Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS ELE5
Unit 5 Communications Systems

Thursday 30 June 2005 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 blue or black ink or ball-point pen. Use pencil for drawing.
- 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 20% of the total marks for Electronics Advanced Level award.
- 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

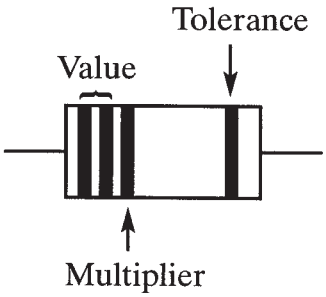
- A perforated *Data Sheet* is provided on pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- Detach this perforated sheet at the start of the examination.

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 $\times 1$
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

$$R_T = R_1 + R_2 + R_3 \quad \text{series}$$

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

Capacitance

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

$$C_T = C_1 + C_2 + C_3 \quad \text{parallel}$$

Time constant $T = CR$

A.C. theory

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

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

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

$$X_L = 2\pi fL \quad \text{reactance}$$

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

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

Turn over ▶

Operational amplifier

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

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

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

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

Astable and Monostable using NAND Gates

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

$$T \approx RC \quad \text{monostable}$$

555 Astable and Monostable

$$T = 1.1RC \quad \text{monostable}$$

$$\left.\begin{aligned} t_H &= 0.7(R_A + R_B)C \\ t_L &= 0.7R_BC \end{aligned}\right] \quad \text{astable}$$

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

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,}]

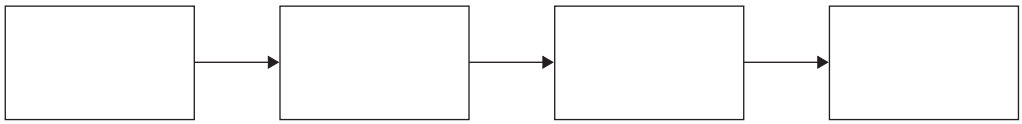
REM remark

TURN OVER FOR THE FIRST QUESTION

LEAVE MARGIN BLANK

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

1 (a) Label the block diagram of a simple radio receiver shown below.



(4 marks)

(b) The receiver in part (a) is tuned to a carrier frequency of 0.6 MHz.

Calculate:

(i) the wavelength of the carrier waves;

.....

.....

(ii) the length of a half-wave dipole for this frequency;

.....

.....

(iii) the value of inductance, L, required if a 500 pF capacitor is used to tune to this frequency.

.....

.....

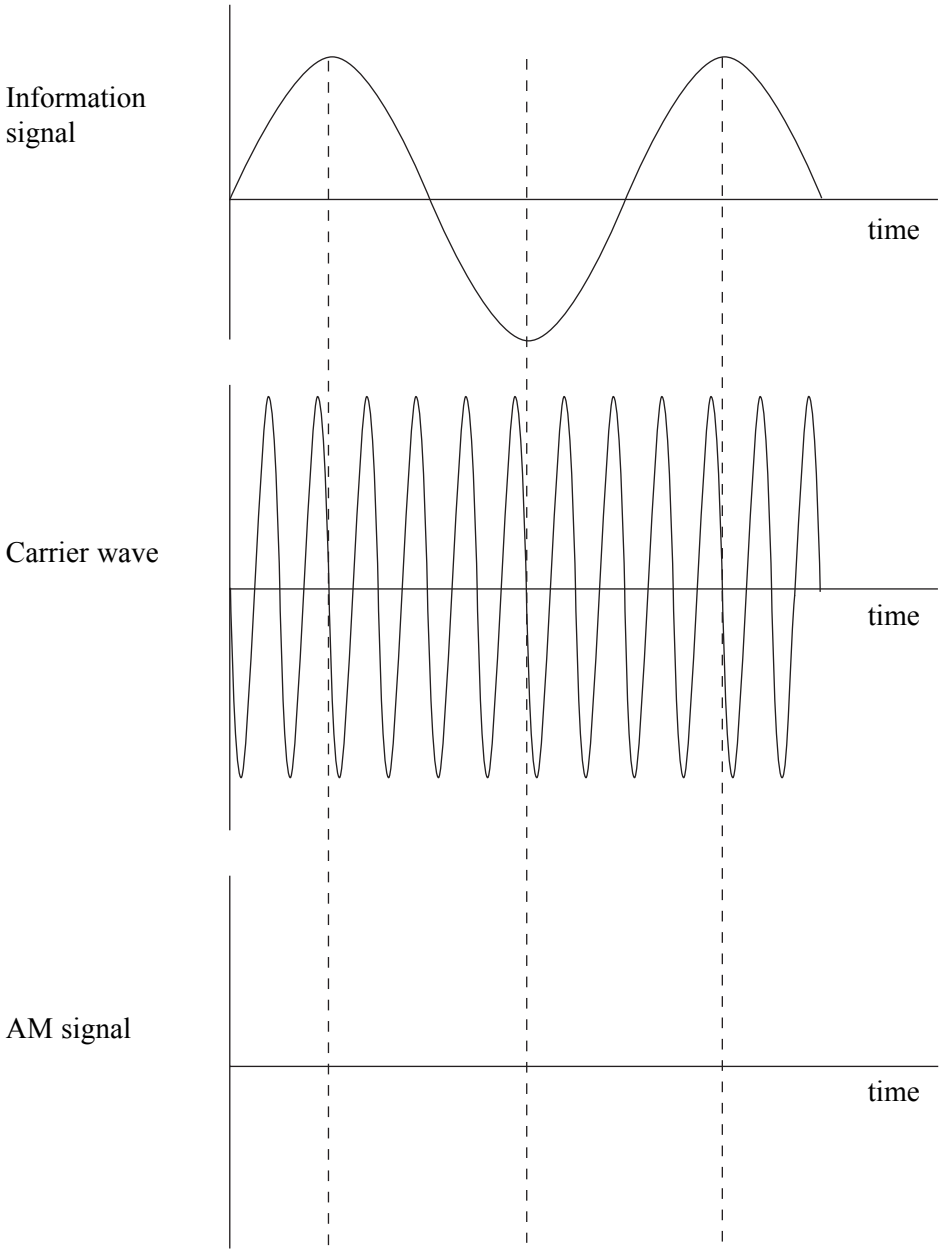
.....

.....

(6 marks)

10

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



(4 marks)

(b) The information signal has a range of frequencies from 300 Hz to 4 kHz.
Calculate the bandwidth of the resulting AM signal.

.....

.....

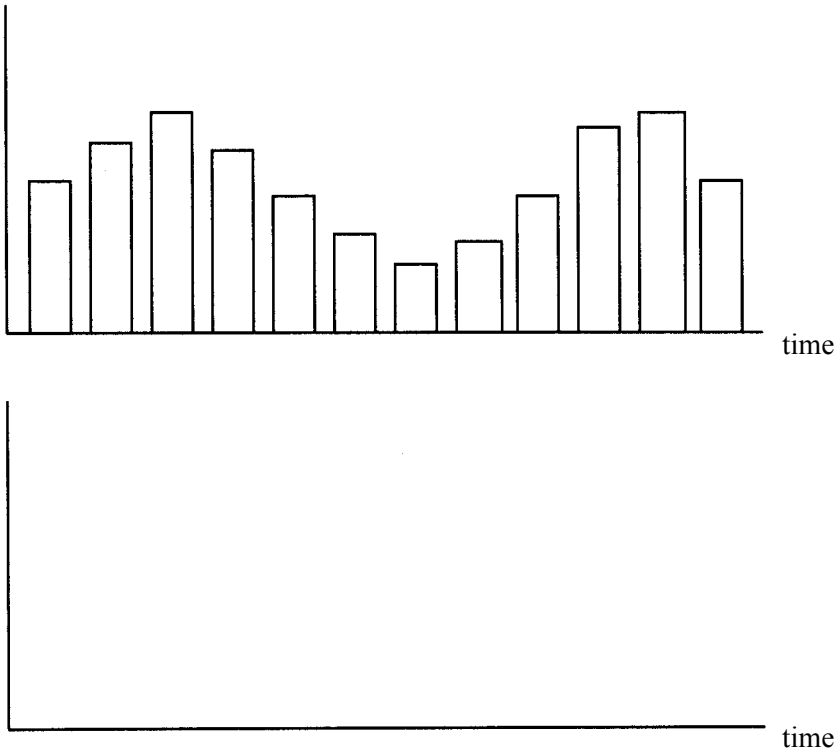
(2 marks)

6

Turn over ▶

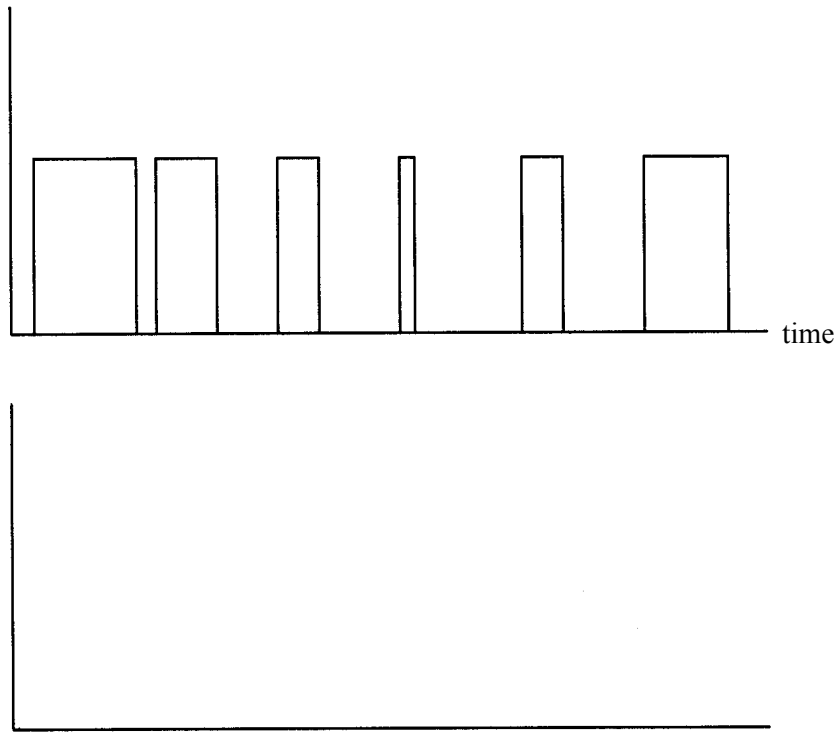
3 Several pulse modulated digital signals are shown below. For each signal draw, on the axes below it, the corresponding analogue signal that would be obtained after demodulation.

(a) PAM signal



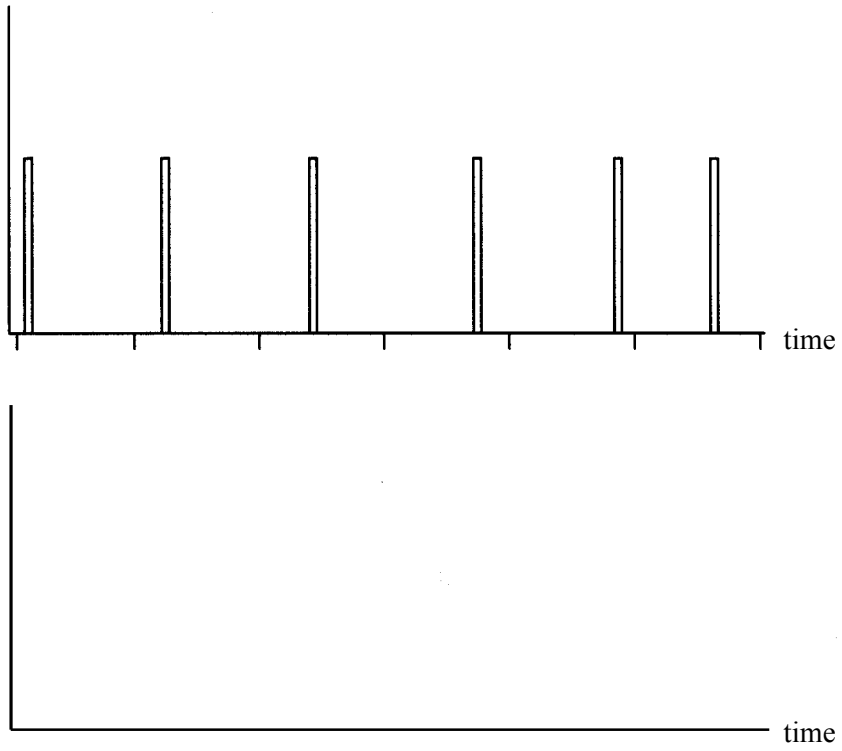
(2 marks)

(b) PWM signal



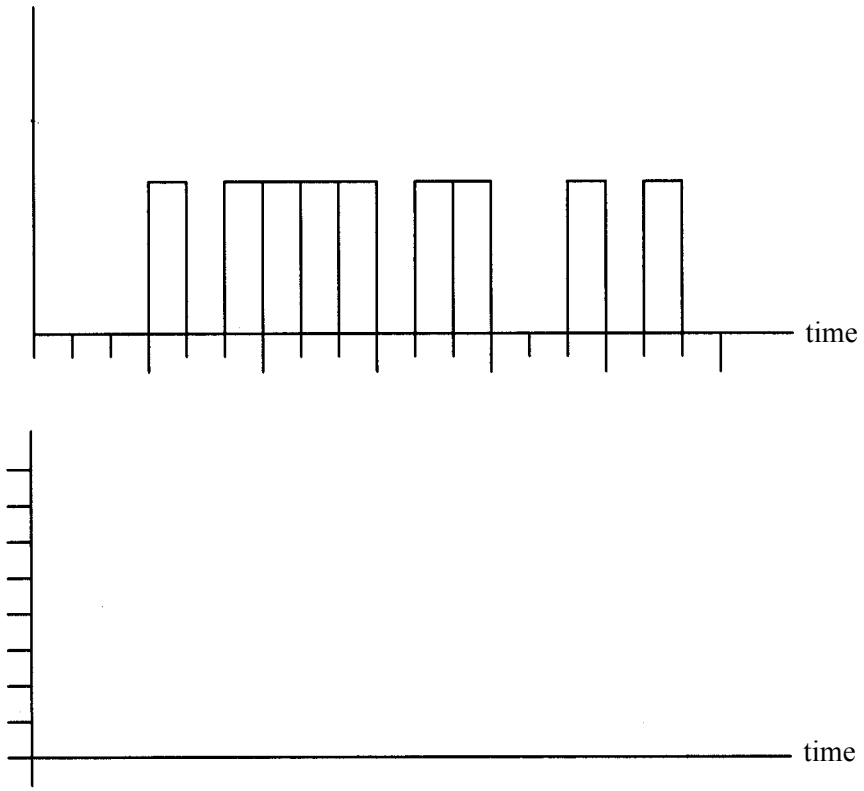
(2 marks)

(c) PPM signal



(3 marks)

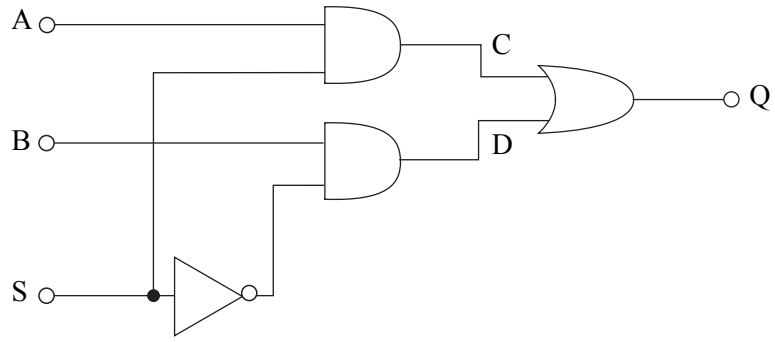
(d) 3-bit PCM signal



(3 marks)

10

4 A digital communications system uses the 2 input data multiplexer shown below.



(a) Complete the truth table for this logic system.

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

(4 marks)

(b) Write Boolean expressions using variables A, B and S, for:

(i) C .....

(ii) D .....

(iii) Q .....

(4 marks)

8

5 (a) Draw and label a diagram of a cross-section through a step-index optical fibre.

(2 marks)

(b) (i) By what process do signals travel along curved sections of the optical fibre?

.....

(ii) Name an output transducer that would be suitable for sending a signal along an optical fibre.

.....

(iii) Name an input transducer that would be suitable for converting the signal from an optical fibre into an electrical signal.

.....

(4 marks)

(c) Describe the effect on an optical signal of:

(i) attenuation;

.....

.....

(ii) dispersion.

.....

.....

(2 marks)

(d) State and explain an advantage of using optical fibres in a communications system rather than wires.

.....

.....

.....

(2 marks)

10

6 A system using op-amp active filter circuits is designed to boost the information signal for a transmitter. The information signal should only contain frequencies from 300 Hz to 4 kHz.

(a) The op-amp used has a gain-bandwidth product of 1 MHz.
Calculate the maximum gain that could be obtained at 4 kHz.

.....

.....

(2 marks)

(b) The system is made using a bass cut filter with a break point frequency of 300 Hz feeding a treble cut filter with a break point frequency of 4 kHz. The resulting output is then amplified by a factor of ten. Draw and label a system block diagram to show all these sub-systems. Include in your diagram the input and output.

(3 marks)

(c) Draw the circuit of a non-inverting amplifier that would amplify the signal by a factor of 10. Label the input and the output, give values for the components used.

(5 marks)

(d) (i) Draw the circuit of the active bass cut filter with $R_1 = 10k\Omega$, $R_f = 100k\Omega$, and capacitor C.

(ii) Given that the reactance of C is the same as the value of R_1 at the break point frequency, or otherwise, calculate the value of C to give the required 300 Hz break point frequency.

.....

.....

.....

(iii) It is then realised that both filters can be made in the same circuit.
Add one capacitor to your diagram in part (d) (i) in the correct place that would also make the circuit into a treble cut filter. Label the capacitor T.

(8 marks)

18

7 (a) How does the signal from a mobile telephone reach the base station?

.....

(1 mark)

(b) Each channel frequency allows eight conversations to take place at the same time.

(i) What type of multiplex system allows this?

.....

(ii) A base station uses sixteen channels. How many users can make calls through this base station at any one time?

.....

(iii) Each mobile phone channel has a bandwidth of 200 kHz.
Calculate the effective bandwidth available to each user.

.....

(5 marks)

(c) Mobile phone signals are digital. When a weak signal is received it is processed by a regenerator.
Describe the process of regeneration of a noisy digital signal.
State what type of sub-system is used and explain briefly how it operates.

.....

.....

.....

.....

(4 marks)

10

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

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