| Candidate Name | Centre Number | Candidate Number |
|---|---|---|
| | | |

**WELSH JOINT EDUCATION COMMITTEE**
**General Certificate of Education**
**Advanced**

**CYD-BWYLLGOR ADDYSG CYMRU**
**Tystysgrif Addysg Gyffredinol**
**Uwch**

384/01

# ELECTRONICS

## ET4

P.M. TUESDAY, 24 January 2006

($1\frac{1}{4}$ hours)

## ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator.

## INSTRUCTIONS TO CANDIDATES

Write your name, centre number, and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

## INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

Your attention is drawn to the Information for the Use of Candidates on pages 2 and 3 of this paper.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

| For Examiner's use only. | |
|---|---|
| **1** | |
| **2** | |
| **3** | |
| **4** | |
| **5** | |
| **6** | |
| **7** | |
| Total | |

## INFORMATION FOR THE USE OF CANDIDATES

**Preferred Values for resistors**
The figures shown below and their decade multiples and sub-multiples are the E24 series of preferred values.

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

| | | |
|---|---|---|
| **RC networks** | $V_C = V_O\,(1 - e^{-t/RC})$ | for a charging capacitor |
| | $V_C = V_O\,e^{-t/RC}$ | for a discharging capacitor |
| | $t = -RC\ 1n\left(1 - \frac{V_c}{V_o}\right)$ | For a charging capacitor |
| | $t = -RC\ 1n\left(\frac{V_c}{V_o}\right)$ | For a discharging capacitor |
| **Alternating Voltages** | $V_o = V_{rms}\sqrt{2}$ | |
| | $X_C = \frac{1}{2\pi fC}$ | Capacitive reactance |
| | $X_L = 2\pi fL$ | Inductive reactance |
| | $f_0 = \frac{1}{2\pi\sqrt{LC}}$ | Resonant frequency |
| | $f_{co} = \frac{1}{2\pi RC}$ | Cut-off frequency for high pass and low pass filters |
| | $\phi = \tan^{-1}\frac{R}{X_C}$ | |
| **Silicon Diode** | $V_F \approx 0{\cdot}7V$ | |
| **Bipolar Transistor** | $h_{FE} = \frac{I_C}{I_B}$ | Current gain |
| | $V_{BE} \approx 0{\cdot}7V$ | in the on state |
| **MOSFETs** | $I_D = g_M V_{GS}$ | |

**Operational amplifier**

$$G = -\frac{R_F}{R_{IN}}$$ Inverting amplifier

$$G = 1 + \frac{R_F}{R_1}$$ Non-inverting amplifier

$$V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$$ Summing amplifier

$$\text{Slew Rate} = \frac{\Delta V_{OUT}}{\Delta t}$$ Slew rate

$$V_{OUT} = V_{DIFF}\left(\frac{R_F}{R_1}\right)$$ Difference amplifier

$$V_L \approx V_Z\left(1 + \frac{R_F}{R_1}\right)$$ Stabilised power supply

**Power Amplifier**

$$P_{MAX} = \frac{V_S^2}{8R_L}$$ where $V_S$ is rail-to-rail voltage

**555 Monostable**

$$T = 1{\cdot}1\ RC$$

**555 Astable**

$$t_H = 0{\cdot}7\ (R_A + R_B)C$$

$$t_L = 0{\cdot}7\ R_B C$$

$$f = \frac{1{\cdot}44}{(R_A + 2R_B)C}$$

**Schmitt Astable**

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



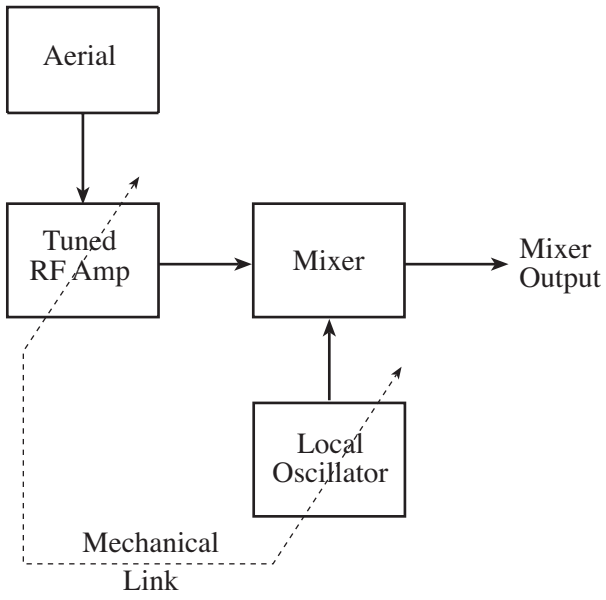
**Turn over.**

**1.** The following words/phrases are frequently used when discussing communication systems. Match the correct word/phrase to the descriptions in the table below: [5]

*modulation noise carrier multiplexer distortion demodulation demultiplexer time division multiplexing frequency division multiplexing*

| Correct word / phrase | Description |
|---|---|
| | A device for redirecting a number of digital channels from a single transmission link to several receivers. |
| | Random errors introduced onto the signal during transmission. |
| | Time slots are used to transmit a number of digital channels through a transmission link. |
| | The process of mixing an audio signal with a carrier signal before transmission. |
| | Errors introduced into an electronic signal by the components of a circuit. |

**2.** The front end of the superheterodyne receiver is shown below:




*(a)* The tuned RF amplifier has been tuned to a frequency of 1·2 MHz. The local oscillator output is measured at 1·67 MHz. What **four** frequency signals will be present at the output of the mixer? [2]

.....

.....

*(b)* Which of these frequencies does not contain any part of the audio signal? [1]

.....

**3.** The internet currently uses a 32 bit binary address to identify each website. The following binary number is an example of one such address.

10101010 00001010 11110110 01110101

*(a)* A shorthand way of writing this binary number is to use *dotted decimal notation*. Convert the binary number given above into *dotted decimal notation*. [2]

..... . ..... . ..... . .....

(*b*) Here are five dotted decimal notation numbers.

| | | | |
|---|---|---|---|
| A. | 200.200.93.103 | B. | 127.89.45.59 |
| C. | 145.87.90.212 | D. | 156.99.223.201 |
| E. | 102.255.259.1 | | |

(i) Which of these cannot represent an IP address? ..... [1]

(ii) Explain why you have chosen your answer to part (i)

.....

.....

.....

[1]

**4.** The simple crystal radio receiver is made from **five** functional blocks. Two of the blocks are shown below.


*(a)* In the space below draw a block diagram to show how these and other blocks are connected together to make a crystal radio receiver. [4]

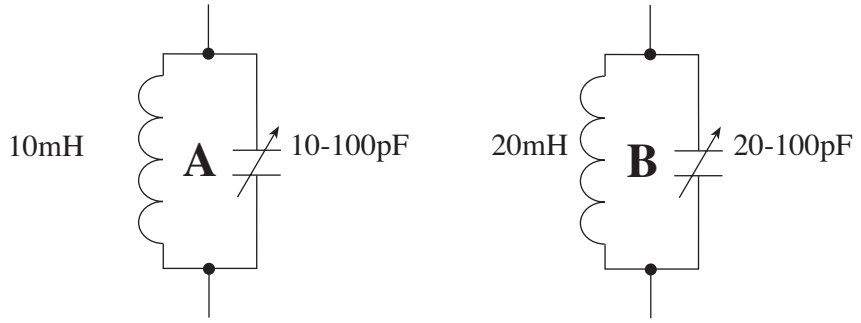
*(b)* What component is used in the demodulator/detector block? [1]

.....

*(c)* What component is used in the RF Filter block? [1]

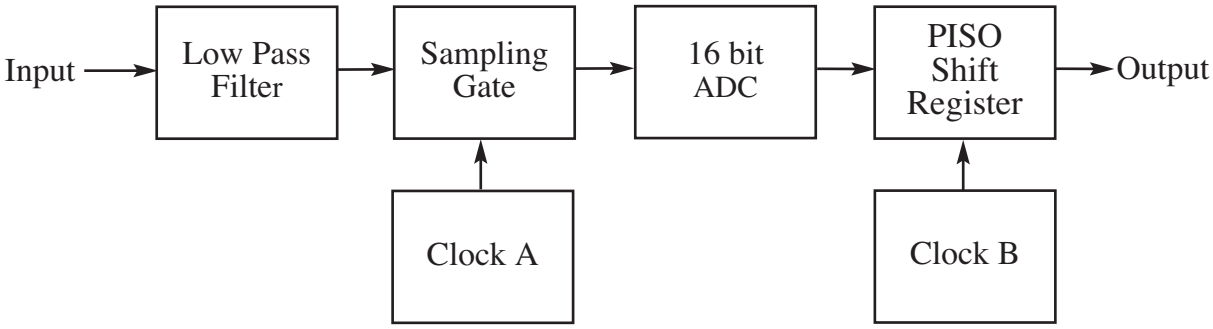
.....

*(d)* Two possible tuned circuits for the radio are shown below.

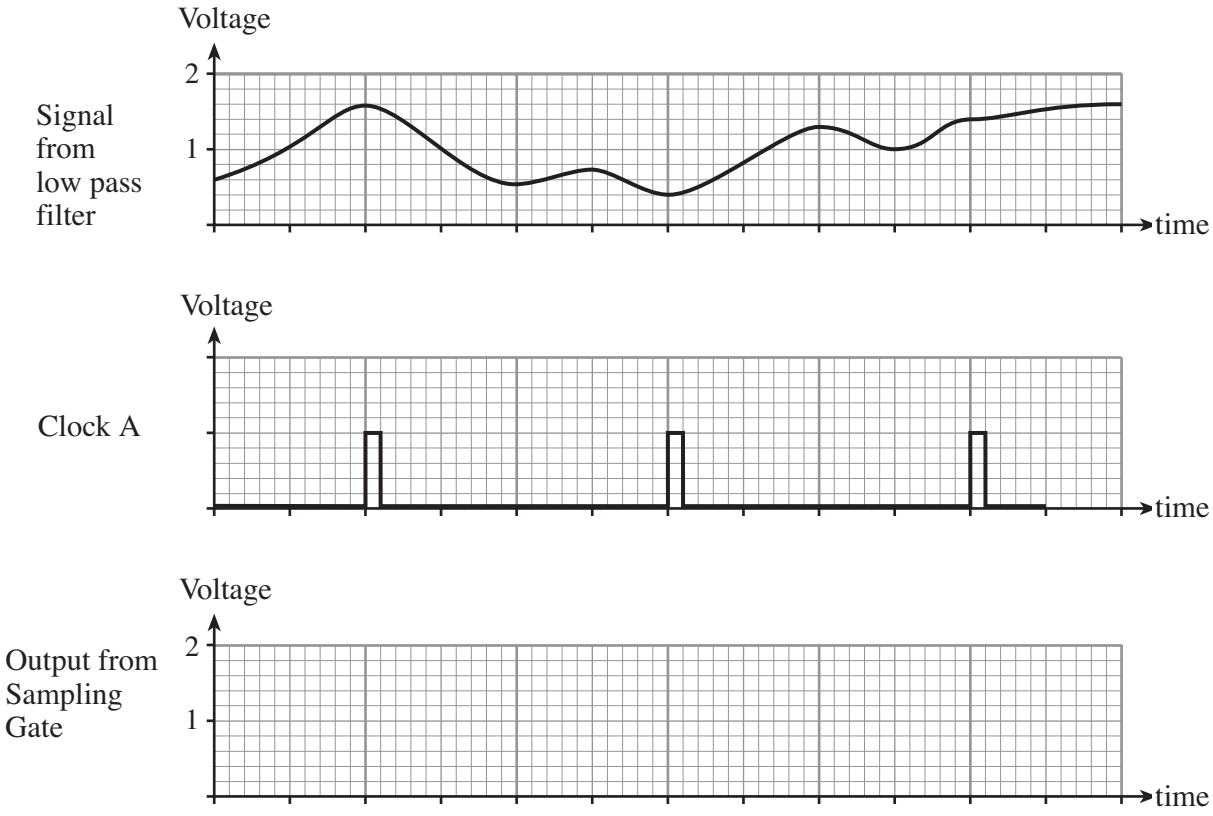



Which circuit, **A** or **B**, provides the user of the radio with the ability to select a frequency range between 120 kHz and 250 kHz. **You must show all of the calculations you have performed.** [3]

**5.** The following block diagram shows a *Pulse Code Modulation* (PCM) Transmitter.




*(a)* The output of the *low pass filter* and the output of *Clock A* are shown below. Complete the graph to show the output of the *sampling gate*. [3]




*(b)* The signal from the Low Pass Filter contains frequencies in the range 20 Hz - 20 kHz.

(i) What is the relationship between the input signal frequency range and the minimum sampling frequency required to allow the signal from the low pass filter to be reconstructed at the receiver? [1]

.....

(ii) Hence, what is the minimum frequency that can be used for Clock A in this transmitter? [1]

.....

*(c)* Clock B must operate at a higher frequency than Clock A for the system to work properly. Explain why this is the case. [1]

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*(d)* For this system, the *Analogue to Digital Converter* (ADC) has an input voltage range of 0 to 4V.

(i) How many voltage levels are provided by the ADC? [1]

.....

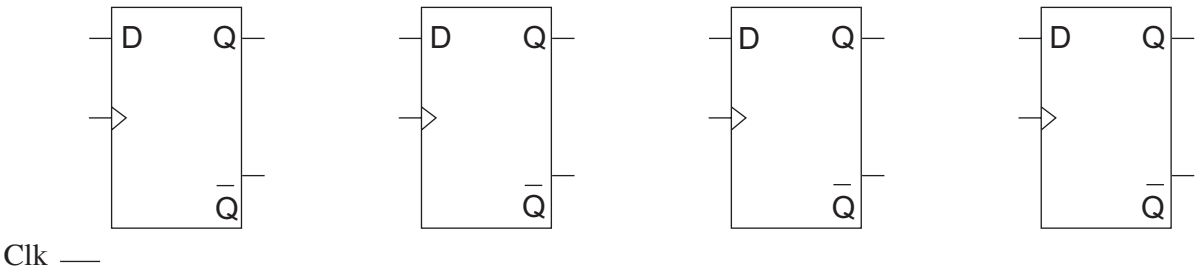
.....

(ii) What is the quantisation error of the system? [1]

.....

.....

*(e)* A PCM **receiver** requires a serial-in-parallel-out shift register (SIPO) which can be constructed using D-type flip-flops.




On the diagram above:

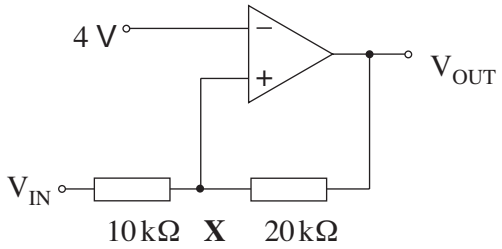
(i) draw the connections needed to make the first 4-bits of a SIPO shift register; [2]

(ii) mark clearly where the input signal is connected; [1]

(iii) mark clearly where the output signal is obtained from. [1]

**Turn over.**

**6.** The following diagram shows the circuit for a Schmitt trigger.




The op amp saturates at +10 V and 0 V.

*(a)* Is this an *inverting* or *non-inverting* Schmitt trigger? [1]

.....

*(b)* Calculate the voltage at **X** when $V_{IN}$ = 7 V and $V_{OUT}$ = +10 V. [2]

.....

.....

*(c)* Calculate the value of $V_{IN}$ that causes $V_{OUT}$ to change from 0 V to10 V. [2]

.....

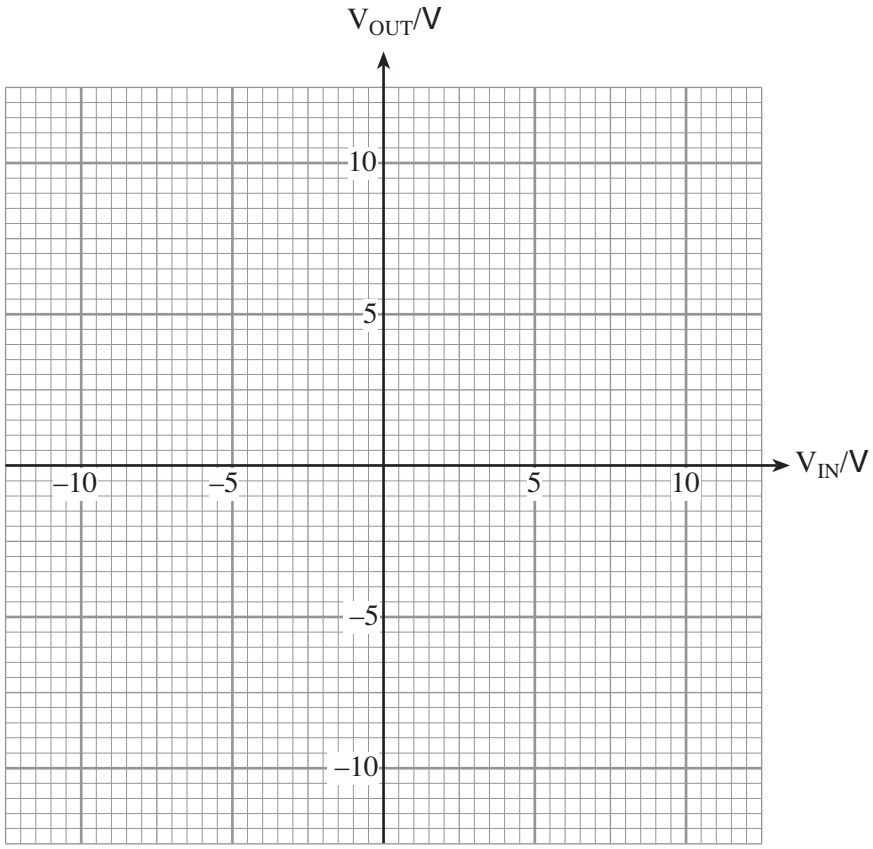
.....

*(d)* Calculate the value of $V_{IN}$ that causes $V_{OUT}$ to change from 10 V to 0 V. [2]

.....

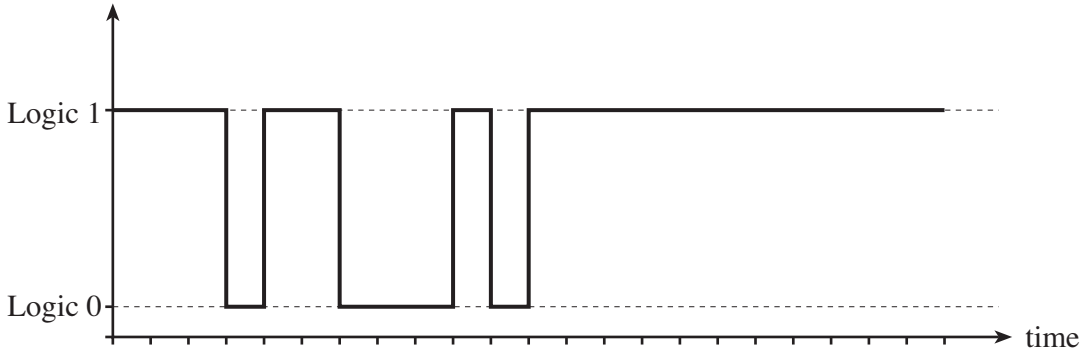
.....

*(e)* Sketch the characteristic for this Schmitt trigger. [3]



**7.** The graph shows the waveform of a signal transmitted from a computer.

The signal carries the ASCII code for an alphanumeric character.




*(a)* The signal includes a start bit and two stop bits, a parity bit, and 7 data bits corresponding to the ASCII character.

(i) Label the start bit and the parity bit. [2]

(ii) Write down the 7 bit character code. [2]

.....

(iii) The system uses **even** parity. Use the graph to work out if the signal contains a single error. [1]

.....

(iv) Explain how you obtained your answer to part (iii). [1]

.....

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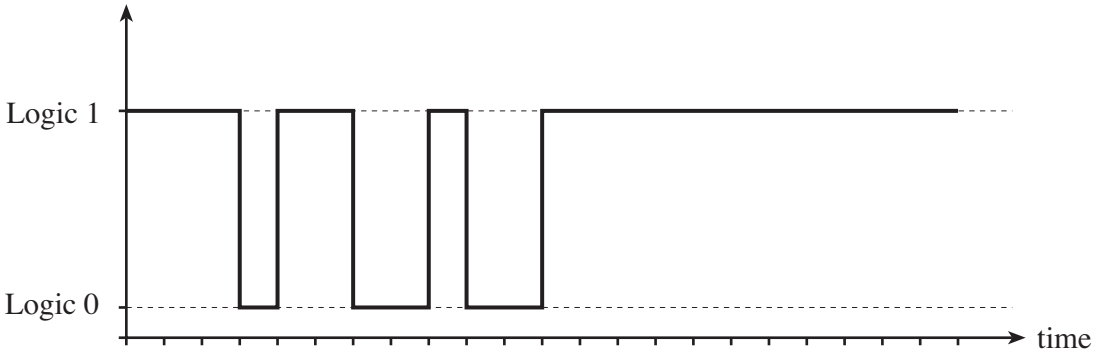
.....

*(b)* The **same** alphanumeric character is sent from a **different** computer using **even** parity. The output is shown below.




An error **has** occurred during transmission. Explain why an error is not detected. [1]

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