OCR
Oxford Cambridge and RSA

Monday 21 May 2018 – 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. 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

Turn over

Data Sheet

Unless otherwise indicated, you can assume that:

- op-amps are run off supply rails at +15 V and –15 V and their outputs saturate at +13 V and –13 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	$\mathrm{A}\cdot\overline{\mathrm{A}} = 0$
	$\mathrm{A} + \overline{\mathrm{A}} = 1$
	$\mathrm{A}\cdot(\mathrm{B} + \mathrm{C}) = \mathrm{A}\cdot\mathrm{B} + \mathrm{A}\cdot\mathrm{C}$
	$\overline{\mathrm{A}\cdot\mathrm{B}} = \overline{\mathrm{A}} + \overline{\mathrm{B}}$
	$\overline{\mathrm{A} + \mathrm{B}} = \overline{\mathrm{A}}\cdot\overline{\mathrm{B}}$
	$\mathrm{A} + \mathrm{A}\cdot\mathrm{B} = \mathrm{A}$
	$\mathrm{A}\cdot\mathrm{B} + \overline{\mathrm{A}}\cdot\mathrm{C} = \mathrm{A}\cdot\mathrm{B} + \overline{\mathrm{A}}\cdot\mathrm{C} + \mathrm{B}\cdot\mathrm{C}$

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 Fig. 1.1 shows the incomplete circuit for controlling a lamp.

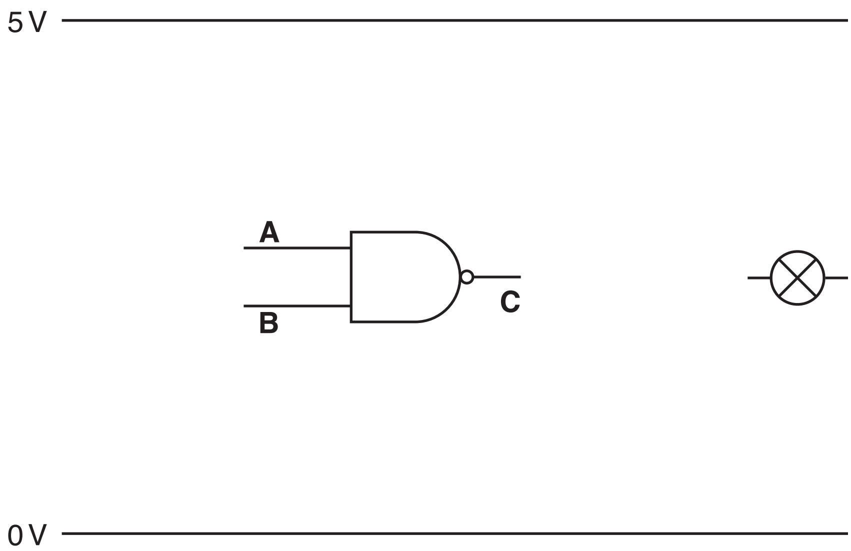


Fig. 1.1

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

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

(d) The lamp needs a voltage of 5 V and a current of 300 mA to operate correctly.

Explain why the lamp cannot be directly connected to the output of the logic gate but should be connected through a MOSFET.

....

....

.... **[2]**

(e) Calculate the power dissipated by the bulb when it is lit normally.

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

(f) Draw on Fig. 1.1 to show how a MOSFET should be connected to operate the lamp at its rated voltage when the output of the logic gate is high. **[4]**

(g) Draw on Fig. 1.1 to show how two push switches and resistors should be added to the circuit so that the lamp lights when either or both of the switches are pressed. **[3]**

2 Fig. 2.1 shows a monostable circuit controlling an LED.

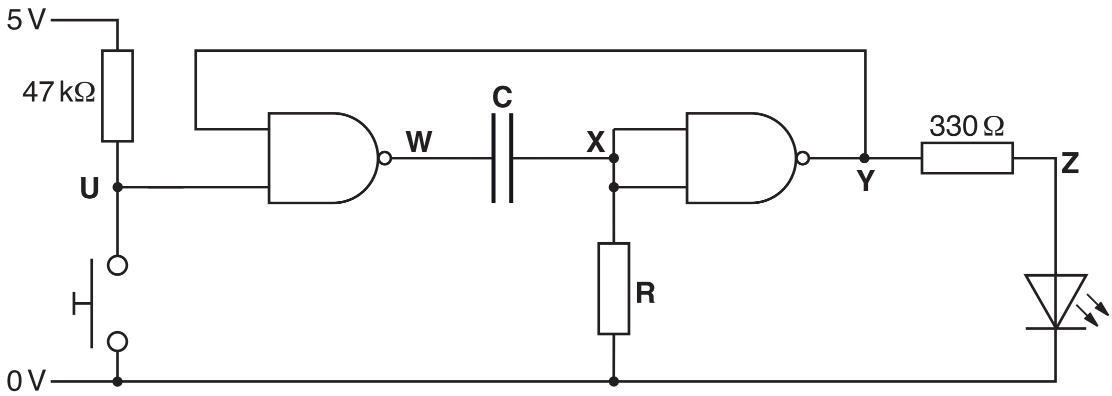


Fig. 2.1

(a) The LED in Fig. 2.1 operates in forward bias with a voltage of 2.1 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. 2.1 to give the monostable a duration of 15 s.

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

(c) Describe what happens to the LED when the switch in Fig. 2.1 is briefly pressed.

....

....

....

.... **[3]**

(d) Complete the graphs in Fig. 2.2 to show how the voltages at **U**, **W**, **X**, **Y** and **Z** change with time.

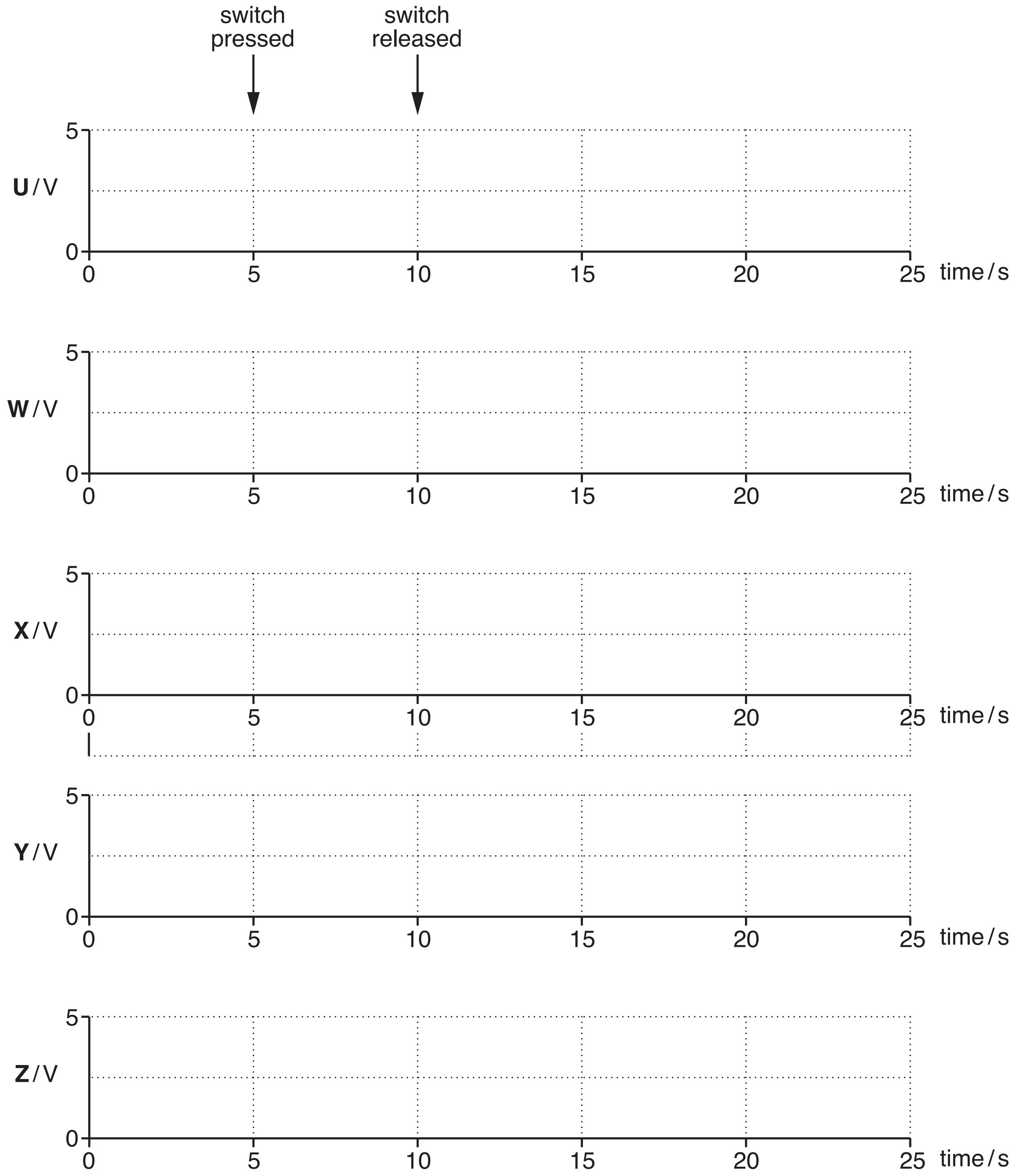


Fig. 2.2

[8]

3 Fig. 3.1 shows a circuit for a night light to turn on an LED when it gets dark.

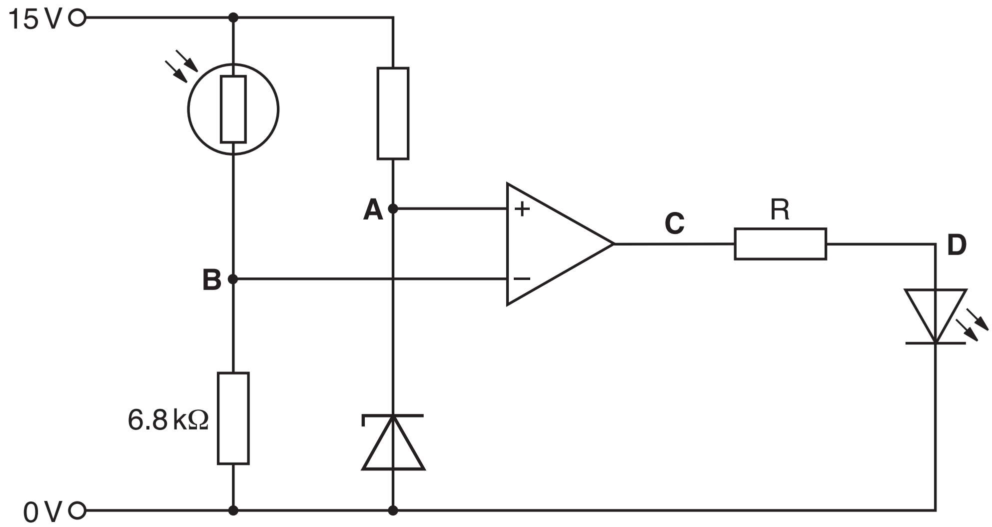


Fig. 3.1

(a) The LED operates in forward bias at a voltage of 3.6 V with a current of 8 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 letters **A**, **B**, **C** or **D** in the circuit to give an example of each type of signal.

....

....

....

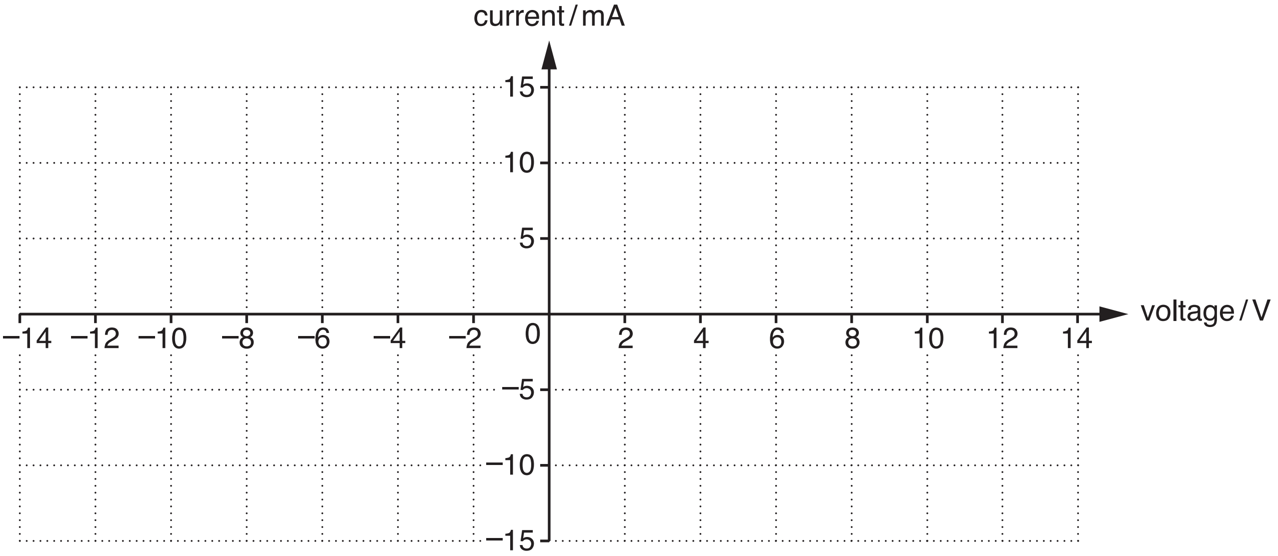
....

.... **[4]**

(c) The circuit uses a 5.6 V 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.

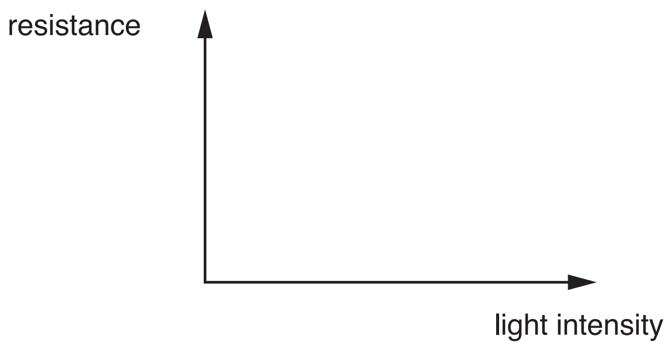


[3]

(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 6 V when the resistance of the LDR is 10 kΩ.

[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 10 kΩ.

....

....

....

.... **[3]**

(g) The circuit is designed to turn on the LED when the light level falls. Calculate the minimum resistance of the LDR that will turn on the LED.

minimum resistance of LDR to turn on LED = ... **[4]**

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

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	0
0	1	1
1	0	0
1	1	0

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

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

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

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

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

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

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

[1]

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

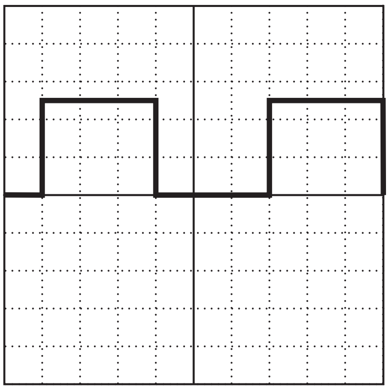
G	**H**	**S**
0	0	1
0	1	1
1	0	0
1	1	1

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

[1]

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

(a) An oscilloscope is used to measure the output of the oscillator. The trace seen on the screen of the oscilloscope is shown in Fig. 5.1.



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

The timebase is set to 500 ms per division.

Fig. 5.1

(i) Calculate the period of the oscillator signal.

period = ... ms **[2]**

(ii) Calculate the frequency of the oscillator signal.

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

(iii) Calculate the amplitude of the oscillator signal.

amplitude = ...V **[1]**

(b) A circuit is now connected to the output of the oscillator as shown in Fig. 5.2.

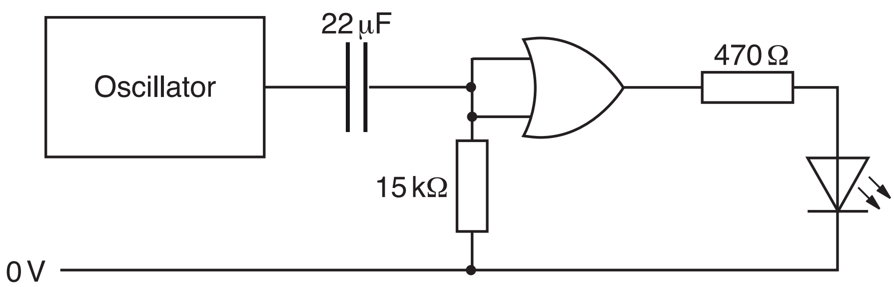


Fig. 5.2

(i) Draw on Fig. 5.2 to show how an oscilloscope should be connected to measure the voltage at the input to the OR gate. **[2]**

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

time constant = ... s **[1]**

(iii) Fig. 5.3 shows the screen of the oscilloscope.

On Fig. 5.3 draw the trace seen on the oscilloscope when it is connected as in **(b)(i)**.

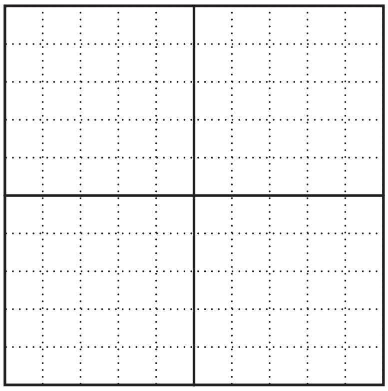


Fig. 5.3

[5]

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

....

....

....

.... **[3]**

6 Fig. 6.1 shows a part of a logic circuit.

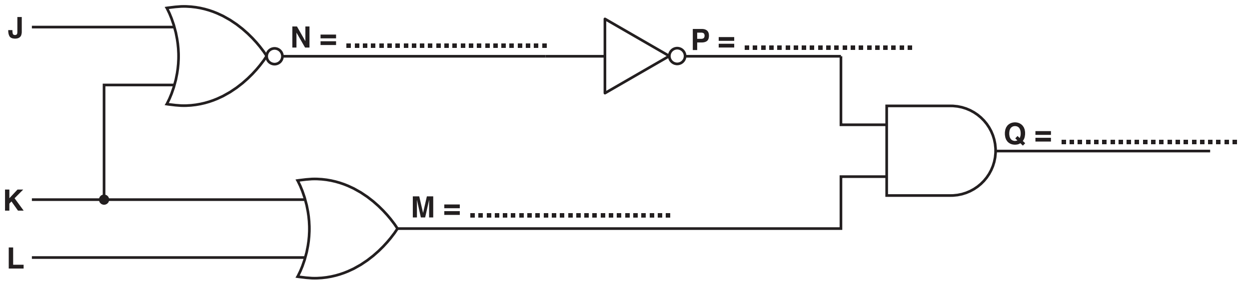


Fig. 6.1

(a) Using only the letters **J**, **K** and **L** write the Boolean expression for the output of each gate in Fig. 6.1. **[4]**

(b) Complete the truth table for the circuit in Fig. 6.1.

J	K	L	M	N	P	Q
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. 6.1 with each gate replaced by its 2-input NAND gate equivalent. Label the points **J**, **K**, **L**, **M**, **N**, **P** and **Q**.

[4]

Quality of written communication [3]

END OF QUESTION PAPER

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).