OCR
Oxford Cambridge and RSA

Tuesday 12 May 2015 – Morning

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. 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 calculator may be used for this paper

Data Sheet

Unless otherwise indicated, you can assume that:

- op-amps are run off supply rails at +15V and –15V.
- logic circuits are run off 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	$A \cdot \overline{A} = 0$
	$A + \overline{A} = 1$
	$A \cdot (B + C) = A \cdot B + A \cdot C$
	$\overline{A \cdot B} = \overline{A} + \overline{B}$
	$\overline{A + B} = \overline{A} \cdot \overline{B}$
	$A + A \cdot B = A$
	$A \cdot B + \overline{A} \cdot C = A \cdot B + \overline{A} \cdot C + B \cdot C$

1 A truth table for a logic system is shown below.

A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
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) Draw a logic circuit with the behaviour of this truth table on Fig. 1.1.
You may use any logic gates you need in your design.

A ———

B ———

——— **Q**

C ———

Fig. 1.1

[2]

2 Fig. 2.1 shows part of a circuit for operating a buzzer.

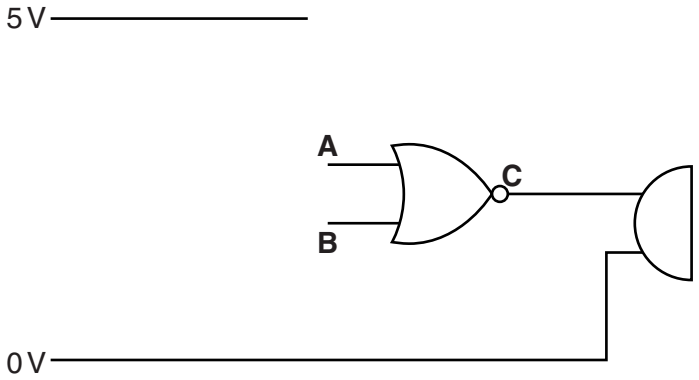

Fig. 2.1

(a) Name the logic gate in Fig. 2.1.

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

(b) Complete the truth table below for the logic gate in Fig. 2.1.

A	B	C

[2]

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

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

(d) Draw on Fig. 2.1 to show how two push switches and resistors should be connected to the input of the logic gate to produce the logic signals at **A** and **B** in your truth table. **[3]**

(e) State which switches you would press to produce the second line of your truth table.

.....

.....

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

(f) Explain why the resistors are needed in your design.

.....

.....

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

(g) Draw on Fig. 2.2 to show how the logic gate in Fig. 2.1 can be replaced with NAND gates.

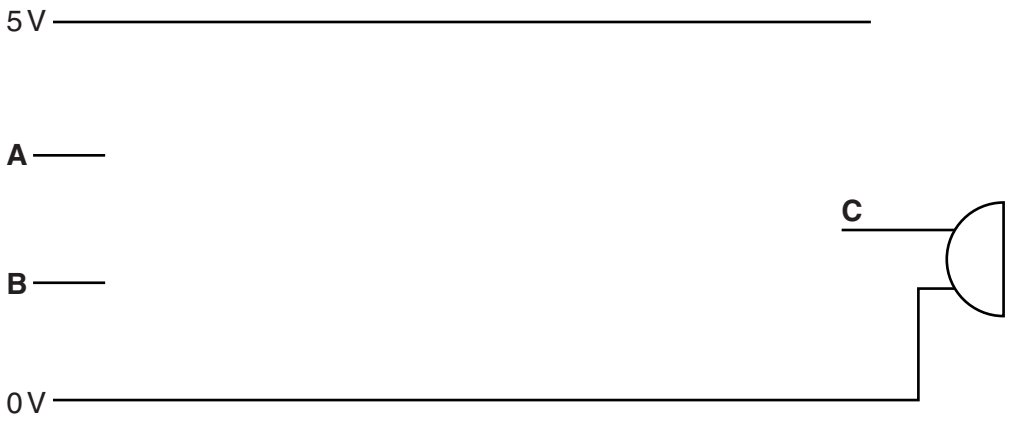

Fig. 2.2

[2]

3 Fig. 3.1 shows a monostable circuit controlling an LED.

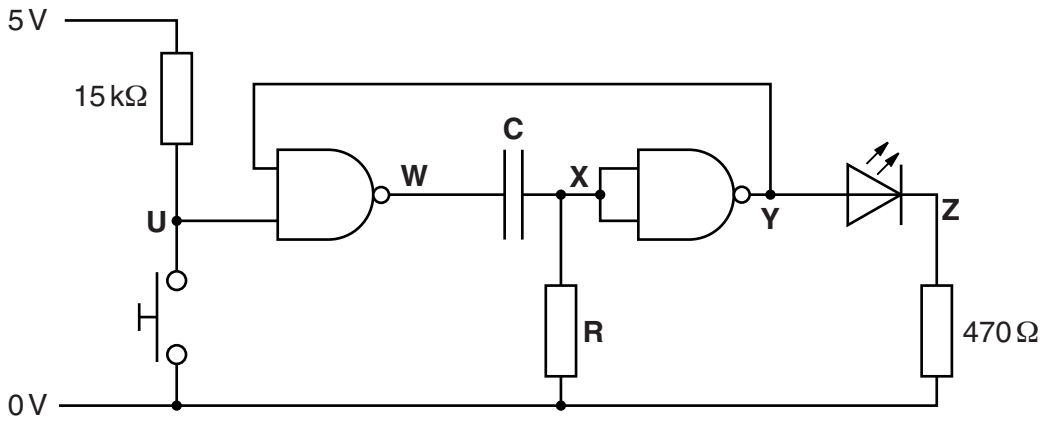

Fig. 3.1

(a) The LED in Fig. 3.1 operates with a forward voltage of 1.8 V.

Calculate the value of current through the LED when the voltage at **Y** is 5 V.

current through LED = ... A **[2]**

(b) Calculate a suitable value for **C** and **R** in Fig. 3.1 to give the monostable a period of 20 s.

C ..... **R** ..... **[3]**

(c) Describe what happens to the LED when the switch in Fig. 3.1 is briefly pressed.

.....

.....

.....

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

(d) Complete the graphs in Fig. 3.2 to show how the voltages at **W**, **X**, **Y** and **Z** change with time when the value of **U** changes as shown.

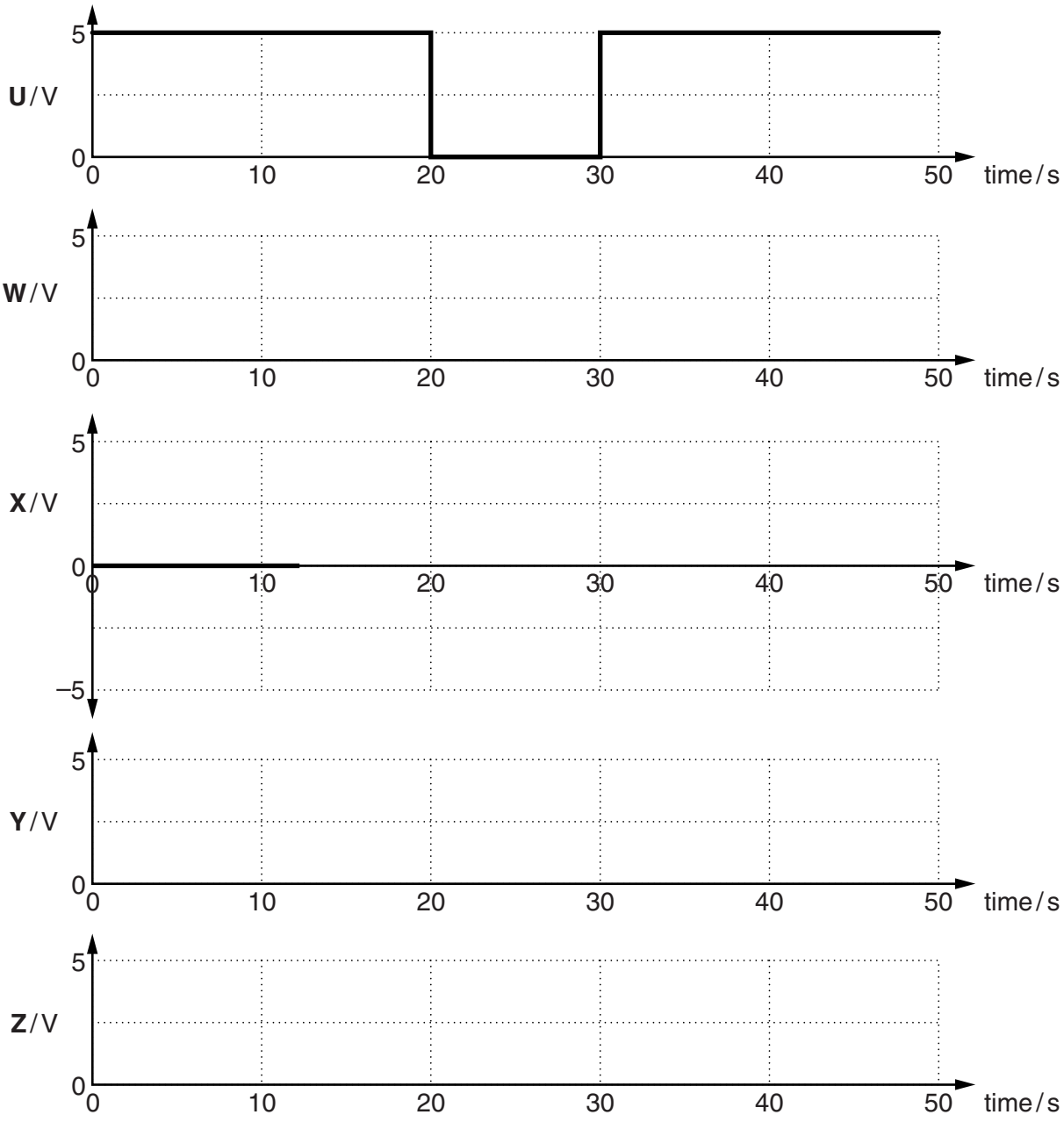

Fig. 3.2

[8]

4 Fig. 4.1 shows an incomplete circuit built by a student for controlling a lamp.

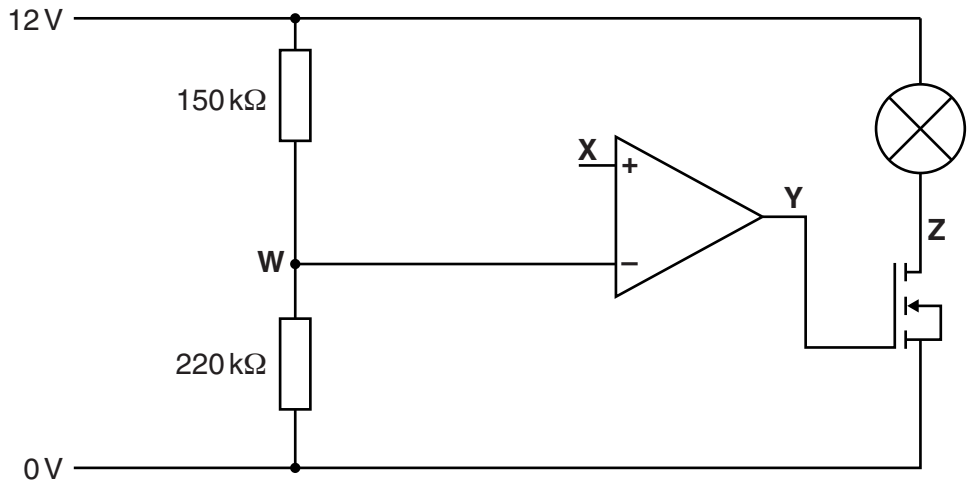

Fig. 4.1

(a) Calculate the voltage at **W** in the circuit.

voltage at **W** = ... V **[3]**

(b) Draw on Fig. 4.1 to show how a potentiometer should be added to the circuit to vary the voltage at **X** between 0 V and 12 V. **[2]**

(c) State and explain what happens to the lamp as the voltage at **X** is slowly increased from 0 V to 12 V.

Refer to the voltages at **W**, **X**, **Y** and **Z** in your answer.

.....

.....

.....

.....

.....

.....

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

(d) The lamp is rated at 36W, 12V.

Calculate the current through the lamp when it is on.

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

(e) Select the most suitable MOSFET for the circuit in Fig. 4.1 from the table below. Justify your answer.

MOSFET	Max current/A	Max power/W	Price
VNP10N07	10	50	90p
STP36NF06L	30	70	39p
2N7000	0.2	0.4	4p
FDN359AN	2.7	0.5	29p
TSM2N7002KCX	0.3	0.2	4p

.....

.....

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

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

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

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

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	0
1	1	1

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

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.

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

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

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

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

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

[1]

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

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

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

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

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

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

[1]

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

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

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

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

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

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

[1]

(e) Draw a line from each expression in the left hand column to the equivalent expression in the right hand column.

$\overline{(p \cdot \overline{r}) \cdot \overline{\overline{q}}}$	$\overline{r} \cdot q$
	$p \cdot \overline{r} \cdot \overline{q}$
$\overline{(\overline{\overline{p}} + r) \cdot \overline{(p + r) \cdot q}}$	$\overline{p} + r + q$
	$p \cdot \overline{q} \cdot \overline{r} + \overline{p} \cdot q \cdot r$
$(p \cdot q \cdot \overline{r}) + (p \cdot \overline{q} \cdot \overline{r})$	$\overline{p} + q$
	$p \cdot \overline{r} + p \cdot \overline{p}$
$(\overline{p} \cdot \overline{q \cdot r}) \cdot r + \overline{p \cdot \overline{\overline{q}}}$	$\overline{q}$

[4]

6 The diagram in Fig. 6.1 shows an incomplete circuit for turning on an LED in a car to warn that the outside temperature is below 4 °C.

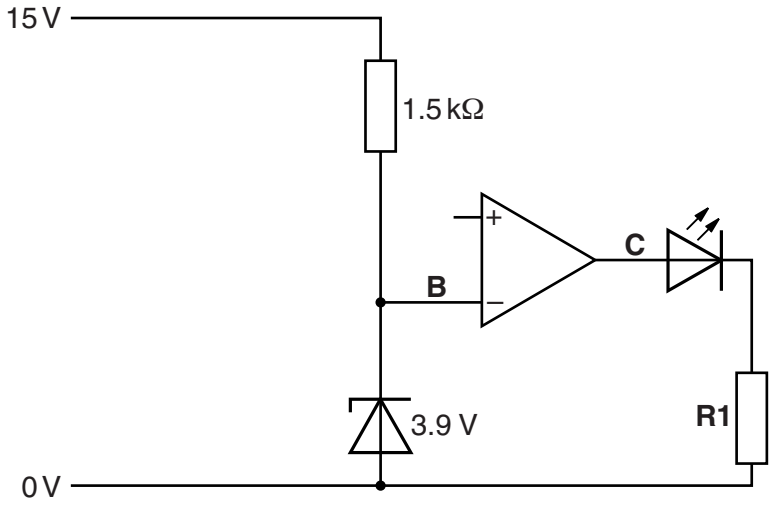

Fig. 6.1

(a) Draw a (ring) around the zener diode in Fig. 6.1. **[1]**

(b) Draw a graph of the current-voltage characteristics of the zener diode on the axes in Fig. 6.2.

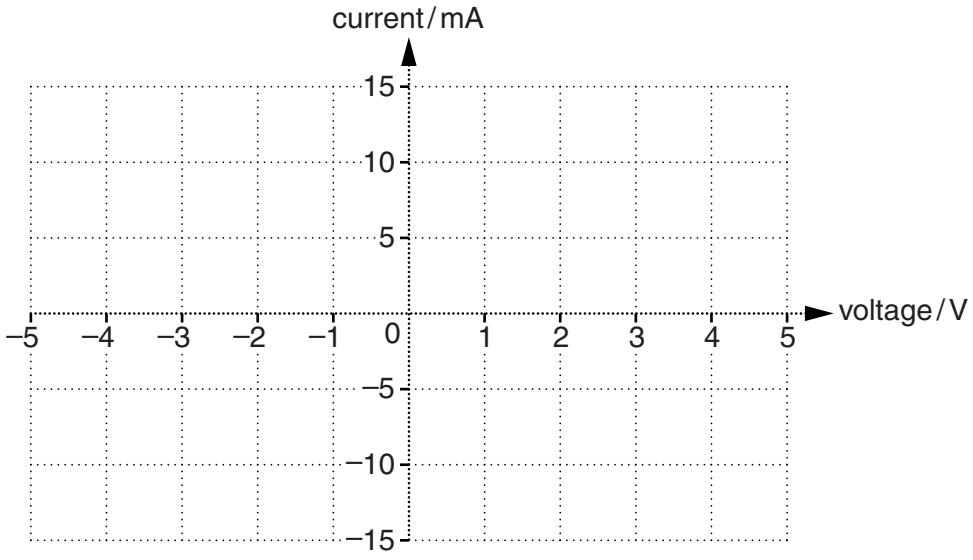

Fig. 6.2

[3]

(c) Explain why the zener diode is used in the circuit.

.....

.....

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

(d) The LED in Fig. 6.1 will start to glow when the temperature falls to 4 °C.
A thermistor is used to sense the temperature.

(i) Describe the electrical properties of a thermistor.

.....

.....

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

(ii) Draw on Fig. 6.1 to show how a fixed resistor **R2** and a thermistor are connected to the circuit to make the LED glow when the temperature falls to 4 °C. **[3]**

(iii) The resistance of the thermistor at 4 °C is 3.7 kΩ.

Calculate the value of **R2** that will cause the LED to glow at this temperature when the temperature falls to 4 °C.

value of resistor **R2** = ... Ω **[3]**

(e) The LED operates at 2.1 V, 8 mA.

Calculate the value of **R1** to make the LED operate correctly.

value of resistor **R1** = ... Ω **[2]**

7 Fig. 7.1 shows a block diagram for a system to make a warning lamp flash at night.

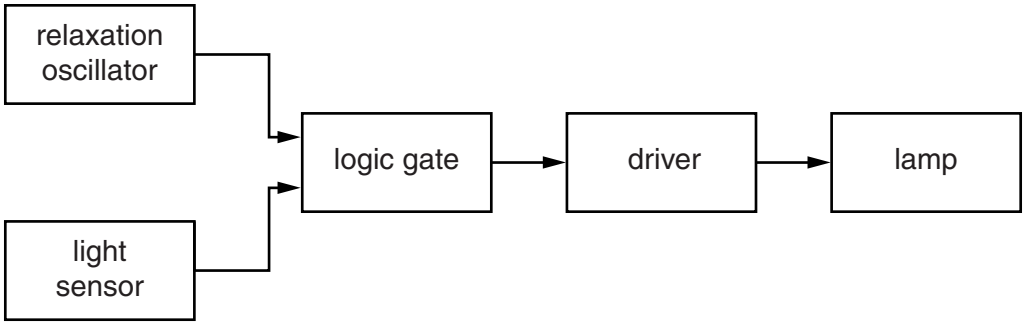

Fig. 7.1

(a) State the function of the logic gate in Fig. 7.1.

.....

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

(b) Explain why the driver is needed in the block diagram.

.....

.....

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

(c) To make the lamp flash the relaxation oscillator goes high for 0.2 s, low for 0.2 s, high for 0.2 s, low for 0.2 s and keeps repeating this behaviour.

(i) Calculate the frequency of the relaxation oscillator.

frequency = ... Hz **[1]**

(ii) Draw the circuit diagram of the relaxation oscillator in the space below.
Show all component values.

[6]

(d) The logic gate in the system shown in Fig. 7.1 is a NAND gate.
Explain how this gate allows the system to respond to make the warning lamp flash at night.

.....

.....

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

8 Fig. 8.1 shows a logic system.

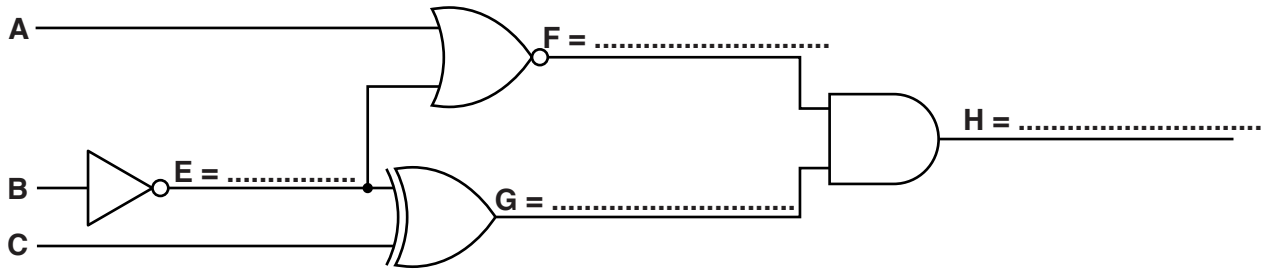

Fig. 8.1

(a) On Fig. 8.1 write 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) Complete the truth table below 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