Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

Leave blank

General Certificate of Education
June 2006
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS **ELE1**
Unit 1 Foundation Electronics

Tuesday 23 May 2006 1.30 pm to 3.00 pm

For this paper you must have:
- a calculator
- a pencil and ruler

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- 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.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- Any correct electronics solutions will gain credit.
- You are reminded of the need for good English and clear presentation in your answers.

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

Data Sheet

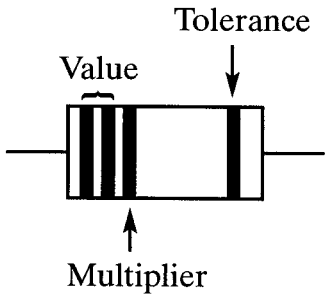
- A perforated *Data Sheet* is provided on pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- Detach this perforated sheet at the start of the examination.

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 $T = CR$

A.C. 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

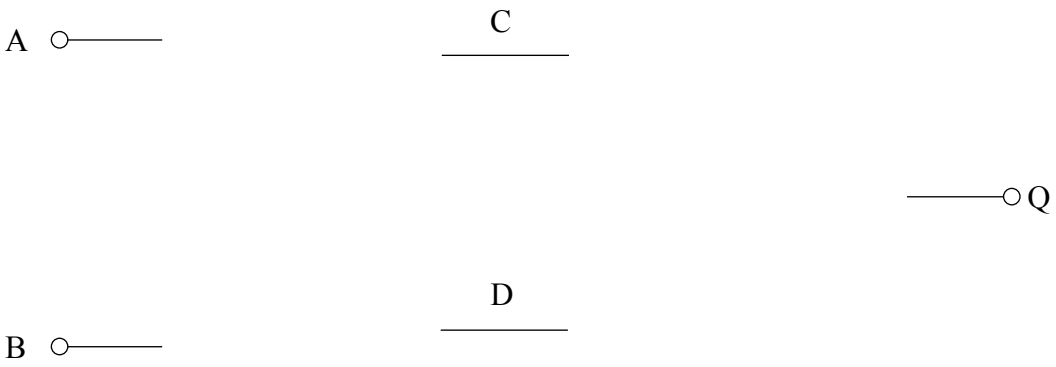
LEAVE MARGIN BLANK

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

1 The truth table for a logic circuit is shown below.

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

(a) Inputs A and B are both connected to two gates, having outputs C and D.
C and D then form the inputs to a third gate providing the output Q.
In the space below draw the logic circuit that would give these outputs.



(5 marks)

(b) Using the truth table above, write the simplest Boolean expression for the logic signals at C and D in terms of the inputs A and B.

C = ...

D = ...

(3 marks)

(c) Write the simplest Boolean expression for Q in terms of the inputs A and B.

Q = ...

(2 mark)

10

2 A student designs an electronic system to turn on a 12 V lamp for a fixed period of time when it gets dark.

(a) Choosing appropriate input, process, and output sub-systems, label the system diagram below to show a possible design for the lamp and its controller.

(5 marks)

(b) In which sub-system could

(i) an op-amp be used, ...

(ii) an LDR be used, ...

(iii) a MOSFET be used? .....

(3 marks)

(c) The whole system draws a current of 15 mA when the lamp is off. The current increases to 515 mA when the 12 V lamp is on.

Calculate

(i) the lamp current, ...

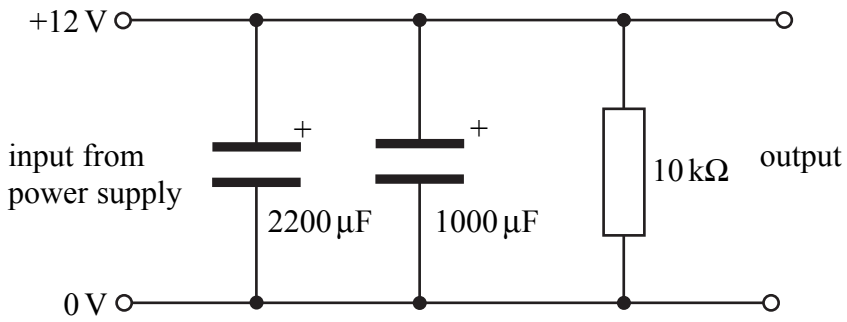
(ii) the power rating of the lamp. .....

.....

(3 marks)

11

3 Two capacitors are connected in parallel to smooth the output of a power supply. A resistor is connected across the capacitors to discharge them when the power supply is switched off.



(a) Calculate

(i) the current through the resistor when the power supply is on,

.....

(ii) the combined capacitance of the two capacitors,

.....

(iii) the time constant of this circuit, assuming there is no load connected to the output.

.....

.....

(5 marks)

(b) When the power supply is switched off, the capacitors will start to discharge. Assume no load is connected to the power supply output.

(i) How long will it take for the capacitors to discharge to 6 V?

.....

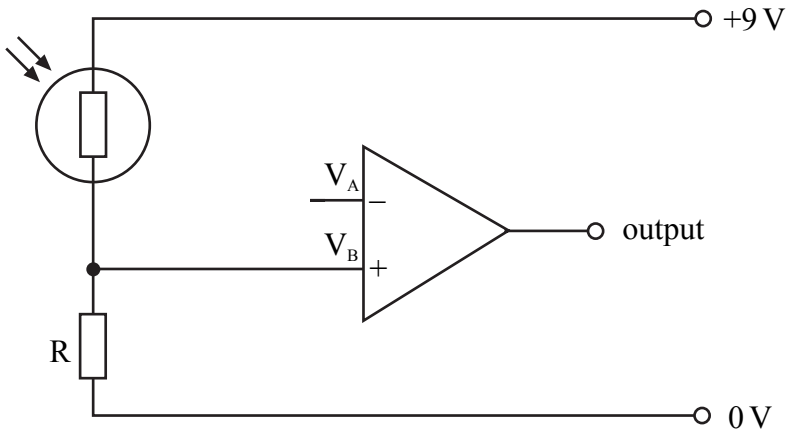
(ii) How long will it take for the capacitors to effectively totally discharge?

.....

(5 marks)

10

4 Part of a comparator circuit is shown below.



(a) The op-amp input V_A requires a reference voltage of 3 V.

(i) On the circuit diagram above draw **two** components and their connections to show how this is achieved.

(ii) Select suitable values for these components and mark these on the circuit diagram next to each component.

(4 marks)

(b) The LDR has a maximum power dissipation of 90 mW.

(i) Calculate the maximum current that could safely flow through the LDR if it had 9 V across it.

.....

(ii) Calculate the combined resistance of the LDR and R that would allow this current to flow.

.....

.....

(iii) The LDR has a minimum resistance of 100 Ω in very bright light. Calculate the value of R required if the current calculated in part (b)(i) is **not** to be exceeded.

.....

(iv) Choose a suitable value from the E24 series if the current limit is **not** to be exceeded.

.....

(5 marks)

(c) State the output voltage from the op-amp in the circuit diagram on **page 8** when $V_A > V_B$

(i) if an ideal op-amp is used, ...

(ii) if a real op-amp is used. .....

(2 marks)

(d) State the output voltage from the op-amp in the circuit diagram on **page 8** when $V_A < V_B$

(i) if an ideal op-amp is used, ...

(ii) if a real op-amp is used. .....

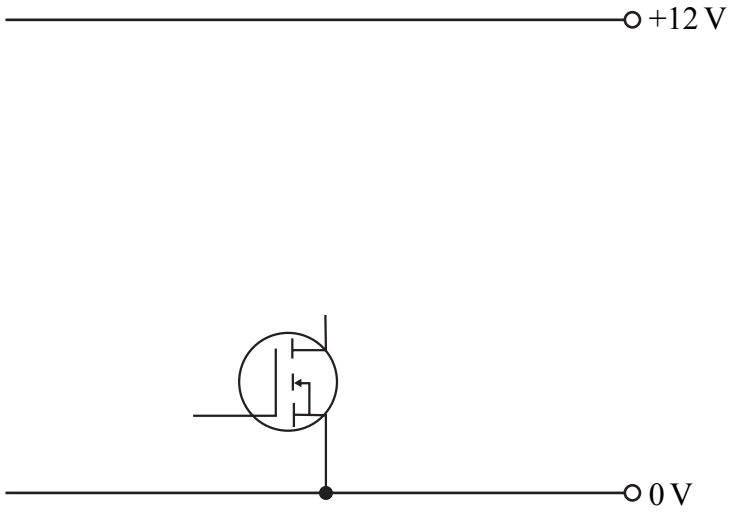
(2 marks)

13

Turn over for the next question

5 A MOSFET is used as a switch to control a motor connected to a 12 V supply. The motor is found to run too fast when switched directly to the supply by the MOSFET and a resistor R is placed in series with the motor to slow it down.

(a) (i) Complete the circuit diagram below to show how the motor and resistor are connected.



(ii) Draw on the circuit diagram above a component required to protect the MOSFET from the back emf generated by the motor. *(5 marks)*

(b) When running at the correct speed, the motor has 4 V across it and a current of 150 mA flowing through it.

(i) Calculate the voltage across R. .....

(ii) Calculate the required resistance of R. .....

.....

(iii) Calculate the power dissipated by R when the motor is running.

.....

(iv) Which is the closest value of resistance available from the E24 series for resistor R?

.....

(v) What will be the effect on the speed of the motor of using the preferred value in part (b)(iv) instead of the calculated value in part (b)(ii)?

.....

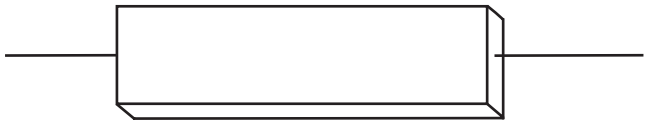
(vi) Choose a suitable power rating for this resistor from the ratings given below by circling the appropriate value.

0.5 W **1 W** **4 W** **7 W** **11 W**

(vii) What type of resistor construction would be best for this application?

.....

(viii) This type of resistor is most likely to have a BS1852 code printed on it for its value and tolerance. Write on the diagram below the code you would expect to see for its value and 5% tolerance.



(ix) What physical factor should you consider when mounting this component on a circuit board?

.....

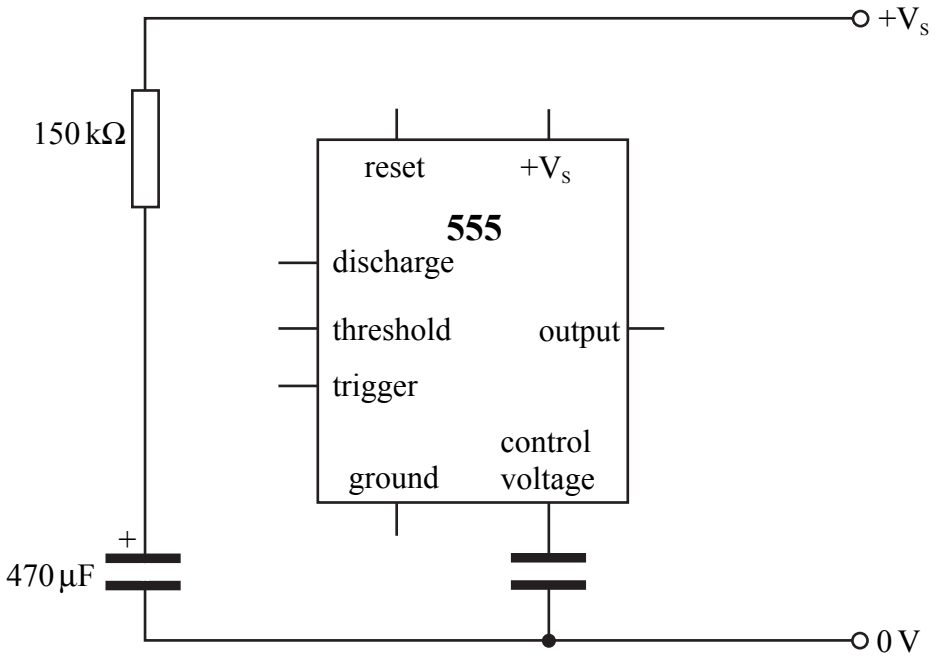
(13 marks)

18

Turn over for the next question

6 A 555 monostable circuit is used to control the time for which a lamp is on.

(a) Complete the circuit diagram below to show how the 555 timer IC is connected as a monostable. Label the input to this circuit.



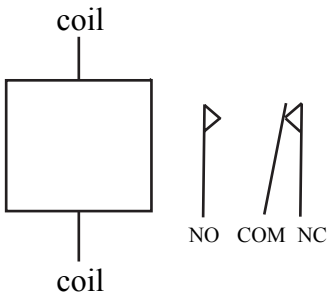
(6 marks)

(b) Calculate the time period of the output pulse from the monostable.

.....

(2 marks)

(c) The current drawn by the lamp is too high for it to be connected directly to the 555 IC output.
The electromagnetic relay shown below is used.



The coil is powered when the monostable output goes high.
Which **two** connections would be used to switch on the lamp?

..... and .....

(2 marks)

END OF QUESTIONS

10