Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2008
Advanced Level Examination

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS **ELE5**
Unit 5 Communications Systems

Tuesday 10 June 2008 1.30 pm to 3.00 pm

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

Time allowed: 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be 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 electronic solution will gain credit.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Question	Mark	Question	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 as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

Data Sheet

Resistors

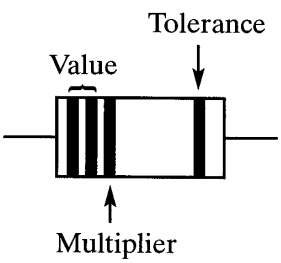
Preferred values for resistors (E24) series:
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 ohms and multiples that are ten times greater.

Resistor Printed Code (BS 1852)

This code consists of letters and numbers:
R means $\times 1$
K means $\times 1000$ (i.e. 10^3)
M means $\times 1\,000\,000$ (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

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

$c = 3 \times 10^8\ m\,s^{-1}$ 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, }]

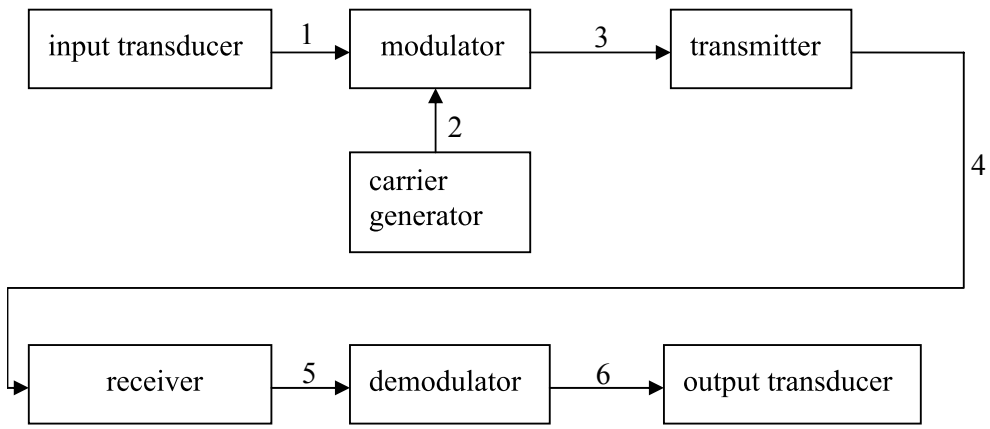
OUT port%, data%

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

REM remark

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

1 A block diagram of a generalized radio communication system is shown below. The signal transfers between stages have been numbered.



Which numbered line represents:

1 (a) (i) an unmodulated radio frequency signal .....

1 (a) (ii) a modulated radio frequency signal in the transmitter .....

1 (a) (iii) a modulated radio frequency signal in the receiver .....

1 (a) (iv) the transmission link .....

1 (a) (v) the information signal in the transmitter .....

1 (a) (vi) the information signal in the receiver?.....

(6 marks)

1 (b) (i) Name **two** different non-wired transmission media.

.....

.....

1 (b) (ii) Name **two** different wired transmission media.

.....

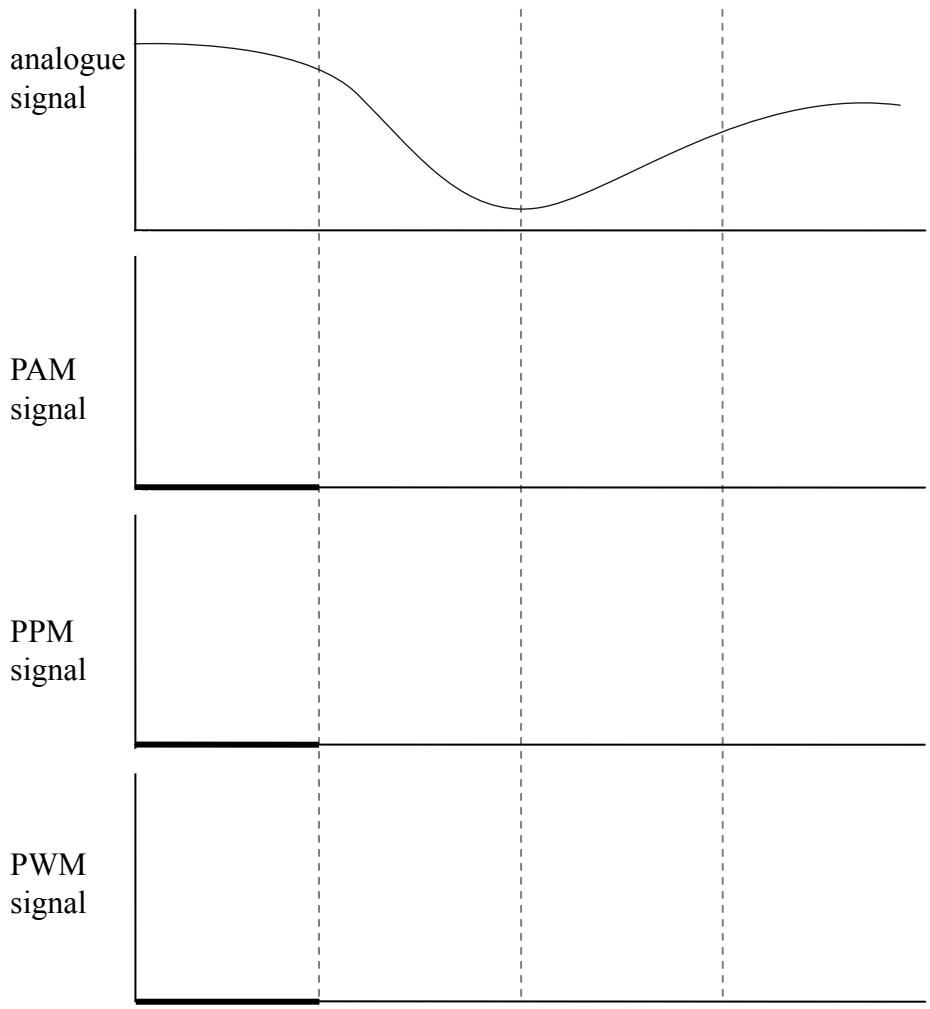
.....

(4 marks)

10

2 (a) The analogue signal shown below is to be converted into various different pulse modulated signals.

Draw on the labelled axes below the resulting digital signals when the analogue signal shown is converted at the sampling points, indicated by the dotted lines on the graphs.



(6 marks)

2 (b) In converting the analogue signal to a digital signal, what process or subsystem is used to retain the amplitude of the analogue signal while it is converted?

.....

(1 mark)

The sampling rate in an ADC system is 10 kHz. The analogue signal must first be filtered to ensure the correct operation of the ADC.

2 (c) (i) What type of filter must be used?

.....

2 (c) (ii) What is the maximum analogue signal frequency that should be used in this system?

.....

2 (c) (iii) The ADC produces an eight-bit parallel output. What subsystem is required to make the output suitable for transmission along a co-axial cable?

.....

2 (c) (iv) Calculate the bit rate of the resulting signal.

.....

.....

2 (c) (v) A start bit, two stop bits and a single parity bit are added to each byte of data from the ADC.
Explain the purpose of adding these bits.

.....

.....

.....

2 (c) (vi) Calculate the baud rate of the resulting digital signal.

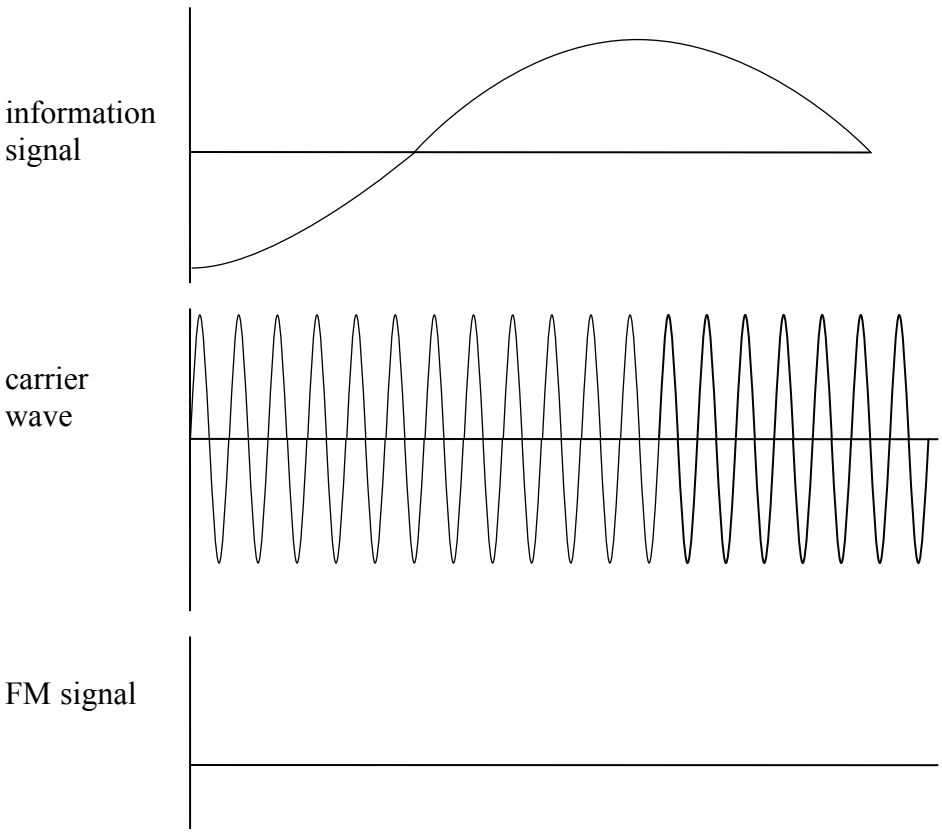
.....

.....

(6 marks)

13

3 (a) An information signal and a carrier wave are shown on the axes below. On the lowest set of axes, show how these combine to form a FM signal.



(3 marks)

3 (b) The information signal has a maximum frequency of 15 kHz, the maximum frequency deviation of the carrier is ± 75 kHz.

3 (b) (i) Calculate the practical bandwidth of the resulting FM signal.

.....

3 (b) (ii) If the channel spacing is 200 kHz on the 88 – 108 MHz VHF band, calculate the number of channels available.

.....

3 (b) (iii) Calculate the length required for a half-wave dipole if the signal frequency is 90 MHz.

.....

(6 marks)

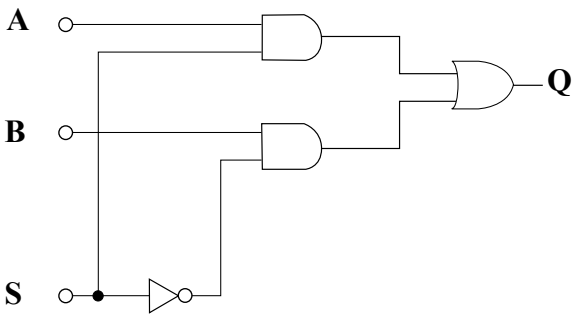
3 (c) Describe an advantage FM has over AM.

.....

(1 mark)

10

4 The diagram shows a 2 to 1 data multiplexer.



4 (a) Complete the output column **Q** in the truth table for this logic system.

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

(4 marks)

4 (b) Write the simplest Boolean expression for the output **Q**, in terms of **A**, **B** and **S**.

.....

.....

(3 marks)

4 (c) Describe the function of the input signal **S** and explain a practical application of this system.

.....

.....

.....

(3 marks)

4 (d) (i) What type of signal multiplexing does this system provide?

.....

4 (d) (ii) Name another type of signal multiplexing.

.....

(2 marks)

5 An optical fibre for a telephone system is laid along a path involving several bends in the fibre.

5 (a) (i) State the process by which the signal can travel along the fibre even though it is laid along a curved path.

.....

.....

5 (a) (ii) State **two** advantages of the use of optical fibres in a telephone system.

1 .....

.....

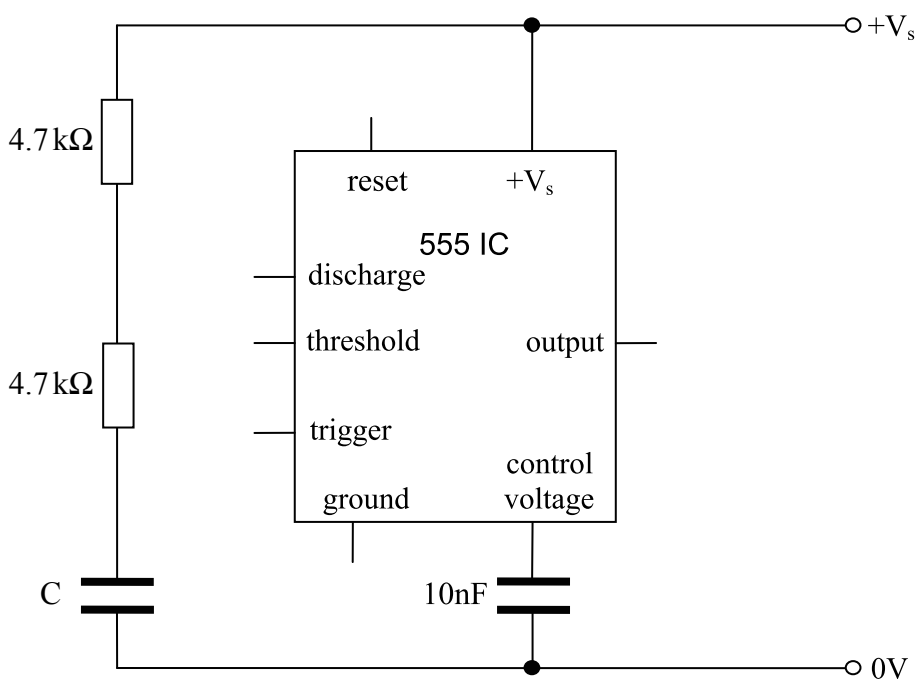
2 .....

.....

(3 marks)

5 (b) A 555 IC is used as an astable to produce pulses for transmission along the optical fibre system.

5 (b) (i) Complete the circuit diagram to show how the IC is connected as an astable.



5 (b) (ii) The output pulse frequency of the monostable is 50 kHz. Calculate the value of C required for this, given the values of the resistors marked on the circuit diagram on **page 10**.

.....

.....

(9 marks)

5 (c) A fibre optic receiver system is now designed.

5 (c) (i) Name an input device that can be used to convert rapid pulses of light from the fibre into an electrical signal.

.....

5 (c) (ii) The input device has a very high source resistance and gives a weak signal. What type of op-amp circuit is required to boost the signal?

.....

5 (c) (iii) Draw a diagram of the type of circuit in part (c) (ii) in the space below. Label its input, output and any components required to make it function.

5 (c) (iv) What property of an op-amp is important when used in the optical receiver if it has to operate with high frequency pulses?

.....

(6 marks)

18

Turn over for the next question

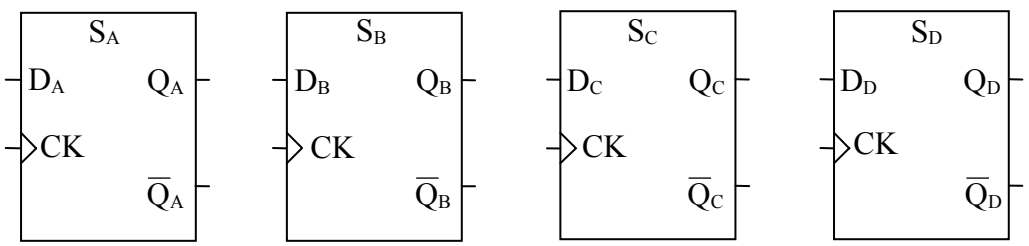
6 A mobile phone system receives PCM serial data which is converted to parallel data and fed through a DAC to drive the earpiece.

6 (a) (i) What does DAC stand for? .....

6 (a) (ii) What does PCM stand for? .....

(2 marks)

6 (b) D-type flip-flops can be used as a shift register to convert serial data into parallel data. Add to the circuit diagram below to show how serial data could be converted into parallel data. Label the serial data input and all the parallel data outputs.
Add wire links and label the other input signal required by the shift register to function in this way.



(5 marks)

6 (c) (i) The mobile phone system can operate with eight users on each available channel. The base station uses six channels including the administration channel. How many mobile phone users can be accommodated in the cell of the base station.

.....

.....

6 (c) (ii) Draw and label the diagram below to show how data from each of the eight users is combined onto a single channel.

(2 marks)

END OF QUESTIONS