EXPERIMENT NUMBER: 1

EXPERIMENT NAME: AMPLITUDE MODULATION AND DEMODULATION

DATE: 10/10/2022, MONDAY

* **AIM:**

To perform amplitude modulation and demodulation for the given carrier and message signal, and verify the same using oscilloscope.

* **COMPONENTS REQUIRED:**

S. No.	Component Name	Quantity
1	Capacitor (100 nF)	2
2	Inductor (25 H)	1
3	Resistor (15 kΩ)	1
4	Diode (IN4007)	2
5	Bread Board	1
6	Wire Box (connecting wires)	1
7	Probes	3
8	Digital Oscilloscope (DSO)	1
9	Function Pulse Generator	1

* **THEORY:**

(a) **AMPLITUDE MODULATION** –

It is a process by which the wave signal is transmitted by modulating the amplitude of the signal. The amplitude of a carrier (high frequency wave) varies as per the amplitude of message signal (low frequency wave).

The equations of carrier and message are given by –

$m(t) = A_m \cos(2\pi f_m t)$

$c(t) = A_c \cos(2\pi f_c t)$

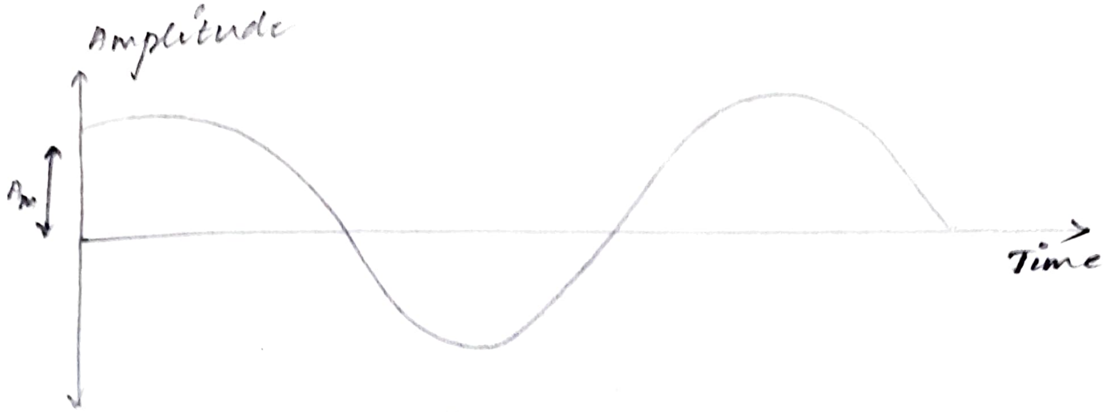
where A_m and A_c are amplitudes;

f_m and f_c are frequencies;

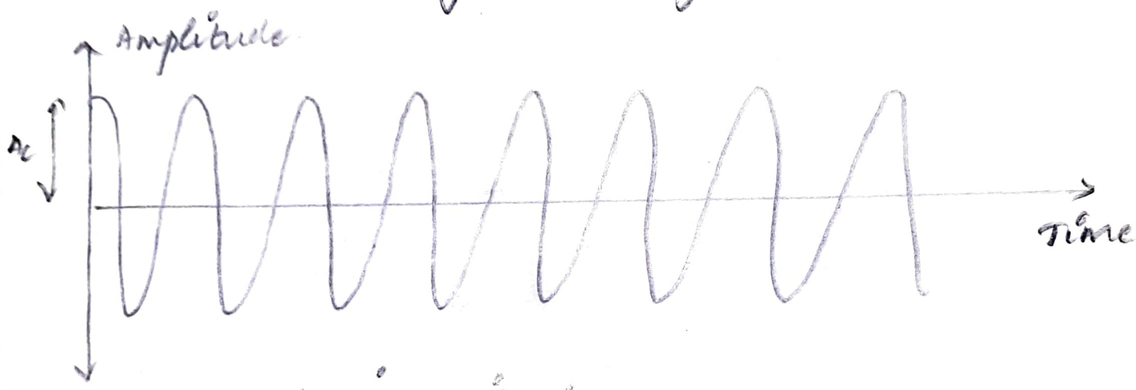
of message and carrier respectively.

The equation of the amplitude modulated wave is -

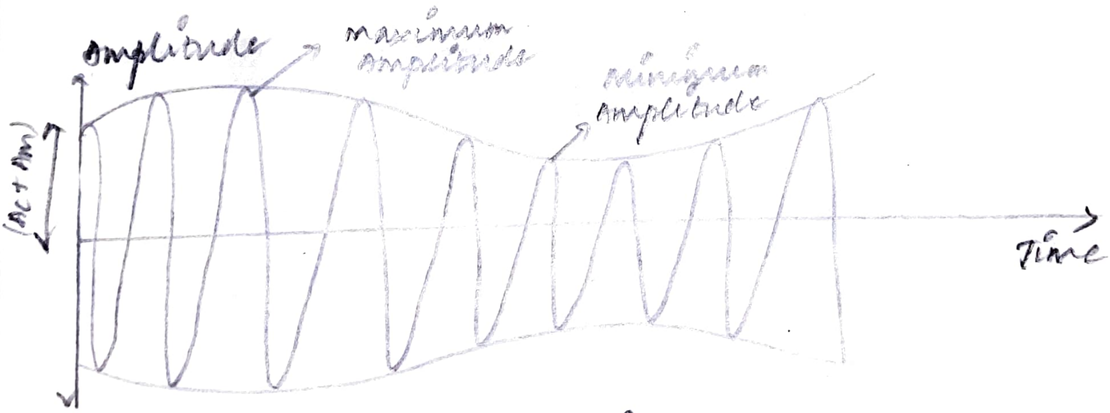
$$u(t) = [A_c + A_m \cos(2\pi f_m t)] \cos(2\pi f_c t).$$



Base - Band Signal (Message)



carrier signal.



Am modulated signal

The modulation index of Am is -

$$s(t) = A_c\left[1 + \frac{A_m}{A_c} \cos 2\pi f_m t\right] \cos 2\pi f_c t$$

$$= A_c\,[1 + \mu \cos 2\pi f_m t] \cos 2\pi f_c t,$$

where modulation index, $\mu = \dfrac{A_m}{A_c}$.

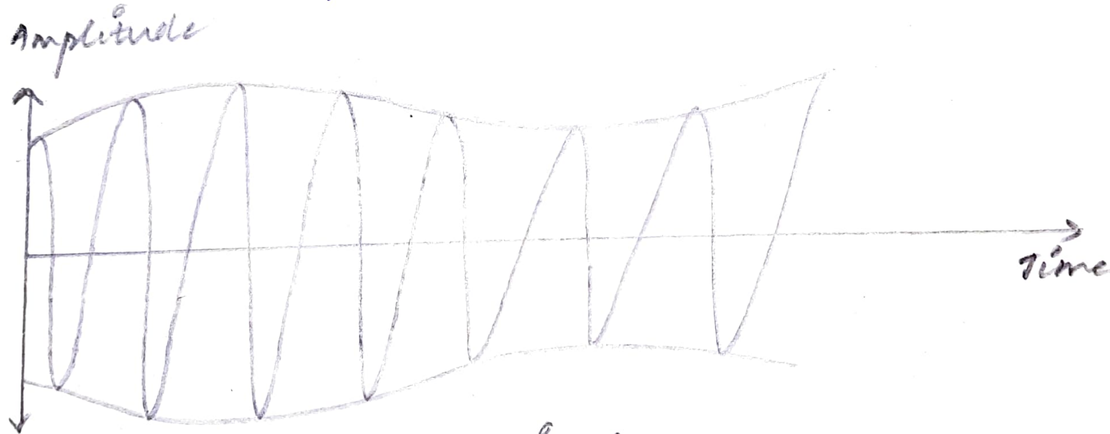
Maximum amplitude of modulated wave = $A_m + A_c$
Minimum amplitude of modulated wave = $A_c - A_m$

$$\boxed{\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}}$$

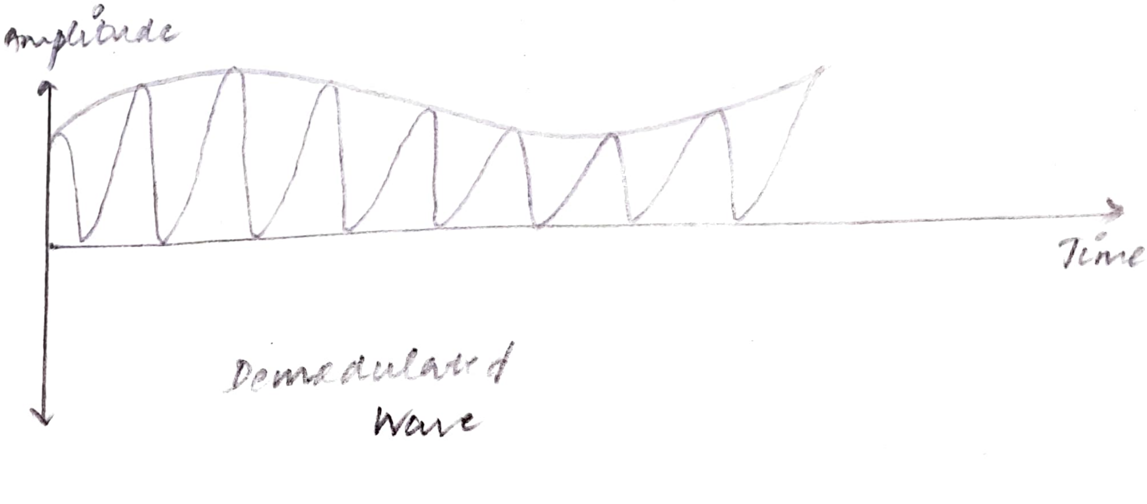
For perfect modulation, the value of modulation index should be 1, which implies the percentage of modulation should be 100%.

(b) AMPLITUDE DEMODULATION:
It is the process of recovering original signal from the modulated wave. It is also known as envelope detection.

An envelope detector is an electronic circuit that takes a high-frequency signal as input and provides an output which is the envelope of the original signal.



AM modulated signal



Demodulated Wave

* CIRCUITS:

(a) AMPLITUDE MODULATION -

The basic circuit diagram for amplitude modulation consists of diode, resistors and LC circuit. The carrier and message signal are mixed and fed into the diode, which rectifies the signal.

The LC circuit is a bandpass filter whose frequency is equal to the carrier frequency. A parallel resonant LC circuit exhibits the highest impedance at the central frequency. Hence it allows only the AM output to pass through.

At the carrier frequency, L and C repeatedly exchange energy with each other resulting in a oscillation that produces negative half cycle pulse for every positive pulse coming out of the diode.

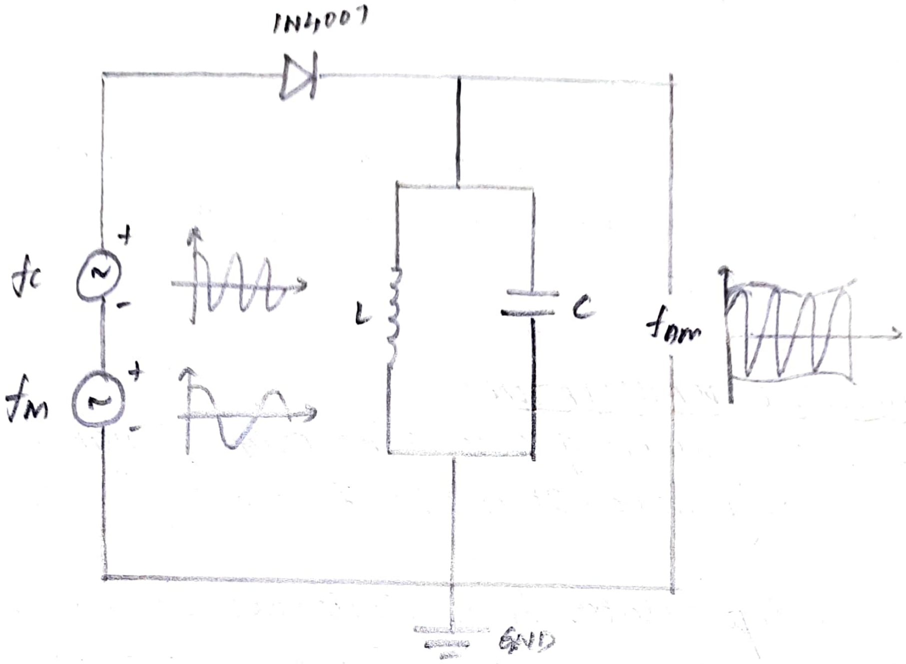
Hence, the frequency of the carrier is equal to the resonating frequency in LC circuit i.e., $f_c = \frac{1}{2\pi\sqrt{LC}}$.

(b) AMPLITUDE DEMODULATION -

The demodulator circuit consists of resistor, capacitor and a diode. In the positive half cycle of AM signal, diode conducts and current flows through 'R', whereas in negative half cycle, the diode is reverse biased and no current flows.

Therefore, only positive half of AM wave appears across resistance R, the capacitor across R provide low impedance at the carrier frequency and much higher impedance at modulating frequency. Thereby, the reconstruction of original signal takes place.

AMPLITUDE MODULATION



$f_c = 100\ \text{kHz}$; $A_c = 5V$; $C = 100\ \text{nf}$

$f_m = 100\ \text{Hz}$; $A_m = 2V$

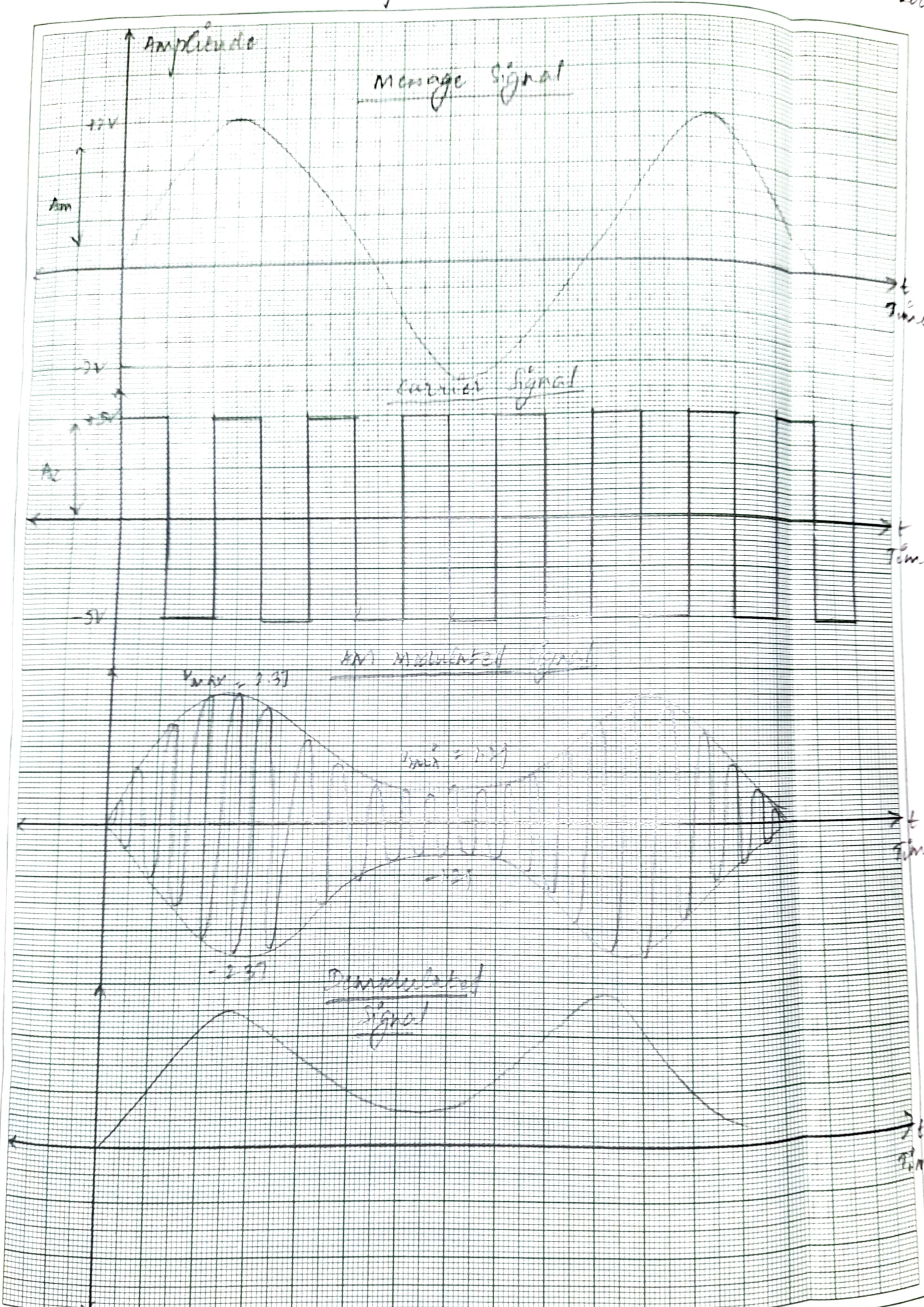
$$f_c = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{L \times 100 \times 10^{-9}}} = 100 \times 10^{3}$$

$$\Rightarrow \sqrt{L} = \frac{1}{2\pi \times 100 \times 10^{3} \times \sqrt{100 \times 10^{-9}}} = 0.00503$$

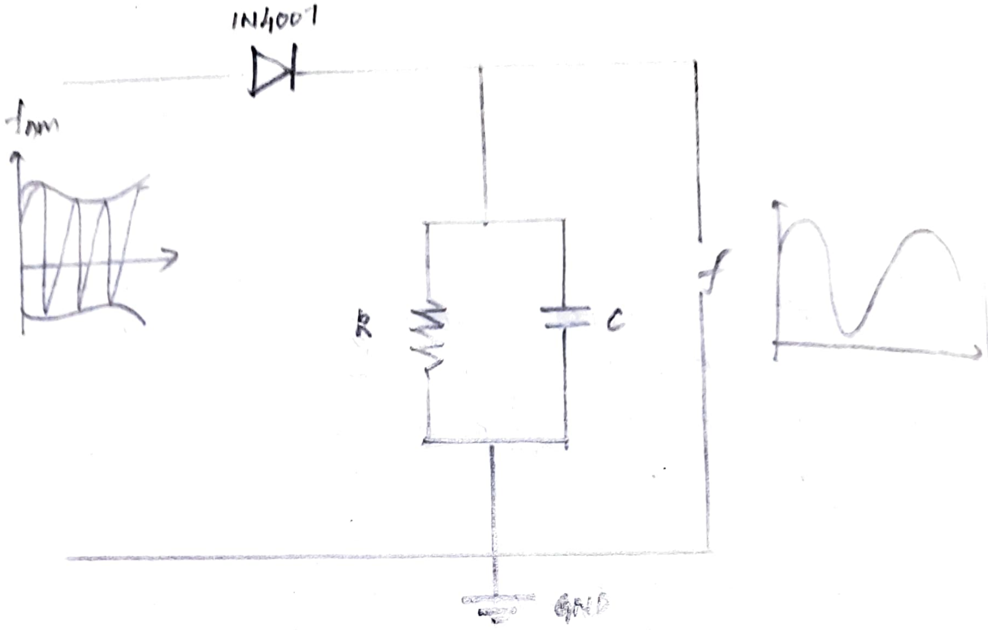
$$\Rightarrow L = 0.0000253303 = \underline{25\ \mu H}$$

Experiment:
Amplitude Modulation

SANTOSH
CB.EN.U4ECE20053



AMPLITUDE DEMODULATION



$f_m = 100$ Hz ; $A_m = 2V$; $C = 100$ nf

$f_c = 100$ KHz ; $A_c = 5V$

$$f_m = \frac{1}{2\pi RC} = \frac{1}{2\pi R \times 100 \times 10^{-9}} = 100$$

$$\Rightarrow R = \frac{1}{2\pi \times 100 \times 100 \times 10^{-9}}$$

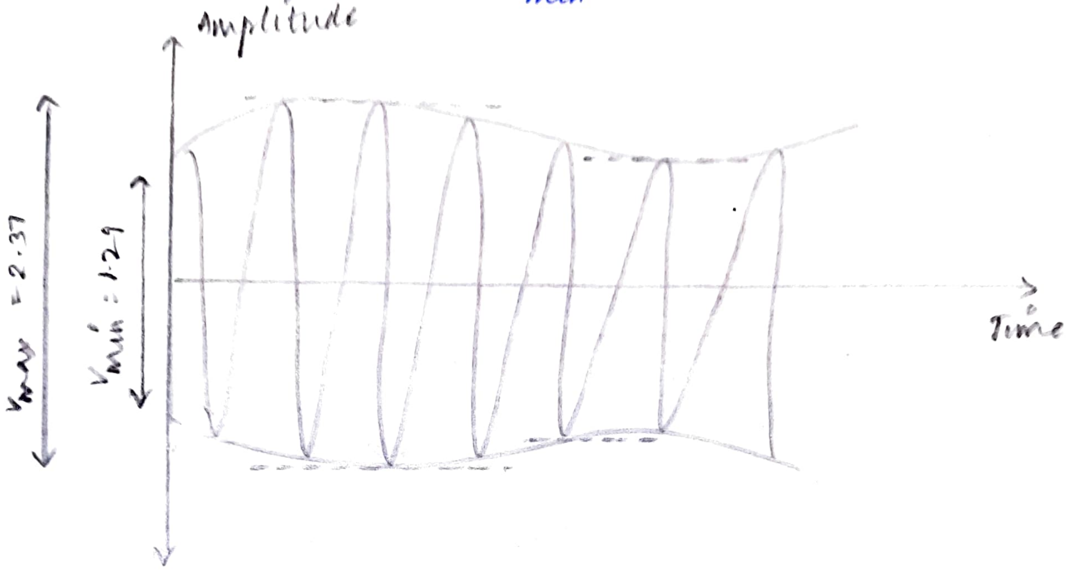
$= 15,915.494 \,\Omega$

$\simeq \underline{15 k\Omega}$

* **RESULT :**

It is obtained from the modulating wave that -

$V_{max} = 2.37$; $V_{min} = 1.29$

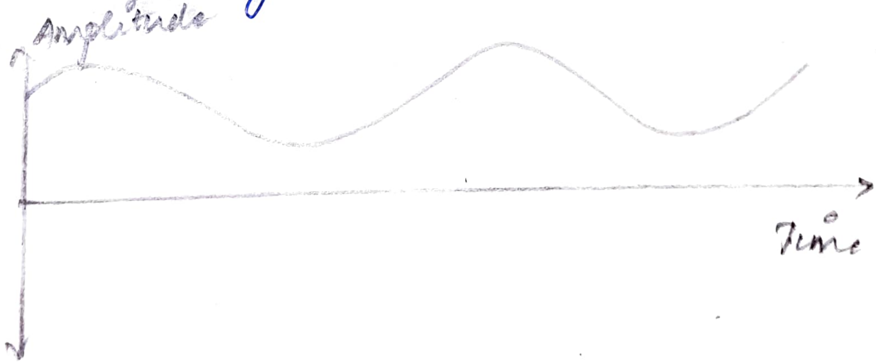


The modulation index is calculated by -

$$\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{2.37 - 1.29}{2.37 + 1.29} = \frac{1.08}{3.66} = 0.29508$$

Percentage of modulation = 29.5%

From the demodulating wave,



This is the envelope of message signal. For perfect reconstruction, we can add on parallel RC's to the circuit till the envelope detected matches the message signal.