 shows the circuit diagram of the monostable.

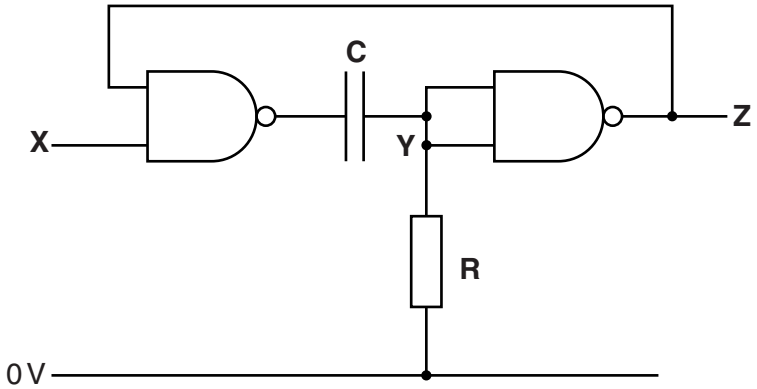


Fig. 6.2

(i) The pulse time of the monostable is 5 minutes. Calculate the values of **R** and **C**.

C = ... μF

R = ... kΩ
[4]

(ii) Fig. 6.3 shows an incomplete timing diagram for the monostable in Fig. 6.2. Complete the graphs for Y and Z.

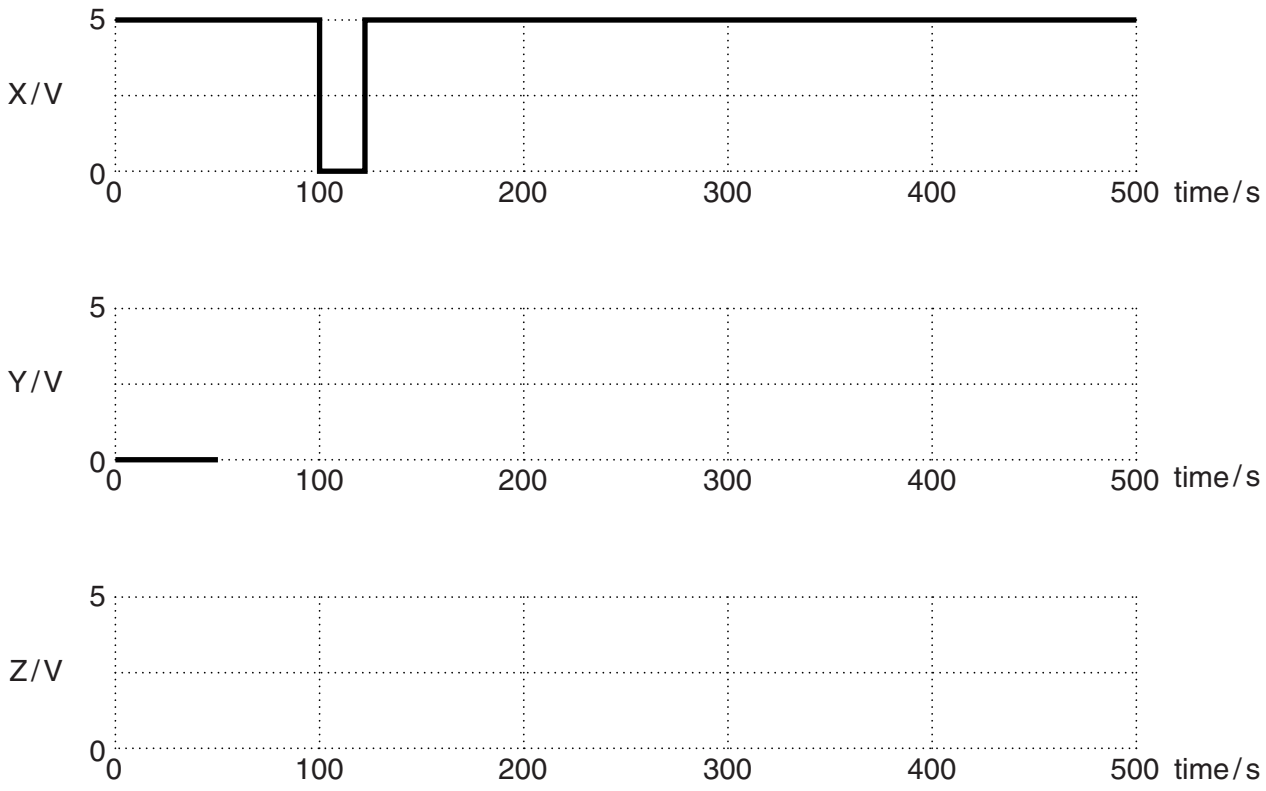


Fig. 6.3 **[6]**

[Total: 12]

7 Fig. 7.1 shows an incomplete circuit diagram for a sensor circuit.

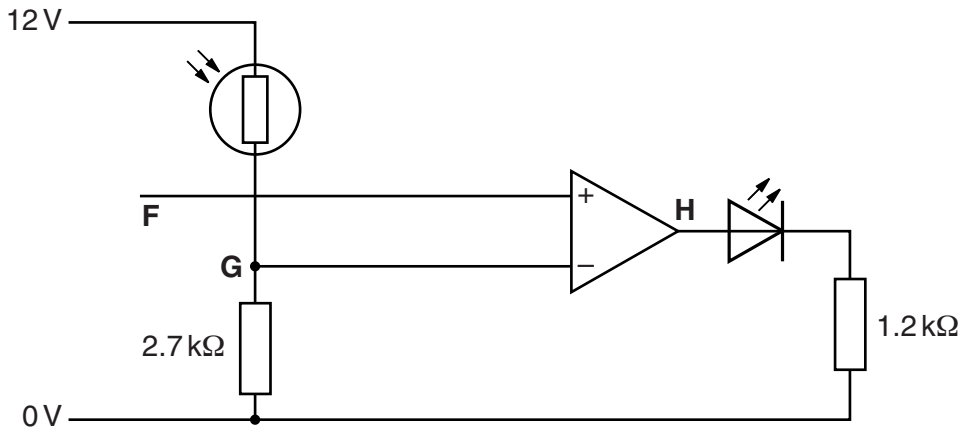


Fig. 7.1

(a) Draw on Fig. 7.1 to show how a potentiometer can be added to the circuit so that the voltage at **F** can be varied from 0 V to 12 V. **[2]**

(b) The circuit in Fig. 7.1 contains an LDR. Describe the electrical characteristics of the LDR.

.....

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

(c) Draw on Fig. 7.1 to show how a voltmeter should be connected to measure the voltage at **G**. **[1]**

(d) The potentiometer is adjusted to make **F** = 6 V. The LDR is placed in complete darkness. Explain the state of the LED. Refer to the voltages at **F**, **G** and **H** in your answer.

.....

.....

.....

.....

.....

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

(e) **F** remains at 6 V. Explain what happens to the LED as the light level is slowly increased from complete darkness to bright light. Refer to the voltages at **F**, **G** and **H** in your answer.

.....

.....

.....

.....

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

[Total: 12]

Quality of written communication [3]

END OF QUESTION PAPER

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