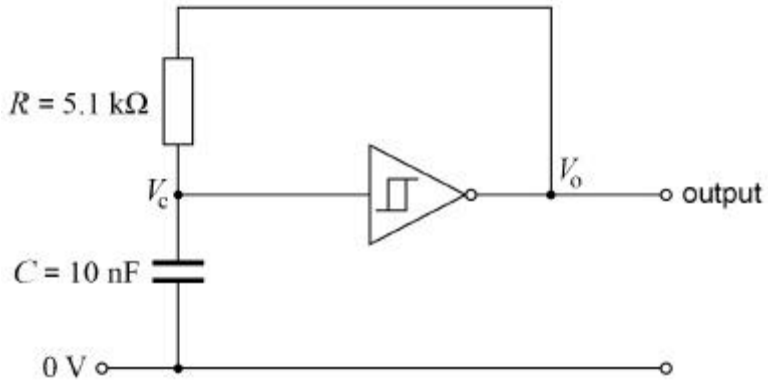
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

(a) **Figure 1** shows an astable circuit based on a NOT logic gate. The symbol in the centre of the logic gate means that the output V_o changes at two different input values of V_c depending on whether the input voltage is rising or falling.

Figure 1



The pulse repetition frequency (PRF) for this particular circuit is given by:

$$\frac{1}{1.4\,RC}$$

Calculate the PRF in kHz

PRF = _____ kHz

(1)

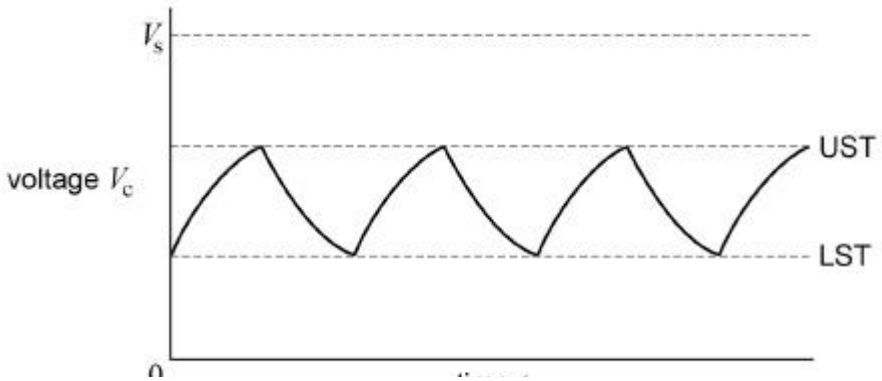
(b) The supply voltage to the NOT gate is V_s

- When V_c increases and reaches the upper switching threshold (UST), the output of the NOT gate will switch from V_s to 0 V
- When V_c decreases and reaches the lower switching threshold (LST), the output of the NOT gate will switch from 0 V to V_s

The graph in **Figure 2** shows V_c constantly changing as the capacitor charges and discharges.

Figure 2

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Draw on **Figure 2** the output voltage V_o for the astable circuit.

(1)

(c) The circuit in **Figure 1** can be modified by the addition of a resistor to vary the PRF.

The astable is to be modified so that it produces a frequency 4 times that of the original.

Calculate the value of the resistor that should be added to the circuit and explain where in the circuit this additional resistor should be placed.

value of resistor = _____ kΩ

_____

_____

_____

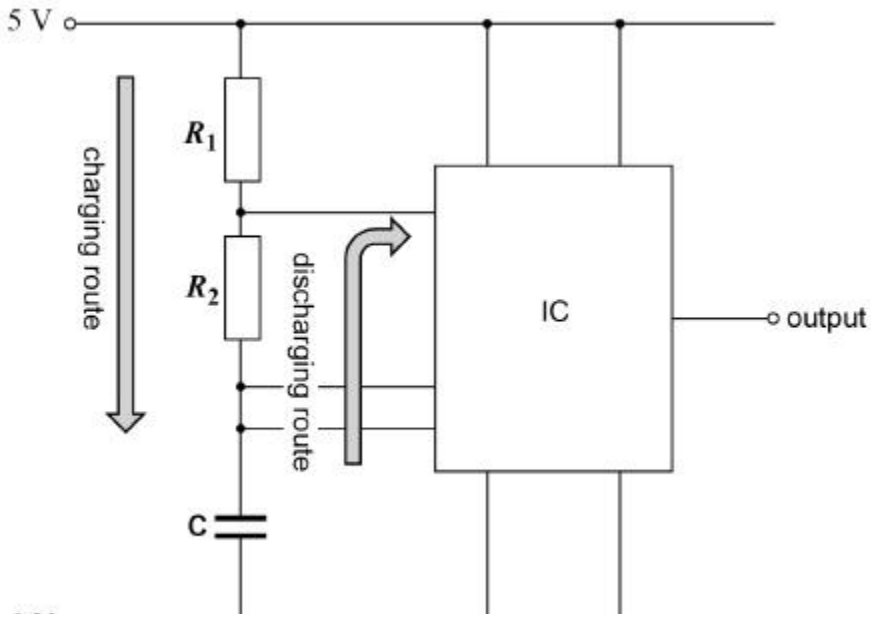
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(2)

(d) In another astable, two resistors (R_1 and R_2) and a capacitor **C** form a timing chain to control the mark and space times for a square wave produced at the output of the integrated circuit (IC) shown in **Figure 3**.

Figure 3

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The charging time for the capacitor **C** is: $t_C = 0.7 \times (R_1 + R_2) \times C$

The discharging time for the capacitor **C** is: $t_D = 0.7 \times R_2 \times C$

Calculate, in kΩ, values for $\boldsymbol{R_1}$ and $\boldsymbol{R_2}$ needed to produce a 5 kHz signal with 75% duty cycle given that the capacitor **C** has a value of 10 nF

$\boldsymbol{R_1}$ = _____ kΩ

$\boldsymbol{R_2}$ = _____ kΩ

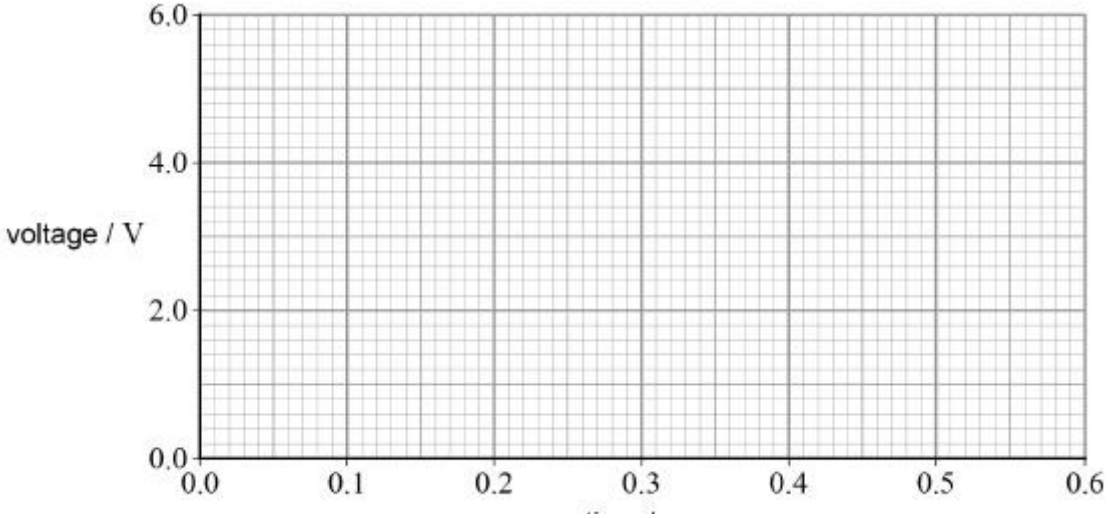
(2)

(e) The output of the IC in **Figure 3** is 5 V during the charging period and 0 V during the discharging period.

Draw on **Figure 4** the wave pattern that represents this signal.

Figure 4

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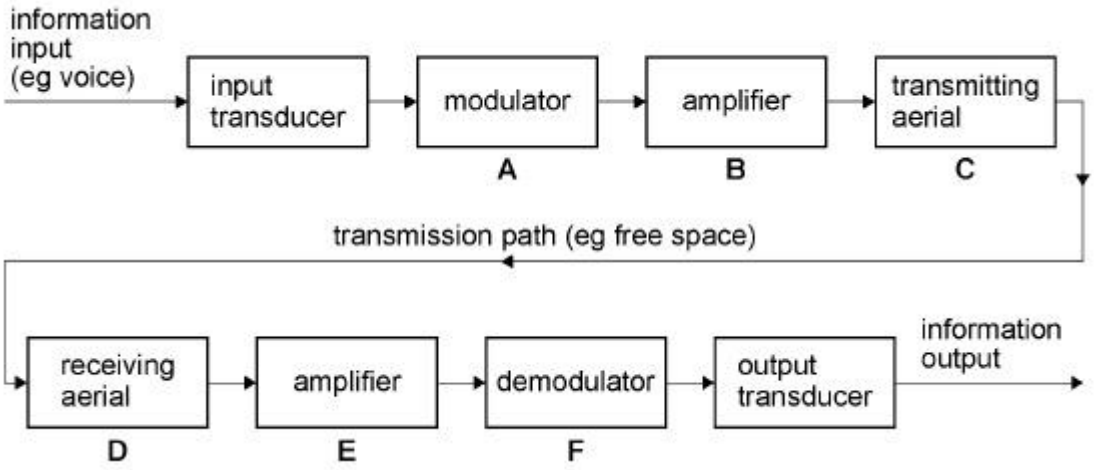
(2)

(Total 8 marks)

Q2.

Figure 1 shows a block (subsystem) diagram for a radio communication system.

Figure 1



(a) State the letter representing the subsystem in which you might find an induced emf being generated.

(1)

(b) State the letter representing the subsystem where the audio and radio waves are combined.

(1)

(c) The signal strength at stage **D** must be amplified.

Explain why the signal strength at stage **D** is weak.

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_____

_____

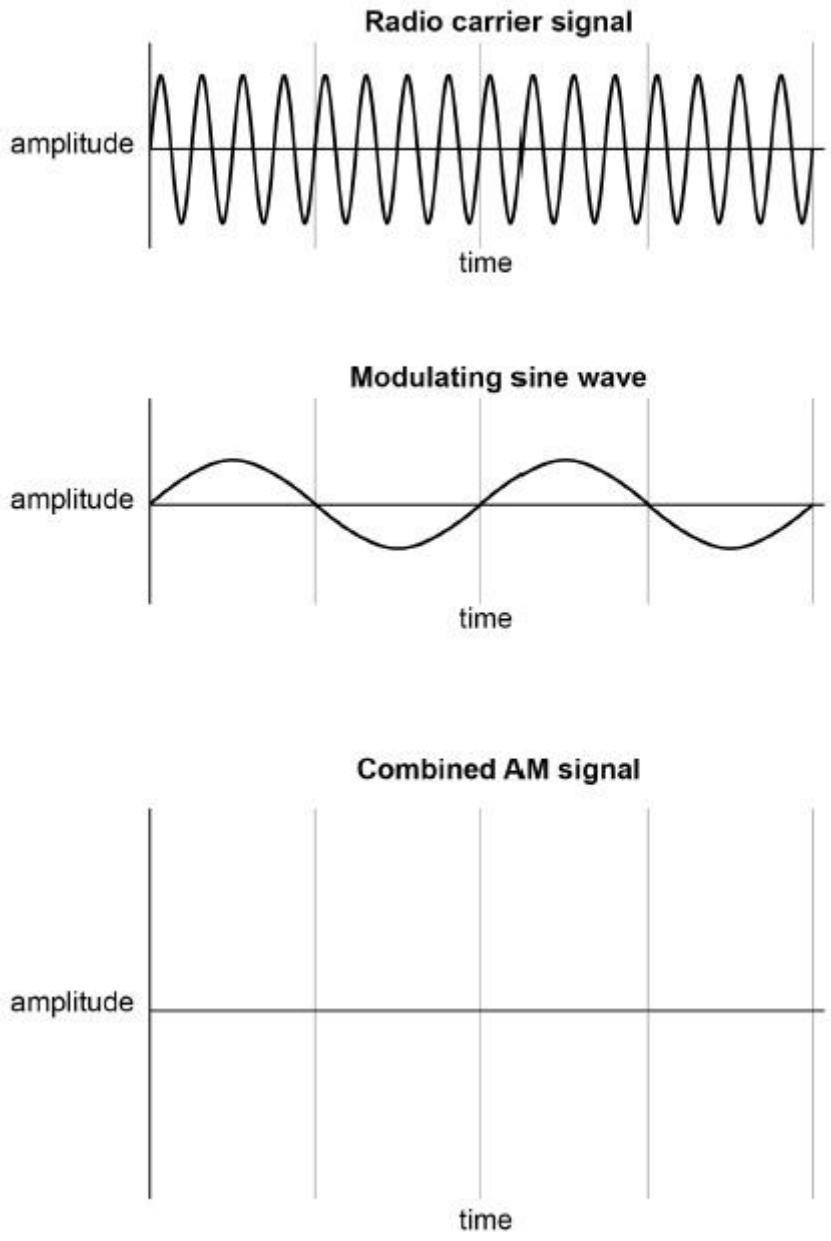
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_____

(1)

(d) **Figure 2** shows graphs of a radio carrier signal and a modulating sine wave.

Figure 2



Complete the graph in **Figure 2** to represent the combined amplitude modulated (AM) signal.

(1)

(e) Approximately 20 radio stations use amplitude modulation (AM) to broadcast to people living in the London area. Another 35 AM stations broadcast to people outside the London area. However, these broadcasts can still be received in London.

The allocated frequency spectrum for all these broadcasts is in the range 540 kHz to 1600 kHz

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Suggest whether all these stations can broadcast hi-fi music using the full audio frequency of 20 kHz

_____

_____

_____

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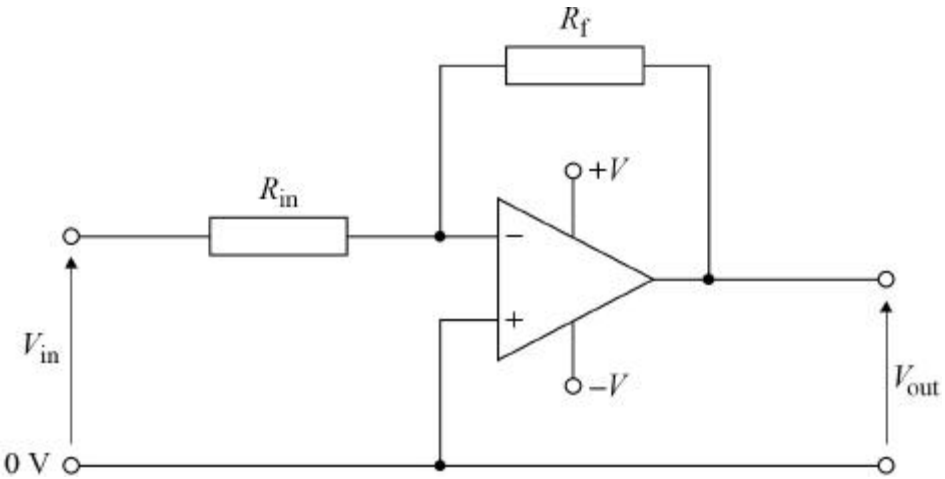
(3)

(Total 7 marks)

Q3.

Figure 1 shows an operational amplifier used as an inverting amplifier.

Figure 1



(a) Label **Figure 1** with an **X** to show the point which is a virtual earth.

(1)

(b) Name the input pin shown by a (+) on the operational amplifier.

_____

(1)

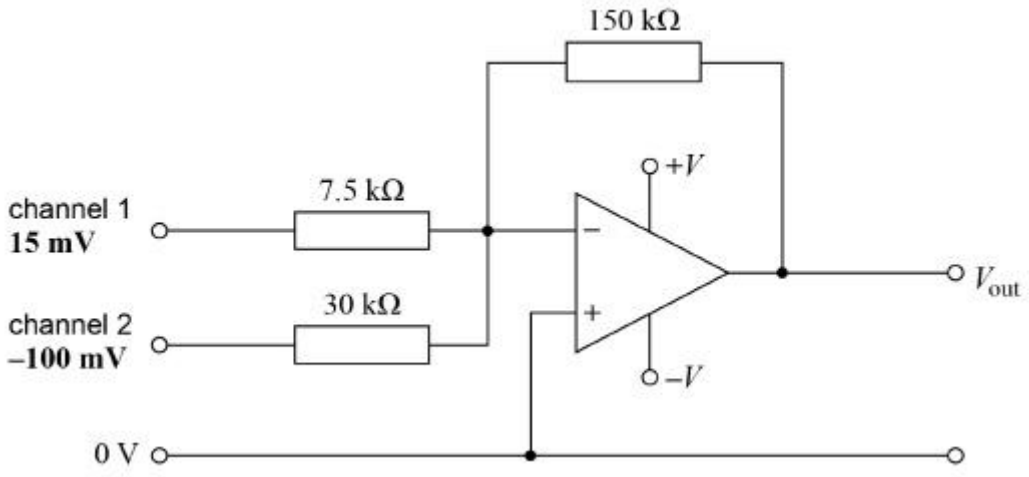
(c) Derive the expression for the inverting amplifier gain $\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$

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(2)

(d) **Figure 2** shows the inverting amplifier modified to make a summing amplifier that is to form part of a two-channel audio mixer.

Figure 2



Calculate the voltage gain produced by channel 1.

voltage gain (channel 1) = _____

(1)

(e) The mixer is tested using the input signals to channels 1 and 2 with the amplitudes shown in **Figure 2**.

Calculate the amplitude of the output voltage V_{out} produced in the test.

V_{out} = _____ V

(2)

(f) Describe how the function of the audio mixer could be improved by changing the two input resistors from fixed values to variable values.

_____

_____

_____

(1)

(Total 8 marks)

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