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Oxford Cambridge and RSA

Tuesday 16 May 2017 – Afternoon

AS GCE ELECTRONICS

F611/01 Simple Systems

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
- Scientific calculator

Duration: 1 hour 30 minutes

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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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 **20** pages. Any blank pages are indicated.

A calculator may be used for this paper

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Data Sheet

Unless otherwise indicated, you can assume that:

- op-amps are run off supply rails at +15 V and –15 V.
- logic circuits are run off supply rails at +5 V and 0 V.

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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Answer **all** the questions.

1 Fig. 1.1 shows a circuit for operating an LED.

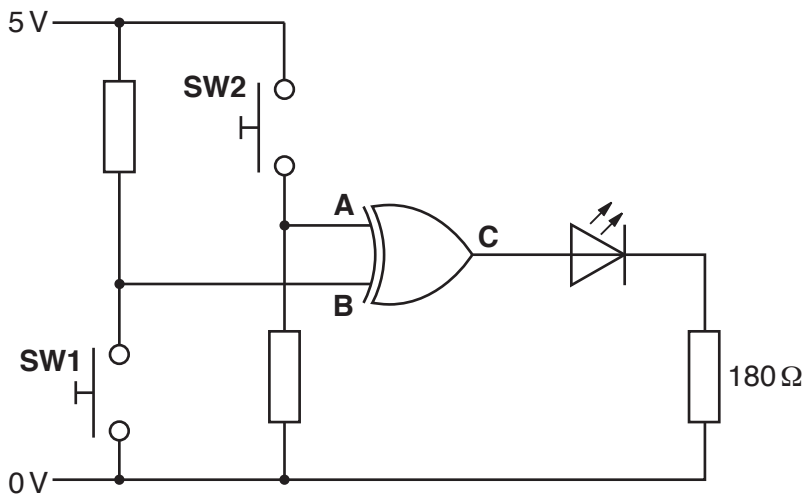

Fig. 1.1

(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 the output **C** of the logic gate in Fig. 1.1 in terms of **A** and **B**.

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

(d) There are **two** ways to make the LED light.
State the positions of the switches to make the LED light.

1 .....

2 .....

[2]

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(e) The LED in Fig. 1.1 operates at 1.9 V. Draw a graph of the current-voltage characteristics of the LED on the axes in Fig. 1.2.

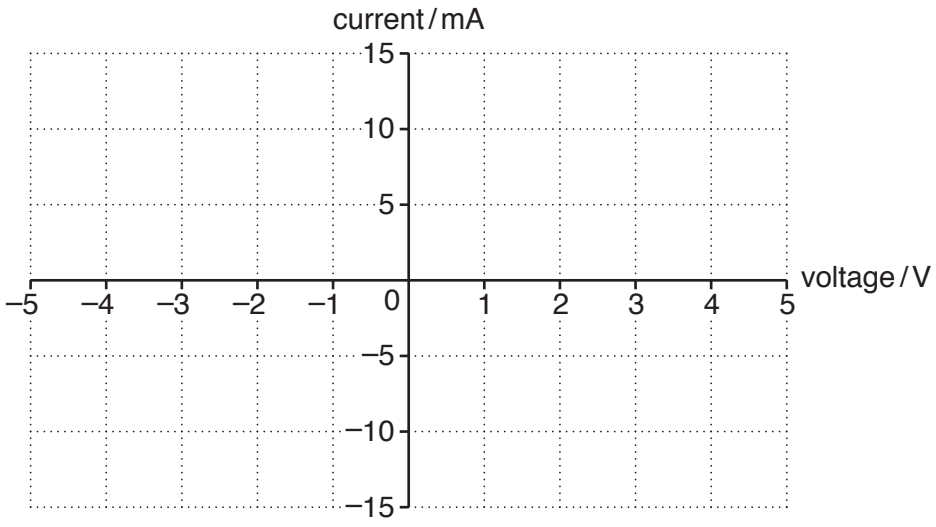

Fig. 1.2

[3]

(f) Calculate the current through the LED when the output of the logic gate is high.

current ..... mA **[3]**

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2 The circuit in Fig. 2.1 operates a lamp.

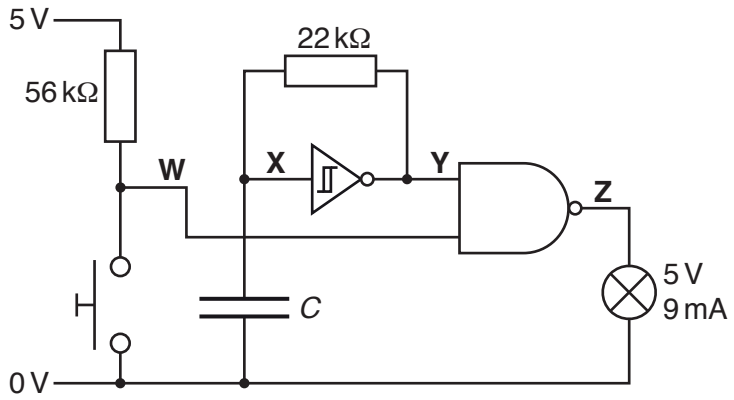

Fig. 2.1

(a) Calculate the power dissipated by the lamp in Fig. 2.1 when **Z** is logic high.

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

(b) Explain what happens to the lamp in Fig. 2.1 when the switch is pressed.

.....

.....

.....

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

(c) The circuit in Fig. 2.1 contains a relaxation oscillator.
Calculate the value of *C* to give the relaxation oscillator a period of 0.5 seconds.

C = ... μF **[3]**

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(d) Complete the graphs in Fig. 2.2 to show how the voltages at **W**, **X**, **Y** and **Z** change with time. The signal at **Y** is initially at 0 V.

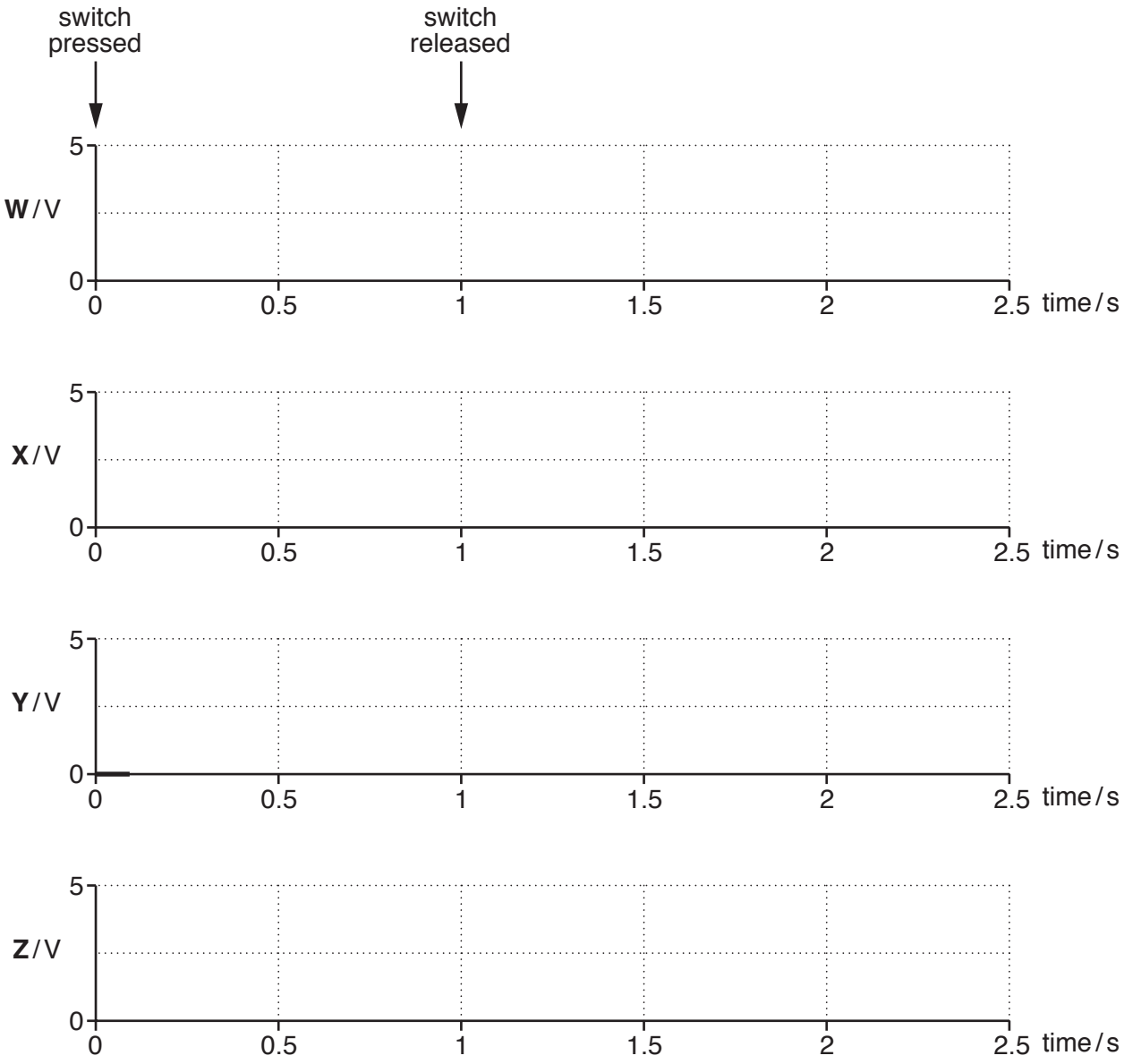

Fig. 2.2

[9]

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3 Fig. 3.1 shows a system for sounding a buzzer when a machine is getting too hot.

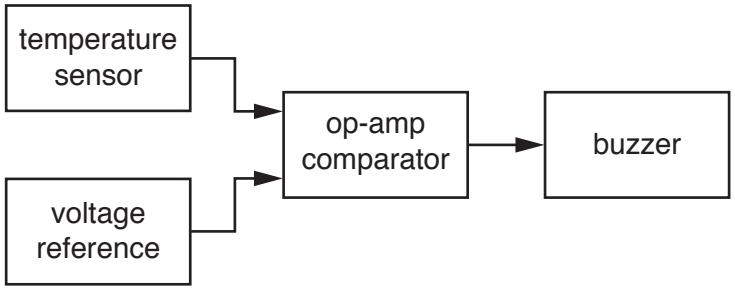

Fig. 3.1

(a) The system uses a thermistor in the temperature sensor.
Describe the electrical characteristics of a thermistor.

.....

.....

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

(b) Fig. 3.2 shows an incomplete circuit diagram for the system in Fig. 3.1.
Draw on Fig. 3.2 to complete the circuit.

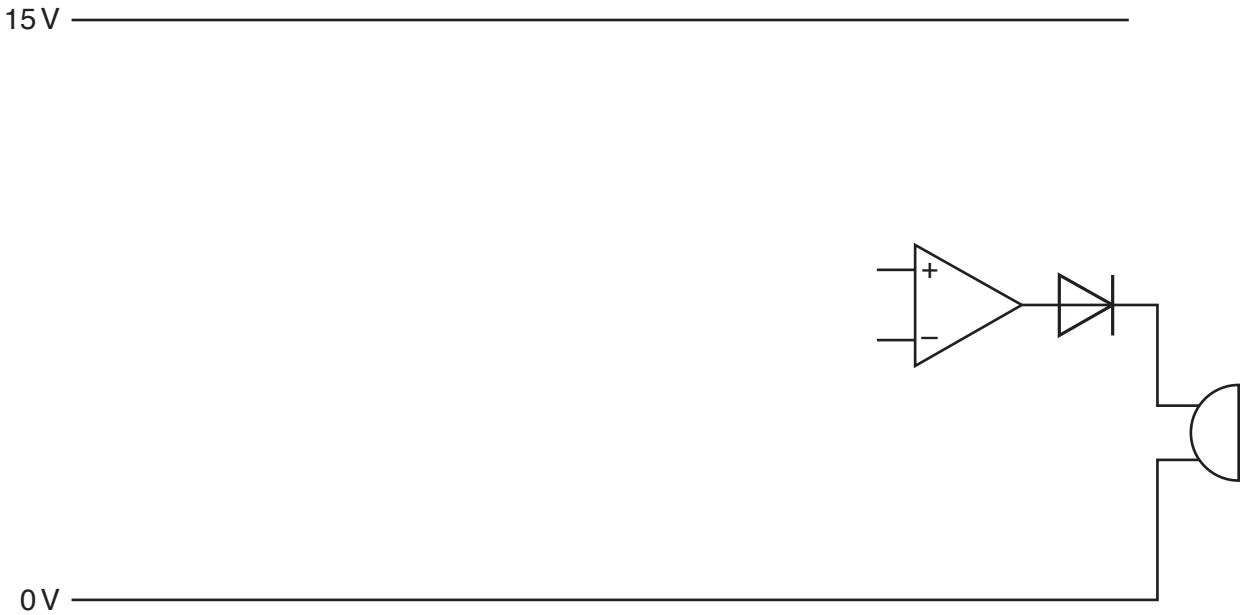

Fig. 3.2

[4]

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(c) Suggest a reason for including the diode in the circuit in Fig. 3.2.

.....

.....

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

(d) The buzzer operates at 80 mW when the output of the op-amp is saturated high. Calculate the current through the buzzer when it operates.

current = ... A **[3]**

(e) Select the most suitable op-amp for the circuit in Fig. 3.2 from the table below.

Op-amp	Max supply voltage / V	Max output current / mA	Price
TB319	30	25	60p
MN393	36	6	16p
OP46	5	80	75p
H081	42	5	14p

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

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

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

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

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

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

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

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

[1]

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

$$P = (\overline{C} + D) \cdot (C + \overline{D})$$

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

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

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

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

[1]

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

$$R = \left(\overline{E \cdot F}\right) \cdot \left(\overline{E} + F\right)$$

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

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

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

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

[1]

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

$$S = (\overline{G \cdot H}) \cdot (\overline{\overline{G} \cdot \overline{H}})$$

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

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

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

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

[1]

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5 Here is the truth table for a logic system.

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

(a) Write a Boolean expression for **Q** in the truth table. You do not need to simplify the expression.

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

(b) On Fig. 5.1 draw a logic circuit with the behaviour of the truth table.

You may use any logic gates you need in your design.

A –

B –

– Q

C –

Fig. 5.1

[3]

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6 Fig. 6.1 shows a circuit for sensing when someone passes between the lamp and the LDR.

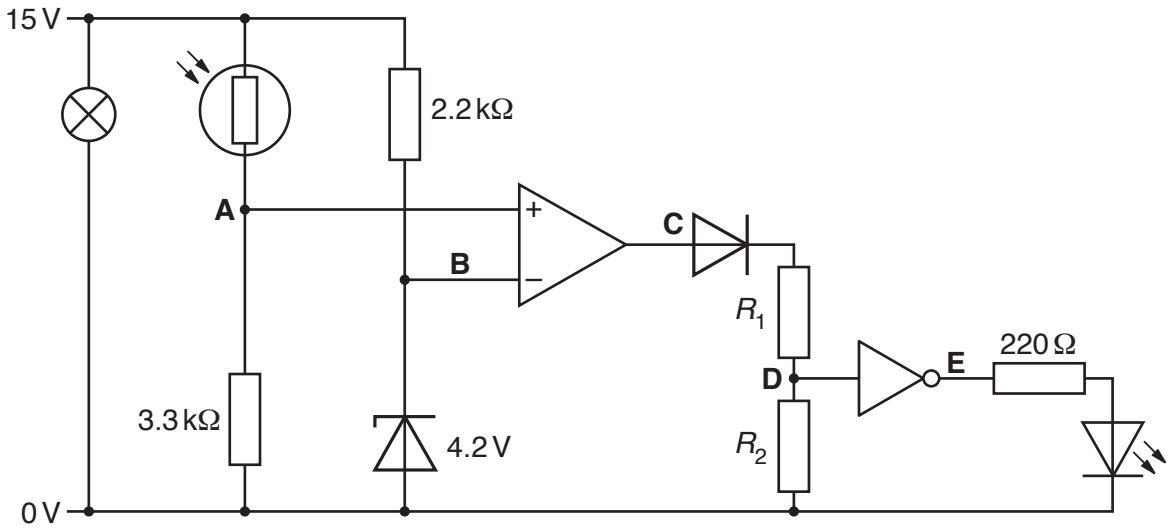

Fig. 6.1

(a) Explain why the voltage at **D** is 0 V when the output of the op-amp is saturated low.

.....

.....

.....

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

(b) Suggest values for the resistors R_1 and R_2 to make the voltage at **D** 5 V when the output of the op-amp is saturated high.

Show your calculations.

R_1 = ... Ω and R_2 = ... Ω **[3]**

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(c) Calculate the resistance of the LDR when the voltage at **A** is the same as the voltage at **B**.

resistance of LDR = ... Ω **[4]**

(d) Explain what happens to the LED when someone passes between the lamp and the LDR. Refer to the voltages at **A**, **B**, **C**, **D** and **E** in your answer.

.....

.....

.....

.....

.....

.....

.....

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

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7 Fig. 7.1 shows the block diagram for a system for controlling a lamp.

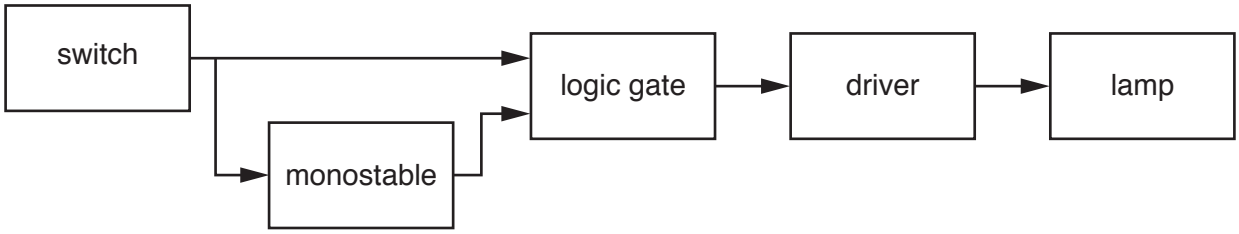

Fig. 7.1

(a) State the meaning of the arrows in Fig. 7.1.

.....

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

(b) The lamp in the system operates at 5 V, 8 W.
State why a driver is needed in the system.

.....

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

(c) Fig. 7.2 shows an incomplete circuit diagram for the system in Fig. 7.1.

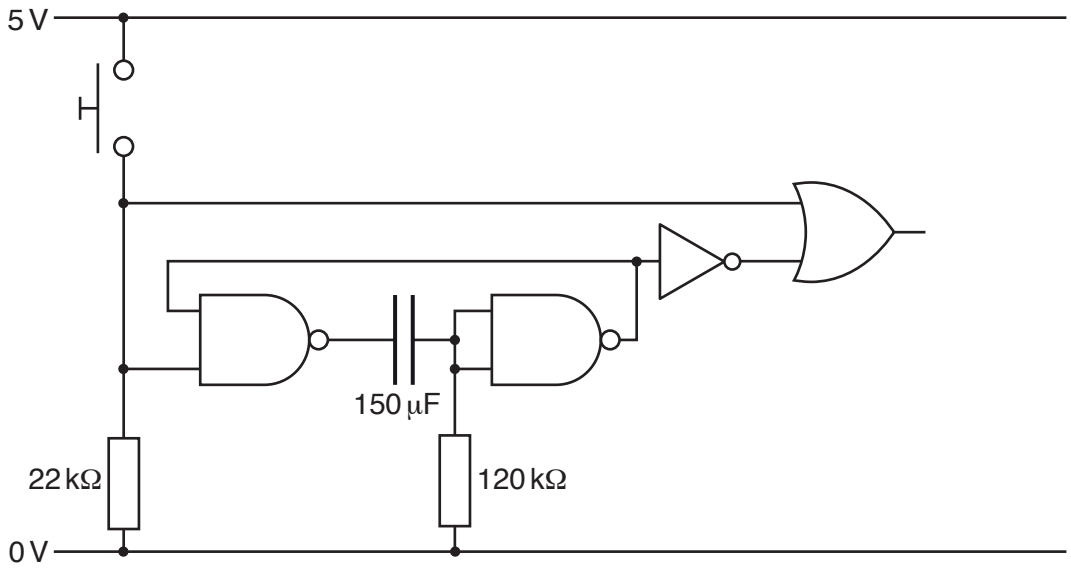

Fig. 7.2

(i) Complete the circuit diagram in Fig. 7.2 to include:

- a MOSFET for the driver
- correctly named labels for the MOSFET terminals
- the 5 V lamp
- all necessary connections. [4]

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(ii) Calculate the period of the monostable in Fig. 7.2.

period = ... s **[2]**

(iii) Describe the behaviour of the lamp when the switch is pressed and held for 30 s and then released.

.....

.....

.....

.....

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

(iv) Explain the function of the 22 kΩ resistor in Fig. 7.2.

.....

.....

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

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8 Fig. 8.1 shows a logic system.

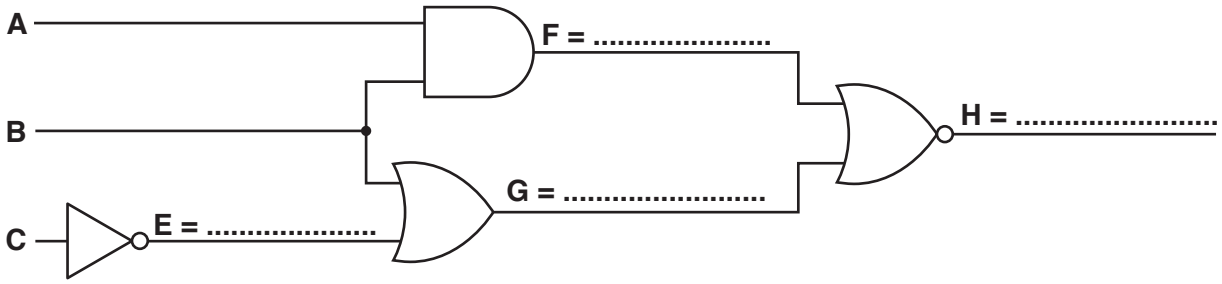

Fig. 8.1

(a) Write on Fig. 8.1 the Boolean expression for the output of each gate using **only** the letters **A**, **B** and **C**. You do not need to simplify your expressions. **[4]**

(b) In the space below, show how each logic gate in the circuit of Fig. 8.1 can be built using only NAND gates.
Label the points **A**, **B**, **C**, **E**, **F**, **G** and **H** in your circuit.
Do not simplify your circuit.

[4]

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(c) Complete the truth table for the logic system in Fig. 8.1.

A	B	C	E	F	G	H
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]

Quality of written communication [3]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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