Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Education
June 2007
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS **ELE5**
Unit 5 Communications Systems

Tuesday 12 June 2007 1.30 pm to 3.00 pm

For this paper you must have:
- a calculator
- a pencil and a 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 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 electronics 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		7	
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.
- Detach this perforated sheet at the start of the examination.

Data Sheet

Resistors

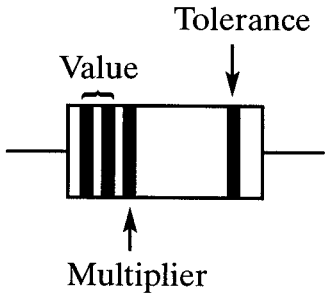
Preferred values for resistors (E24) series:
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 ohms and multiples that are ten times greater.

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

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

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

1 (a) A simple radio receiver uses the following subsystems:

af amplifier, antenna, detector/demodulator, loudspeaker, tuned circuit.

Draw a labelled block diagram to show how these subsystems are connected.

(*4 marks*)

(b) The receiver in part (a) is tuned to a carrier frequency of 600 kHz.
Calculate

(i) the wavelength of the carrier waves,
(c, speed of electromagnetic waves in vacuo, is $3 \times 10^8 \, m \, s^{-1}$)

.....

.....

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

.....

(3 marks)

7

2 The audio amplifier subsystem in a radio receiver consists of two stages, an op-amp voltage amplifier, followed by a push-pull output stage.

(a) The op-amp voltage amplifier has an input resistance of 10 kΩ and a voltage gain of –10.

(i) Calculate the value of the feedback resistor required.

.....

(ii) Draw the circuit of the voltage amplifier stage. Label the components with their values and mark its input and output.

(*4 marks*)

(b) The push-pull output stage uses a p-channel and an n-channel MOSFET.

(i) What type of amplification does this stage give?

.....

(ii) Draw the circuit of this stage labelling the p-channel and n-channel MOSFETs, and mark the input and output.

(iii) The MOSFETs operate at high power. On what must they be mounted?

.....

(8 marks)

12

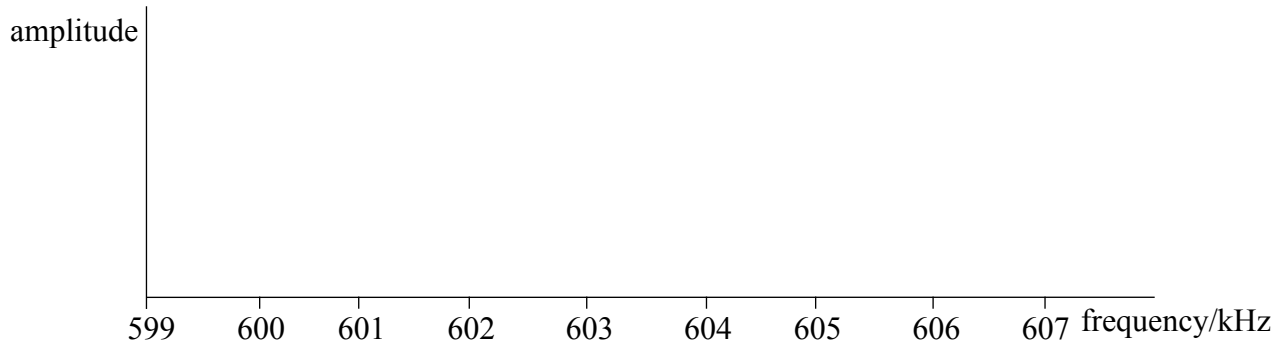
3 A transmitter has a carrier frequency of 603 kHz and is amplitude modulated by an audio frequency signal which occupies a frequency range from 300 Hz to 3 kHz.

(a) In which broadcast waveband would the modulated signal appear?

.....

(1 mark)

(b) Draw a frequency spectrum diagram of the modulated signal to show the carrier and sidebands. Label all the features of the spectrum and draw all the components of the spectrum in their correct locations.



(*5 marks*)

(c) Calculate the bandwidth of the modulated signal.

.....

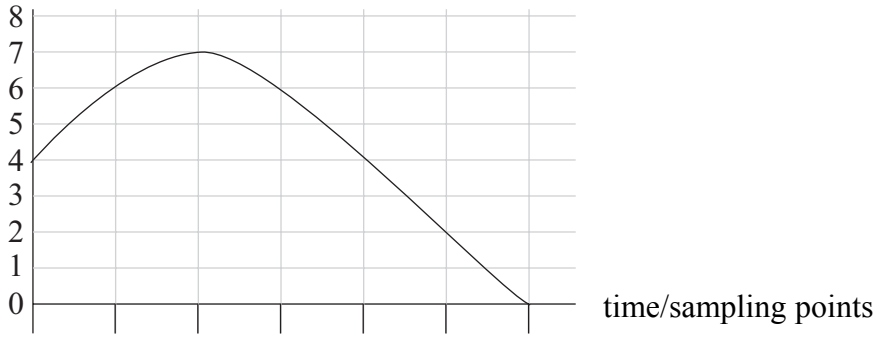
(1 mark)

7

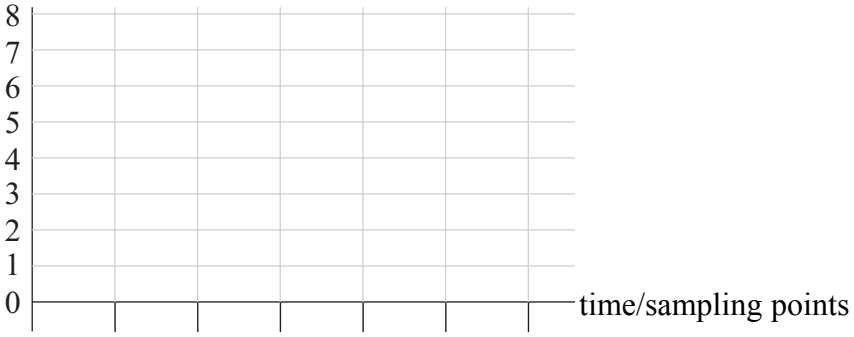
Turn over for the next question

4 The analogue signal shown below is to be converted into different types of pulse modulated signal.
In each case, show how the analogue signal would be represented as the given type of pulse modulated signal.

analogue signal

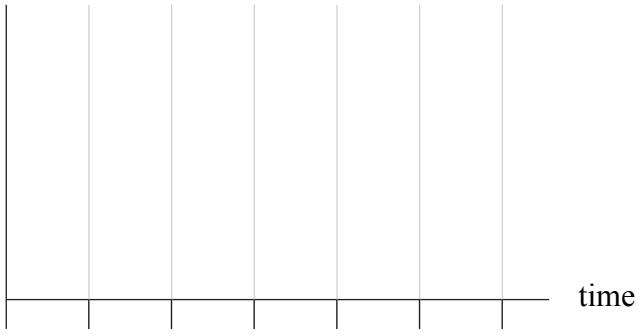


(a) PAM signal



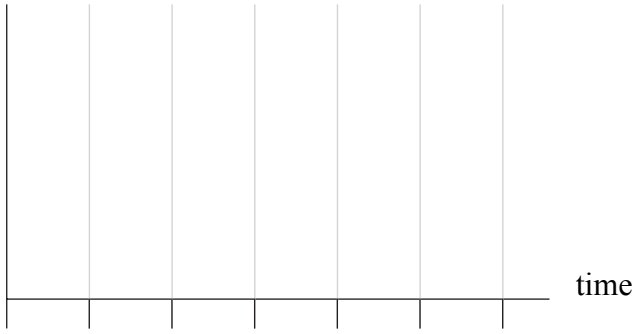
(2 marks)

(b) PWM signal



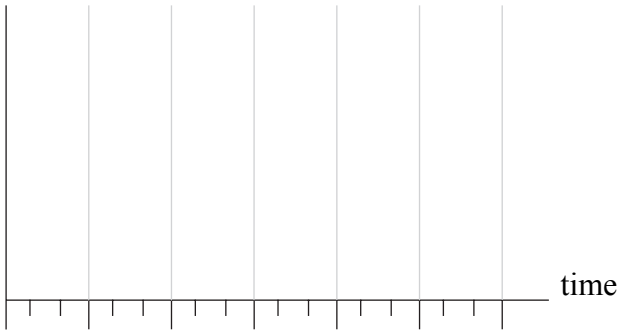
(2 marks)

(c) PPM signal



(*3 marks*)

(d) 3-bit PCM signal

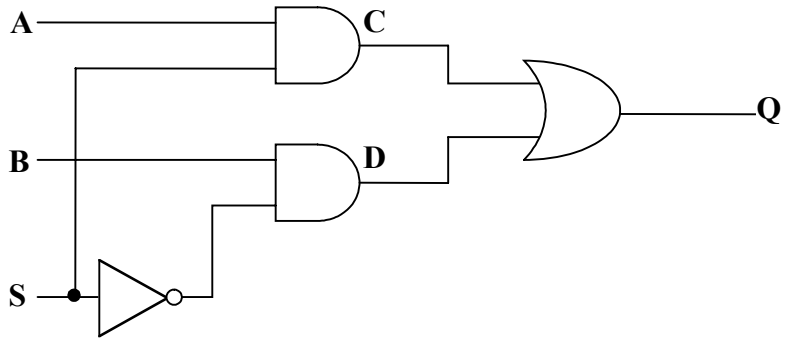


(3 marks)

10

Turn over for the next question

5 A logic diagram for a 2-input data multiplexer system is shown below.



(a) Write Boolean expressions in terms of **A**, **B** and **S**, for:

(i) **C** = ...

(ii) **D** = ...

(iii) **Q** = ...

(*4 marks*)

(b) Convert this logic system into one which uses **four** NAND gates and has the same function. Draw the converted system below.

(*4 marks*)

(c) Give **two** practical advantages that are gained by using the converted system.

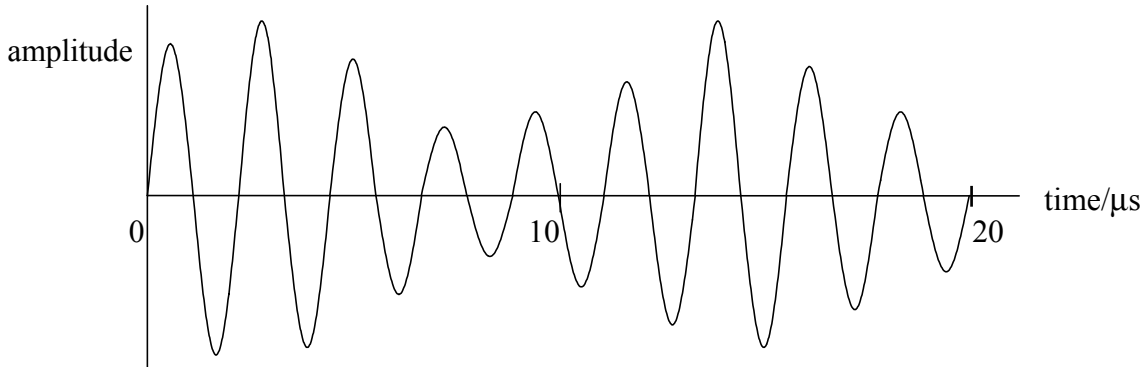
.....

.....

(2 marks)

10

6 The input signal to the demodulator of a superheterodyne radio receiver is shown below.



(a) Calculate the period and frequency of the carrier wave in the input signal to the demodulator.

Period .....

.....

Frequency .....

.....

(3 marks)

(b) Draw on the graph above the output signal from the demodulator. *(2 marks)*

(c) The local oscillator of the superheterodyne radio receiver contains a 100 μH coil and a variable capacitor set to 100 pF.

Calculate

(i) the frequency of the local oscillator signal,

.....

.....

(ii) a frequency to which the superheterodyne receiver would respond if it had an intermediate frequency of 455 kHz.

.....

(3 marks)

8

7 (a) Draw a labelled diagram of a curved length of a step-index optical fibre. Include on your diagram the path of a ray of light travelling through the fibre.

(*4 marks*)

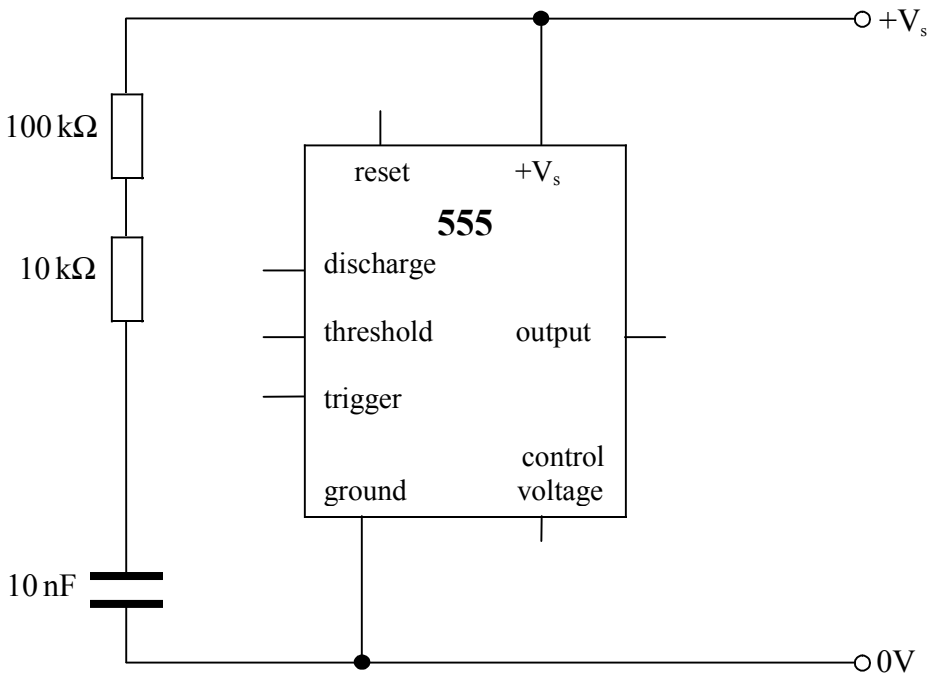
(b) Name an output device which can be used to create pulses that will travel through the fibre.

.....

(1 mark)

(c) A 555 timer IC is used as an astable to generate pulses for a fibre optic system.

(i) Complete the circuit diagram to show how the IC is connected as an astable and label the connection to the output device.



(ii) Calculate the frequency of the output pulses.

.....

.....

.....

(iii) Calculate the time period during which the output pulse gives a logic 0.

.....

.....

(8 marks)

(d) An optical fibre system can be used to carry signals from a mobile telephone base station to the rest of the telephone network.

(i) How do signals from the mobile telephone travel to the base station?

.....

(ii) Explain how the mobile telephone network can support almost the entire population of this country using mobile telephones when only a restricted frequency allocation is available.

Credit will be given for using relevant technical terms in your answer.

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.....

.....

.....

(5 marks)

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END OF QUESTIONS

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