Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS ELE1
Unit 1 Foundation Electronics

Wednesday 22 May 2002 Morning Session

In addition to this paper you will require:
- a calculator;
- a pencil and a ruler.

Time allowed: 1 hour 30 minutes

Instructions
- Use a blue or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.
- A *Data Sheet* is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information
- The maximum mark for this paper is 72.
- Mark allocations are shown in brackets.
- Any correct electronics solution will gain credit.
- The paper carries 30% of the total marks for Electronics Advanced Subsidiary and 15% of the total marks for Advanced awards.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Data Sheet

- A perforated *Data Sheet* is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- Detach this sheet before you begin work.

Data Sheet

Resistors

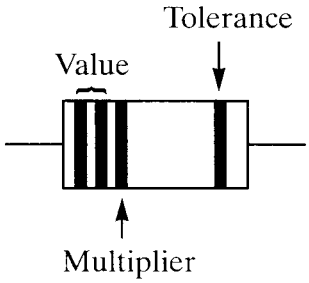
Preferred values for resistors (E24) series:
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 ohms and multiples that are ten times greater.

Resistor Printed Code (BS 1852)

This code consists of letters and numbers:
R means × 1
K means × 1000 (i.e. 10^3)
M means × 1 000 000 (i.e. 10^6)
Position of the letter gives the decimal point
Tolerances are given by the letter at the end of the code, F = ± 1%, G = ± 2%, J = ± 5%, K = ± 10%, M = ± 20%.

Resistor Colour Code

Number	Colour
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Grey
9	White



Tolerance, gold = ± 5%, silver = ± 10%, no band ± 20%.

Silicon diode

$V_F = 0.7\,V$

Silicon transistor

$V_{be} \approx 0.7\,V$ in the on state
$V_{ce} \approx 0.2\,V$ when saturated

Resistance

$R_T = R_1 + R_2 + R_3$ series

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ parallel

Capacitance

$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ series

$C_T = C_1 + C_2 + C_3$ parallel

Time constant

$T = CR$

ac theory

$I_{rms} = \frac{I_o}{\sqrt{2}}$

$V_{rms} = \frac{V_o}{\sqrt{2}}$

$X_C = \frac{1}{2\pi fC}$ reactance

$X_L = 2\pi fL$ reactance

$f = \frac{1}{T}$ frequency, period

$f_o = \frac{1}{2\pi\sqrt{LC}}$ resonant frequency

Turn over ▶

Operational amplifier

$G_V = \frac{V_{out}}{V_{in}}$ voltage gain

$G_V = -\frac{R_f}{R_1}$ inverting

$G_V = 1 + \frac{R_f}{R_1}$ non-inverting

$V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$ summing

Astable and Monostable using NAND Gates

$f \approx \frac{1}{2RC}$ astable

$T \approx RC$ monostable

555 Astable and Monostable

$T = 1.1RC$ monostable

$t_H = 0.7(R_A + R_B)C$
$t_L = 0.7R_BC$] astable

$f = \frac{1.44}{(R_A + 2R_B)C}$ two resistor circuit

Electromagnetic Waves

$c = 3 \times 10^8\ \text{m s}^{-1}$ speed in vacuo

List of BASIC Commands

DIM variable [(subscripts)]

DO [{**WHILE** | **UNTIL**} condition]
    [statement block]
LOOP

DO
    [statement block]
LOOP [{**WHILE** | **UNTIL**} condition]

FOR counter = start **TO** end [**STEP** increment]
    [statement block]
NEXT counter

GOSUB [label | line number]
    [statement block]
RETURN

IF condition **THEN**
    [statement block 1]
ELSE
    [statement block 2]

INKEY$

INP (port %)

INPUT [;] ["prompt" {;1, }] variable list (comma separated)

LPRINT [expression list] [{ ;1, }]

OUT port%, data%

PRINT [expression list] [{;1,}]

REM remark

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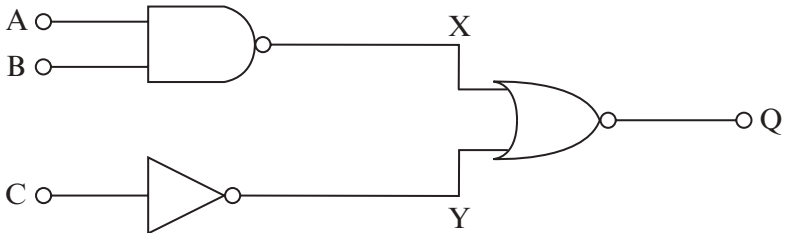
Answer **all** questions in the spaces provided.

1



(a) Write down Boolean expressions for the signals at points X, Y, and Q in terms of the inputs A, B, and C in this logic circuit.

X = ...

Y = ...

Q = ...

(5 marks)

(b) Complete the truth table below for the signals at X, Y, and Q in the logic circuit shown above.

A	B	C	X	Y	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 marks)

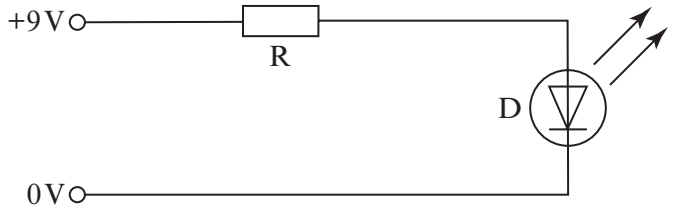
(c) What single logic gate would have the same function as the complete circuit?

.....

(1 mark)

10

2 An output indicator is designed using the components as shown in the circuit below.



(a) Name the type of component labelled D in this circuit .....
(1 mark)

(b) (i) A current of 20 mA through D produces 2 V across it.

Calculate the voltage across resistor R.

.....

(ii) State the current through R under these conditions.

.....

(iii) Calculate the value of R.

.....

(iv) Select an appropriate value for R from the E24 series if the current through D is not to exceed the value in (b)(ii).

.....

(v) Give the colour code for this resistor if the tolerance is 5%.

....

(vi) Resistors with the following power ratings are available:

0.125 W 0.25 W 0.5 W 1 W 2 W

Calculate the actual power dissipated in the resistor under these conditions. State which is the lowest acceptable power rating for the resistor.

.....

.....

.....

lowest acceptable power rating .....
(12 marks)

13

3 A circuit is designed to switch a lamp on as darkness falls. The input sub-system is shown in **Figure 1** together with an extract from the data sheet for the LDR in **Figure 2**.

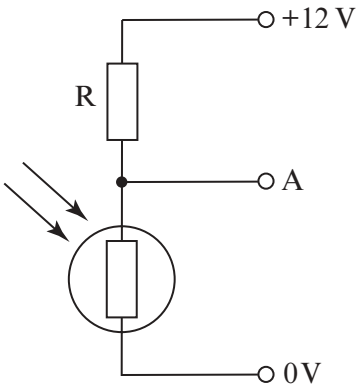


Figure 1

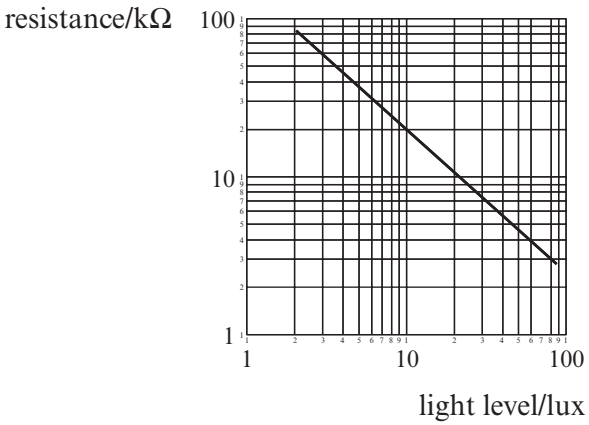


Figure 2

(a) (i) What is the LDR resistance in a light level of 10 lux?

.....

(ii) The LDR can reach a very low resistance in bright light, and it can be damaged by high currents. Calculate the value of R required to limit the current through the LDR to a maximum of 1 mA no matter how low the resistance of the LDR.

.....

.....

(iii) Calculate the voltage at point A in the circuit when the light level is 10 lux and R has the value calculated in (a)(ii).

.....

.....

(6 marks)

(b) The input sub-system in **Figure 1** is connected to an op-amp comparator circuit which gives a positive output to turn on an LED when darkness falls. Draw a circuit diagram of the whole system.

Component values are not required.

(4 marks)

Turn over ►

10

4 A solid state electronic switch is required to control a powerful 12 V 21 W lamp from the output of an op-amp comparator.

(a) Name **two** solid state *electronic devices* that can be used as a switch.

1. .....

2. .....

(2 marks)

(b) Draw a circuit diagram to show how **one** of these devices could be used to control the lamp. Label the terminals of your chosen electronic device, the input from the comparator and the lamp.

(5 marks)

(c) (i) What type of electromagnetic device could also be used to control the lamp?

.....

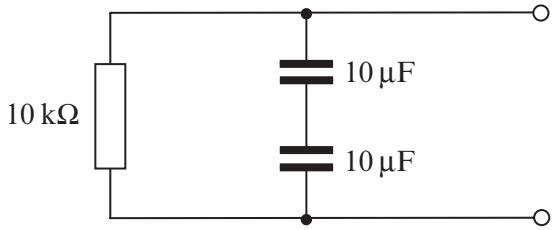
(ii) What other component would have to be connected to this device to protect the op-amp?

.....

(2 marks)

9

5



(a) (i) Calculate the combined capacitance of the **two** capacitors in the circuit above.

.....

.....

(ii) Calculate the time constant of the circuit above.

.....

.....

(3 marks)

(b) The circuit is initially charged up to 12 V.

(i) Calculate the time for the circuit to discharge to 6 V.

.....

(ii) Calculate the approximate time the circuit will take to discharge to 0 V.

.....

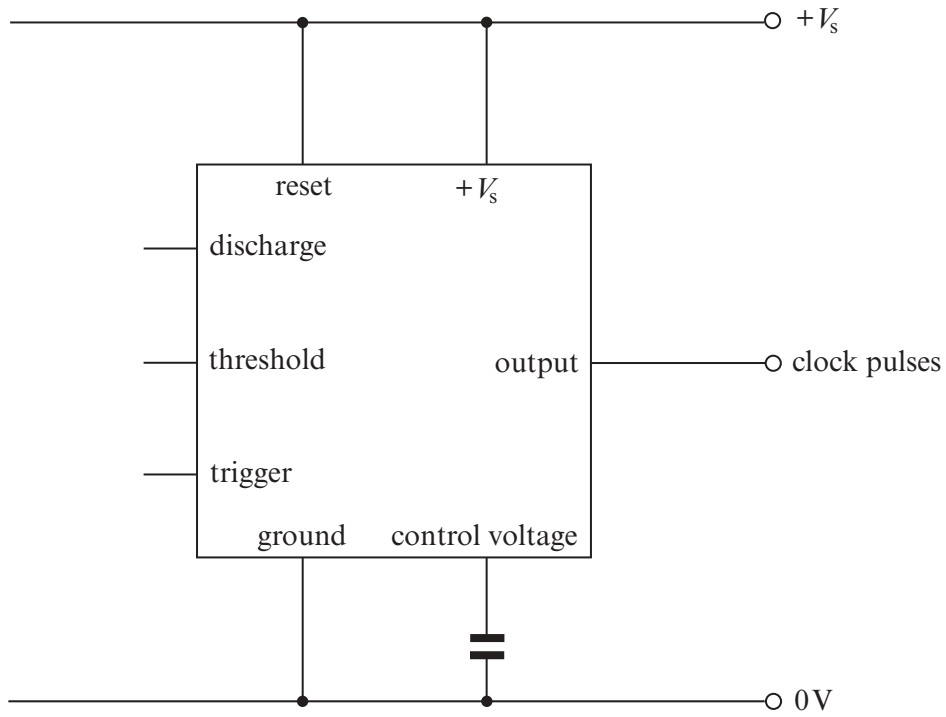
.....

(4 marks)

7

6 A 555 timer IC is used to produce clock pulses.

(a) Complete the diagram of the astable below, by adding **two** resistors R_A and R_B, and a capacitor C. Label the components you have added.



(3 marks)

(b) Calculate the frequency of the clock pulses if R_A is 1 kΩ, R_B is 10 kΩ, and C is 1 μF.

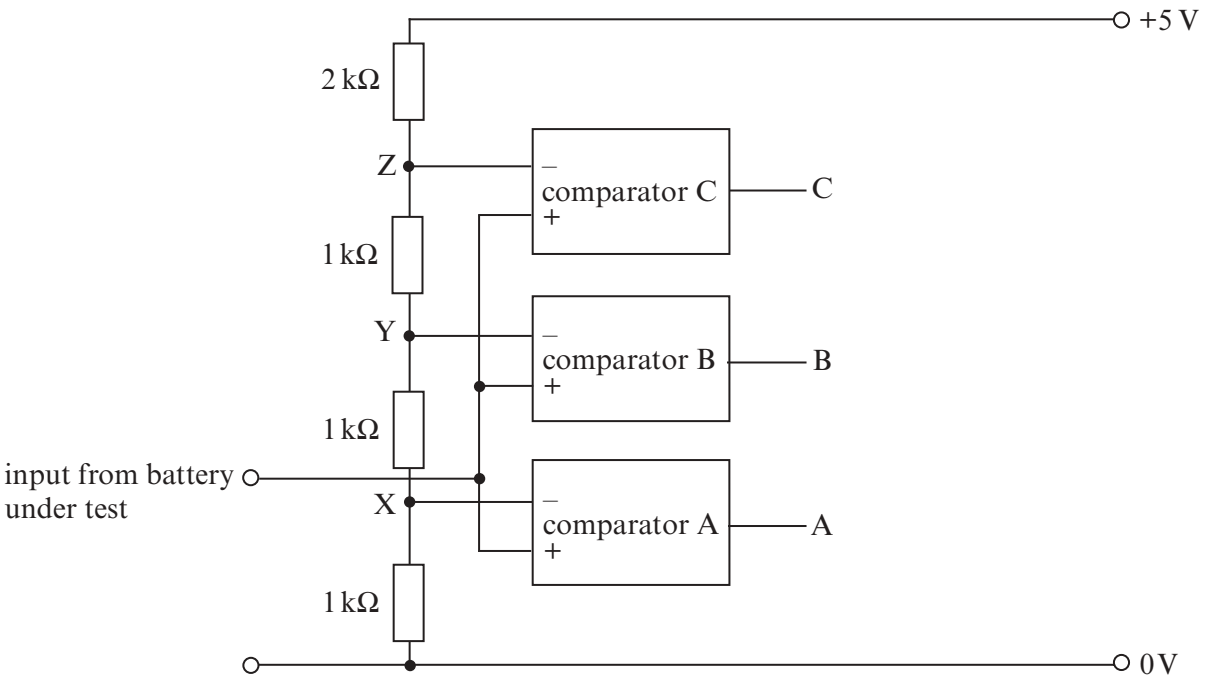
.....

.....

(2 marks)

5

7 The circuit below shows a battery tester which uses comparators to test the battery output against a series of set voltages.



(a) (i) Calculate the total resistance of the voltage divider formed by the four resistors.

.....

(ii) Calculate the current through the voltage divider.

.....

(iii) Calculate the voltages at X, Y, and Z.

X .....

Y .....

Z .....

(5 marks)

(b) Complete the table below to give the output states, **high** or **low** at A, B, and C for the input voltages given.

input voltage (V)	A	B	C
0.5			
1.5			
2.5			
3.5			

(4 marks)

Turn over ►

(c) A simple output sub-system is now added to the design that would light a line of LEDs as the input voltage rises. Show how this could be achieved by drawing suitable components on to the diagram on the previous page.

(3 marks)

(d) In an alternative indicator the comparator signals are first converted into a binary code, and then decoded to drive a display. The truth table below shows certain input logic levels R, S, and T. The output signals required for the decoder are labelled Q_1 and Q_2.

input levels			output signals	
R	S	T	Q_1	Q_2
0	0	0	0	0
1	0	0	0	1
1	1	0	1	0
1	1	1	1	1

(i) Write down a Boolean expression for Q_1.

.....

(ii) Write down a Boolean expression for Q_2.

.....

(iii) Complete the logic circuit diagram below using AND, OR and NOT gates only, that would give Q_1 and Q_2 from R, S, and T. Label Q_1 and Q_2.

R _____

S _____

T _____

(6 marks)

18

END OF QUESTIONS