

1). The UHF television channel 44 has a frequency of 655.25MHz.

(a) If the intermediate frequency (if) of a television receiver is 36MHz, calculate the possible frequencies of the local oscillator.

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(2)

(b) State two reasons why a television receiver has a high if.

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(2)

(c) Explain why most of the voltage gain in a television receiver occurs in the if amplifiers.

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(d) Calculate the approximate length of a half-wave dipole aerial for this television channel.

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(e) (i) Calculate the value of the inductor that will resonate with a 22pF capacitor at the frequency of this television channel.

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(ii) Give **two** reasons why different constructional techniques have to be employed for circuits at UHF compared to those at audio frequencies.

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2). (a) (i) When two wires carrying electrical signals are positioned close to each other, signals from one wire may be picked up by the other. This is called crosstalk. Explain how this occurs and give **two** ways in which it may be reduced.

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(ii) Explain why crosstalk does not occur if the signals are transmitted by optical fibre.

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(b) Explain the following statement.

"Satisfactory telephone conversation transmission can be obtained using a bandwidth of 3kHz, but for transmission of good quality music 20kHz is needed."

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(c) In digital communication, information is transmitted by encoding analogue signals as 8-bit binary numbers and transmitting these binary numbers as pulses.

(i) If a telephone channel has a bandwidth of 3kHz and is sampled twice per cycle, calculate the bit rate.

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(2)

(ii) A modern optical fibre system can transmit signals at 140Mbps. Explain why this would carry more than 2000 telephone channels, but only two colour TV channels.

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(iii) Explain the meaning of time division multiplexing.

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(iv) The following two bytes are to be encoded and transmitted at the transmitter so that a signal generated in the transmission will be detected at the receiver:

10111010      10001000

Show how each of these signals can be modified at the transmitter by adding an even parity bit and explain how a signal error will be detected at the receiver.

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(v) Explain why the quality of information transmitted by digital methods is generally much higher than that transmitted as analogue signals.

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- 3). (a) The tuning circuit of a radio receiver consists of a  $110\mu\text{H}$  inductor and a variable capacitor, connected in parallel.
- (i) Calculate the resonant frequency for the tuned circuit when the capacitor is set to  $100\text{pF}$ .

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- (ii) Show, by means of a sketch, how the impedance of the circuit varies with frequency in the region of the resonant frequency. (2)

- (iii) Explain what is meant by the quality factor  $Q$  in a resonant circuit and state how the selectivity of a resonant circuit is related to the  $Q$  factor. (1)

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(3)

4). (a) (i) Explain what is meant by noise in an electronic system.

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(ii) Give an example of noise internal to the equipment.

..... (1)

(iii) Give an example of noise generated by external conditions.

..... (1)

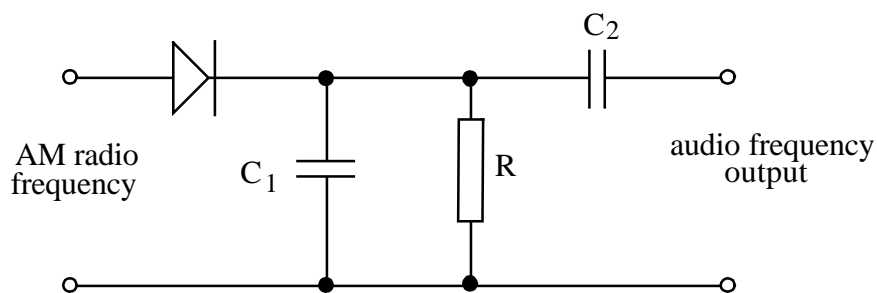
(iv) Explain why the signal/noise ratio received at a radio receiver must be as large as possible, even though the signal is amplified before it reaches the loudspeaker.

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(b) In order to transmit information by radio, the information must modulate the carrier wave. Explain why this is necessary.

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(c) The diagram below shows a simple demodulation circuit in an amplitude modulated radio receiver.



(i) Suggest a typical value for the AM carrier frequency

..... (1)

(ii) State the purpose of the diode.

..... (1)

(1)

(iii) State the purpose of the capacitor  $C_2$ .

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(1)

(iv) How would you decide on a suitable value for the product  $R C_1$ ?

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(2)

- 5). (a) Draw a system diagram to show how the following subsystems can be combined to form a superheterodyne receiver.

**af amplifier, if amplifier, rf amplifier, detector, local oscillator, mixer**

- (b) A receiver is required for the radio amateur band with a frequency range of 14.000MHz to 14.350MHz. Calculate the approximate length for a half wave dipole aerial suitable for this band.

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(3)

- (c) It is decided to use a local oscillator that has a range of 14.001MHz to 14.351MHz.  
(i) With an unmodulated carrier frequency of 14.000MHz and a local oscillator of 14.001MHz, what frequency would be heard from an af amplifier connected directly to the mixer of the receiver?

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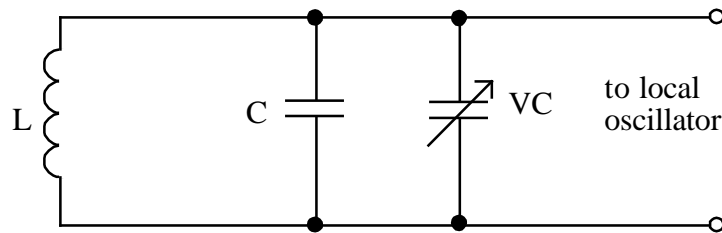
(2)

- (ii) What would be the intermediate frequency of this receiver?

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(1)

- (d) The tuning circuit for the local oscillator is shown below. The tuning capacitor, VC, has a tuning range of 15pF to 50pF.



If the capacitor C has a value of 500pF, calculate a value for the inductance L so that the lowest frequency of the local oscillator is 14.001MHz

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(5)

- (e) Draw a system diagram showing a simplified version of the superheterodyne receiver described in (a), suitable for reception of Morse code.

- (f) State **one** advantage and **one** disadvantage of the type of simplified receiver described in (e) as compared with the receiver described in (a).

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6). (a) Give **two** advantages and **two** disadvantages of serial transmission of data, as compared with parallel transmission of data.

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(4)

(b) The normal video bandwidth for a television receiver is 6MHz. The bit frequency for teletext information is 6.9375MHz.

(i) What is the baud rate of the teletext information?

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(1)

(ii) Explain what effect the video bandwidth will have on the teletext information.

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(1)

(iii) Draw a diagram to show what the waveform of the byte 10110101 would be immediately after it has been extracted from the video information.

(2)

7). (a) State and explain **one** advantage and **one** disadvantage of parallel data transfer as compared with serial data transfer.

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(4)

(b) A serial data transmission system consists of 1 start bit, 8 data bits and 2 stop bits. If the system operates at 300baud, how long does it take for the transmission of 1KB of data?

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8). (a) Explain, with the aid of diagrams, what is meant by AM and FM.

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(b) It is found that the reception of a 99.7MHz FM signal has a greater audio bandwidth, less noise and very little interference compared with the reception of a 1.02MHz AM signal. State and explain the reasons for this. (4)

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- 9). (a) To separate a required radio station from all the other stations received by the aerial, tuned circuits are used.  
What value of inductor, together with a capacitor of 250pF, would form a tuned circuit that resonates at 1.2MHz?

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(2)

- (b) Explain what is meant by the *quality factor* of a tuned circuit.

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(2)

10). (a) (i) Digital information can be transmitted by radio, coaxial cable or optical fibre. State **one** advantage **other** than cost of **each**:

Radio.....

Coaxial cable.....

Optical Fibre.....

(3)

(ii) Which of these is able to support the greatest data rate?

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(b) To increase the number of telephone calls that can be sent along a cable or optical fibre, the telephone calls are often multiplexed in either the time or frequency domain. Explain briefly the difference between time and frequency division multiplexing.

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(4)

(c) A serial data transfer system uses the following method to check for errors. The data is transmitted as blocks of 4 bytes. The 4 bytes of each block are added together and then the least significant byte of the sum is transmitted after each block as a check byte. After the data has been received the 4 bytes are added together. The least significant byte of the sum is then compared with the check byte.

(i) What would be the value of the check byte for the block consisting of the 4 bytes  $42_{16}$ ,  $79_{16}$ ,  $74_{16}$ ,  $65_{16}$ ?

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(2)

(ii) Referring to the data in c(i), give an example of an incorrect received block that would still give the same check byte.

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(2)

11). (a) (i) Discuss ways in which electromagnetic interference causes problems in the transmission of electrical signals in metallic wires.

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(ii) State and explain **two** ways in which the effects can be minimised.

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(4)

(iii) Explain why these effects do not occur when the signal is carried by an optical fibre.

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(1)

(iv) State one other advantage of optical fibres over metallic wires.

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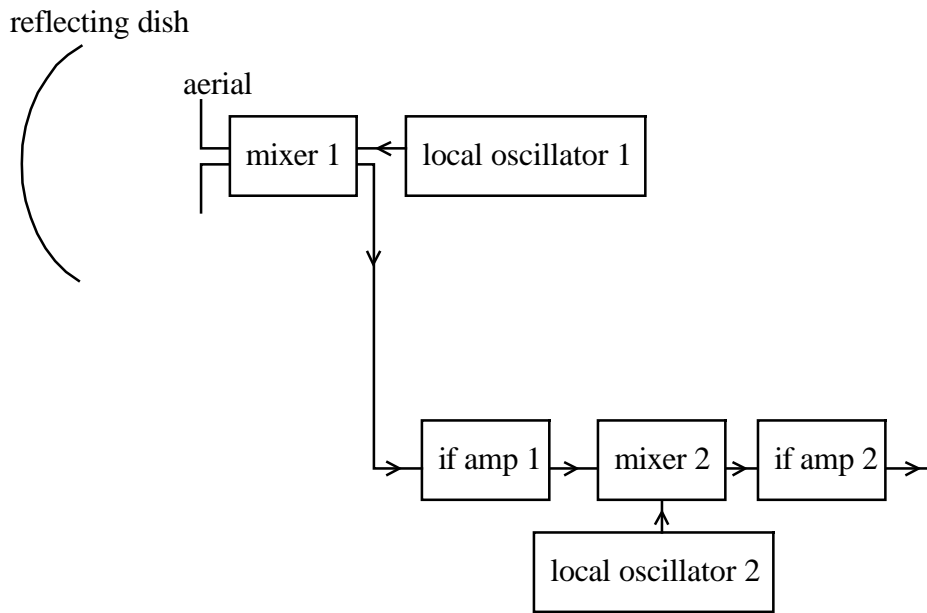
(1)

(v) Explain why an optical fibre is capable of simultaneously transmitting several thousand separate telephone conversations.

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(2)

12). The block diagram below shows part of a satellite television receiving system.



(a) Local oscillator 1 is fixed at a frequency of 10GHz. The system receives signals in the frequency band 10.95GHz to 11.70GHz.

(i) Suggest a reason why it is necessary to locate mixer 1 and local oscillator 1 next to the aerial.

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(1)

(ii) What is the required bandwidth of intermediate frequency amplifier 1?

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(1)

(iii) Suggest why the coaxial cable linking mixer 1 to IF amplifier 1 should be of good quality.

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(1)

(b) (i) IF amplifier 2 has a frequency centred on 479.5MHz. What is the tuning range of local oscillator 2?

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(2)

(ii) State and explain two functions of an IF amplifier

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13). (a) (i) Explain how twisted pairs of wires minimise the pickup of electromagnetic interference.

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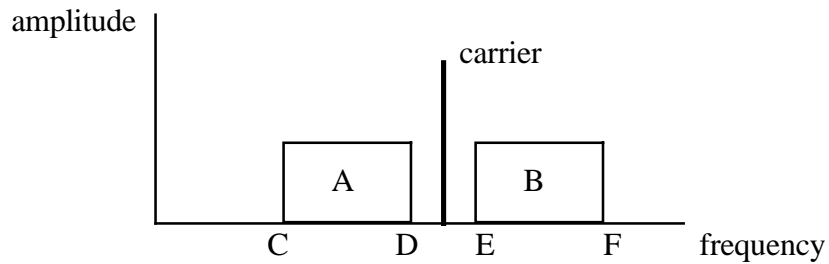
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(ii) State **three** other methods of reducing the problems of interference from electromagnetic sources.

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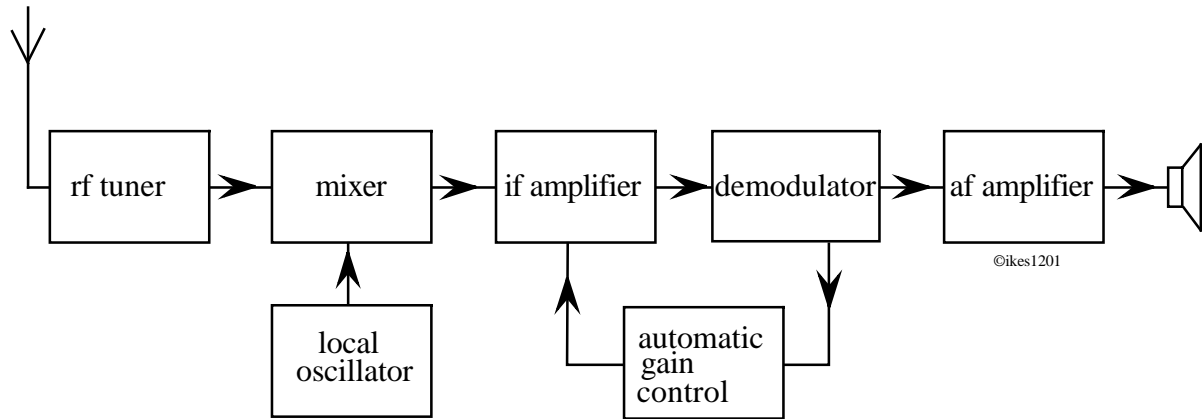
(3)

14). In amplitude modulation the carrier wave is modulated by a range of sinusoidal audio frequency waves. The resulting frequency spectrum of the modulated carrier is shown below.



- (a) (i) What is the name of region A?  
 ..... (1)
- (ii) What is the name of region B?  
 ..... (1)
- (b) If the carrier frequency is 1MHz and the range of modulating frequencies is 50Hz to 4.5kHz give the values of the frequency ranges:
- (i) C-D..... (1)
- (ii) E-F..... (1)
- (c) What is the bandwidth of the transmitted signal?  
 ..... (1)

15). Below is a block diagram of an AM superheterodyne receiver tuned into a modulated carrier.



(a) State one function of the RF amplifier.

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(1)

(b) (i) If the RF signal has a frequency of 3.8MHz and the IF is 1.6MHz state two suitable frequencies for the local oscillator.

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(2)

(ii) State **one** advantage and **one** disadvantage of using a lower intermediate frequency.

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(2)

(c) State and explain **two** functions of the IF amplifier.

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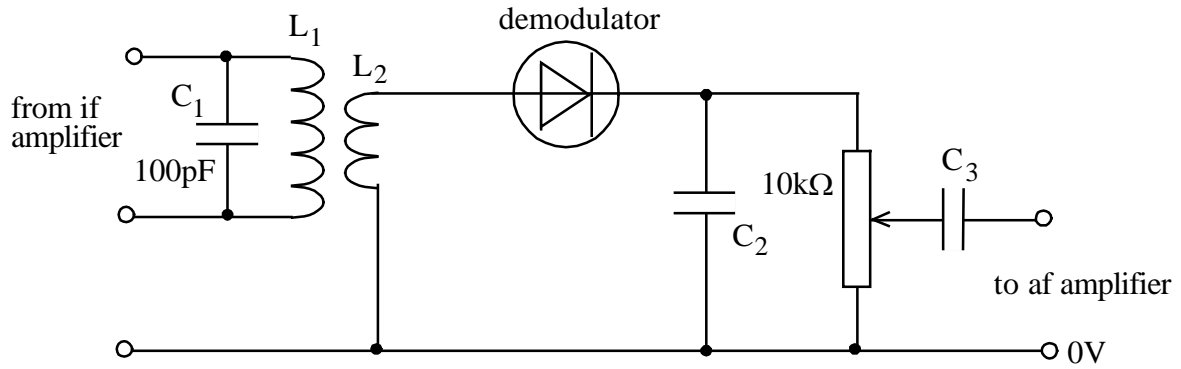
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(4)

(d) The circuit diagram for the demodulator is shown below.



(i) Explain why a step-down transformer, consisting of  $L_1$  and  $L_2$ , is often used to connect the IF amplifier to the detector.

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(2)

(ii) For an IF of 1.6MHz, calculate the value of  $L_1$  at resonance.

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(2)

(e) Draw a voltage-time sketch graph on the axes below of the signal across:-



(2)



(2)

(f) (i) State and explain the function of  $C_2$ .

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(2)

(ii) Estimate, with a supporting calculation a value for  $C_2$

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(2)

- 16). (a) The tuning circuit of a radio receiver works on the principle of resonance.  
 (i) For a parallel tuned circuit draw a typical resonance curve on the axes below. Indicate the resonant frequency on your graph.



(1)

- (ii) On the axes below show how the resonance curve changes if a circuit of higher Q factor is used.



(1)

- (iii) State what effect increasing the Q factor has on the bandwidth.

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(1)

- (b) Distinguish between the *sensitivity* and *selectivity* of a radio receiver.

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(2)

- (c) State two differences between analogue and digital signals.

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17). (a) Many long distance telephone links have been replaced by optical fibres.  
State **three** advantages of optical fibres over other types of cable.

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(3)

(b) To enable more cost effective use of telephone cables, telephone calls are *multiplexed* together, either in the *time domain* or *frequency domain*.  
Explain what is meant by:

(i) time-domain multiplexing,

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(2)

(ii) frequency-domain multiplexing,

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(2)

18). (a) Draw a block diagram of a superhet receiver which includes the following sub-systems:  
**mixer, local oscillator, rf amplifier, if amplifier, af amplifier, detector.**

(b) State **two** functions of the IF amplifier. (4)

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(c) A superhet receiver has an IF of 10.7MHz and a local oscillator that is at a higher frequency than the received signal. When tuned to a weak radio signal of frequency 94.2MHz, a signal on 115.6MHz can be heard at the same time. (2)

(i) Explain why this second higher frequency radio signal is being received at the same time.

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(ii) Explain what improvements could be made to the superhet receiver to eliminate this problem. (2)

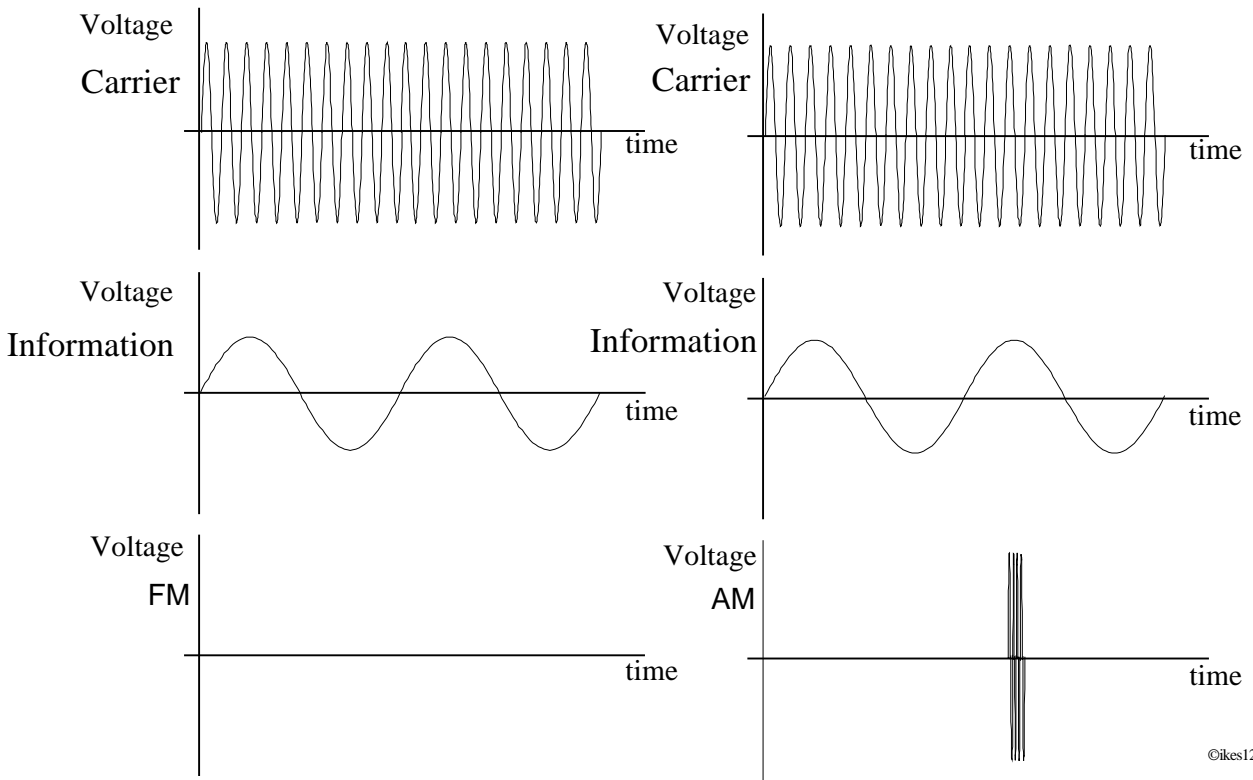
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(d) The local oscillator of the superhet has a coil of inductance  $0.1\mu\text{H}$ . Calculate the capacitance that would be needed so that a signal of 94.2MHz can be received. (2)

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..... (3)

19). The diagrams below show carrier and modulation waveforms. On the axes underneath show the resulting waveforms for frequency modulation (FM) and amplitude modulation (AM).



(4)

(b) State:

(i) one advantage of FM compared with AM.

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(1)

(ii) one disadvantage of FM compared with AM.

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(1)

(c) (i) Draw a labelled diagram of the cross-section of a coaxial cable.

(3)

(ii) State the purpose of each part.

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(2)

20). (a) To send data from one computer to another, the information can be sent in either serial form or parallel form

(i) By considering the form of the signals used, explain how data is sent by each method

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(4)

(ii) Explain in which circumstances it is advantageous to use each method.

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(2)

(b) To send data between two computers which are situated some distance apart, it is necessary to use either twisted pair cables or coaxial shielded cables to minimise interference. Explain how each type of cable is able to minimise interference.

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(4)

(c) (i) Explain why optical fibre cable is more effective in minimising interference than the two cables mentioned in (b)

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(2)

(ii) Give **two** other advantages of optical fibre for data transmission.

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(2)