Experiment - 3

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AIM : Study of an amplitude modulated (AM) scheme, depth of modulation, waveforms, spectra and trapezoidal display.

APPARATUS: Lab alive software.

THEORY:

1. Classification of AM modulation

- Double Side Band Suppressed Carrier (DSB-SC)
- Double Side Band with Carrier (AM)
- Single Side Band (SSB)
- Vestigal Side Band (VSB)

2. AM

let modulating signal be $m(t) = A_m \cos(2\pi f_m t)$, carrier signal be $c(t) = A_c \cos(2\pi f_c t)$.

$\therefore$ AM wave be $s(t) = [A_c + A_m \cos(2\pi f_m t)] \cos(2\pi f_c t)$

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

Modulation index, $m = \frac{A_m}{A_c}$

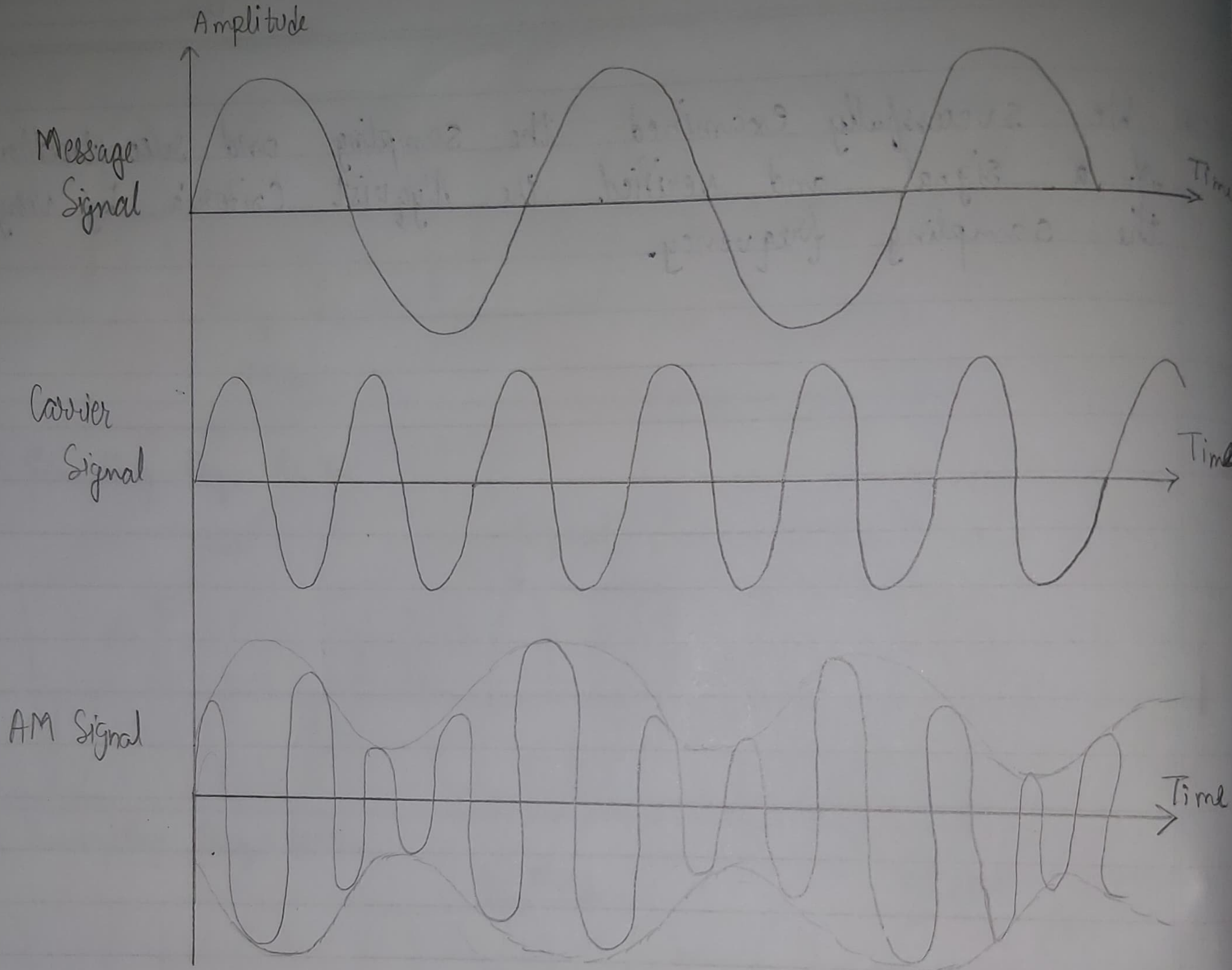
$$s(t) = A_c \cos(2\pi f_c t) + \frac{m}{2} A_c \cos(2\pi)(f_c - f_m)t + \frac{m}{2} A_c \cos 2\pi (f_c + f_m)t.$$

3. Measurement of 'm'

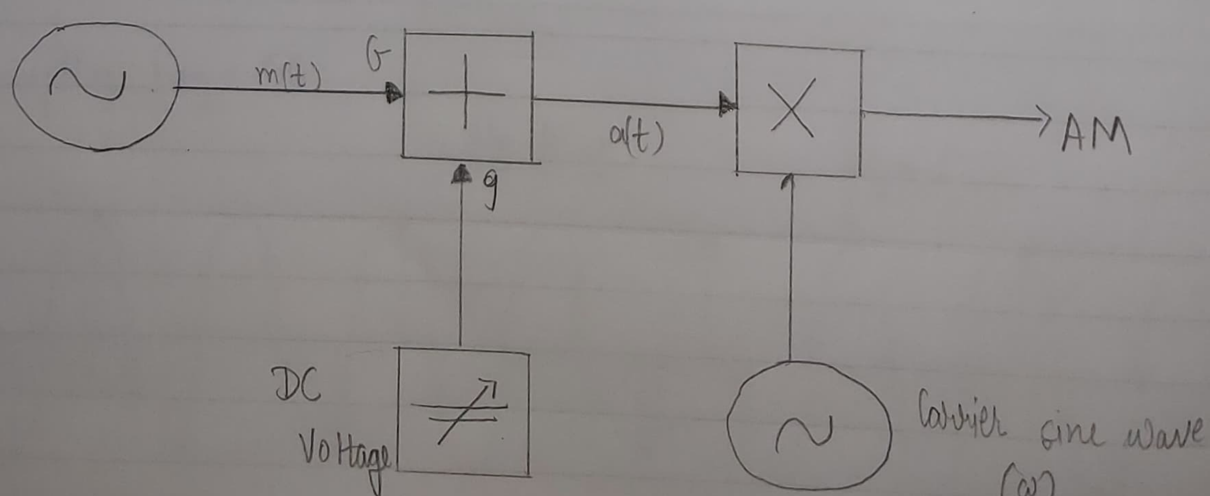
- The magnitude of 'm' can be measured directly from the AM display itself

Teacher's Signature :

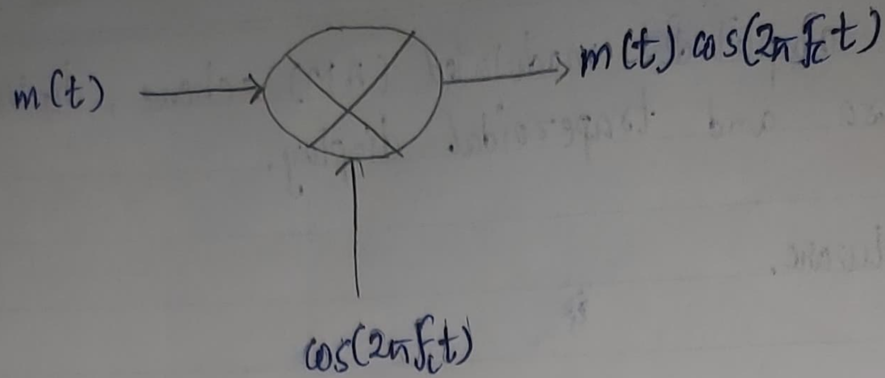
AM



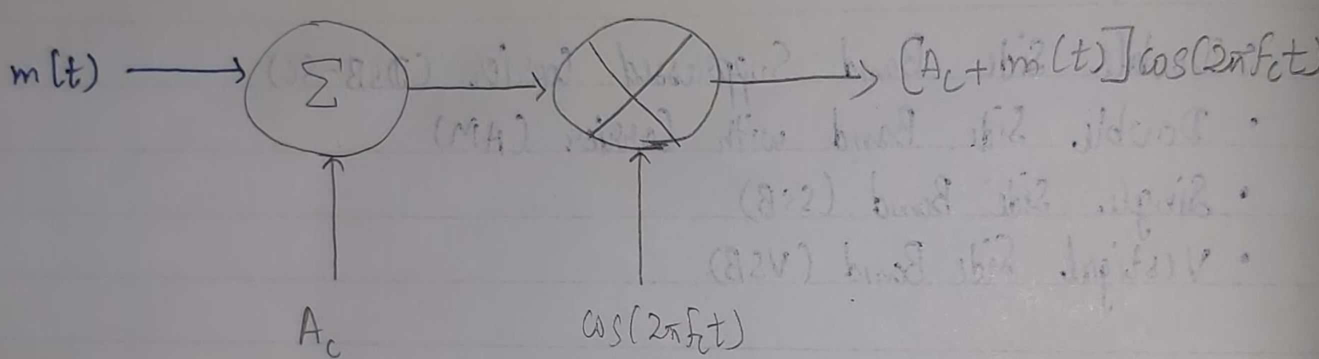
Schematic Block Diagram for AM, Tx and Rx.



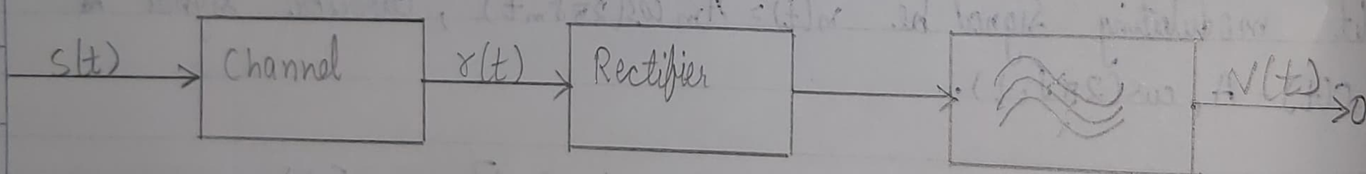
DSB-SC



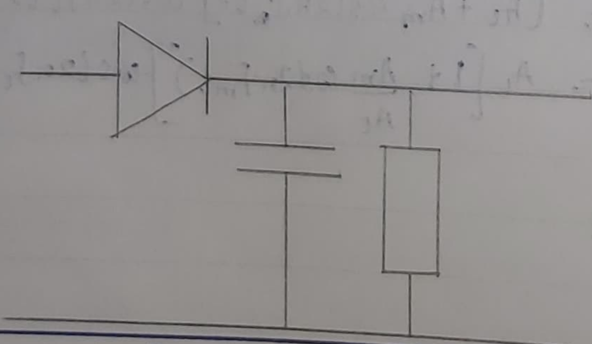
AM



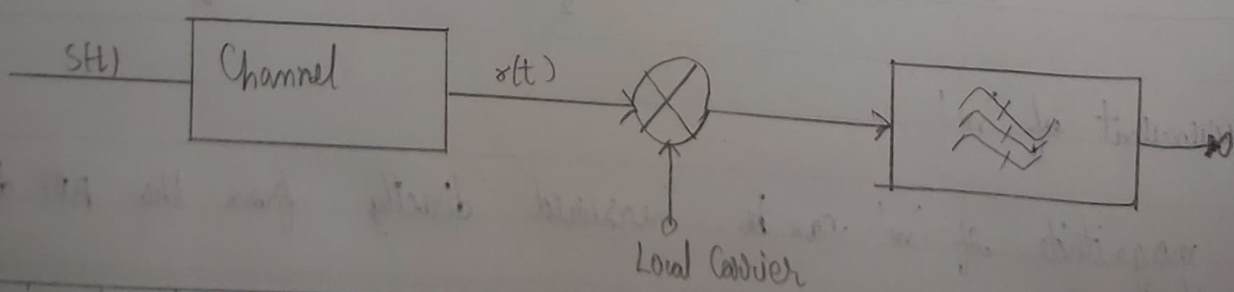
Envelope Detector



Rectifier (Diode, Capacitor)



Synchronous detector.



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AIM :

- Maximum and minimum amplitudes of the transmission signals envelope determine the modulation depth:

$$m = \frac{A_m}{A_c}$$

Max. amplitude of modulated wave, $a = A_m + A_c$
Min. amplitude of modulated wave, $b = A_c - A_m$

$$\therefore \quad A_c = \frac{a+b}{2}, \quad A_m = \frac{a-b}{2}$$

$$\therefore \quad m = \left(\frac{A_c}{A_m}\right)^{-1} = \left(\frac{a+b}{a-b}\right)^{-1} = \frac{a-b}{a+b}$$

4. Envelope detector

- This non-coherent detection doesn't require a carrier recovery circuit. In its simplest form it consists of a rectifier diode and a low-pass filter.

5. Synchronous detector

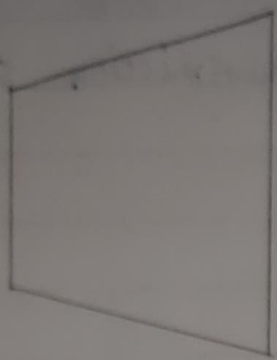
- AM without a carrier. Envelope detection can't be deployed because the transmitted signal's envelope changes sign. Transmit spectrum of DSB-SC.

6. Trapezoid Method

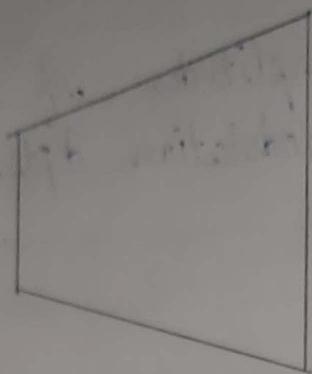
- We can calculate m in the time domain using an oscilloscope and

Teacher's Signature :

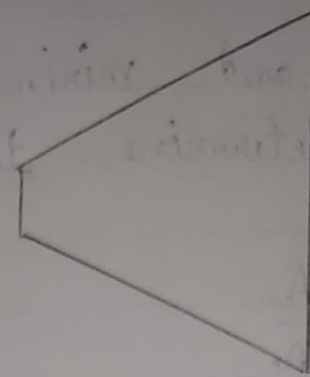
⇒ Trapezoid width is unaffected by modulation depth.



$m = 0.1$



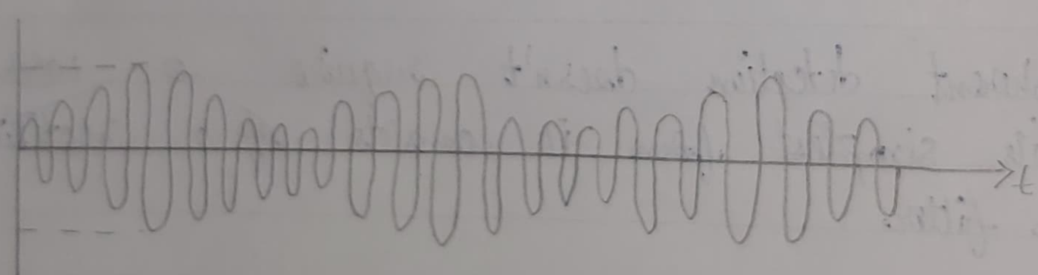
$m = 0.3$



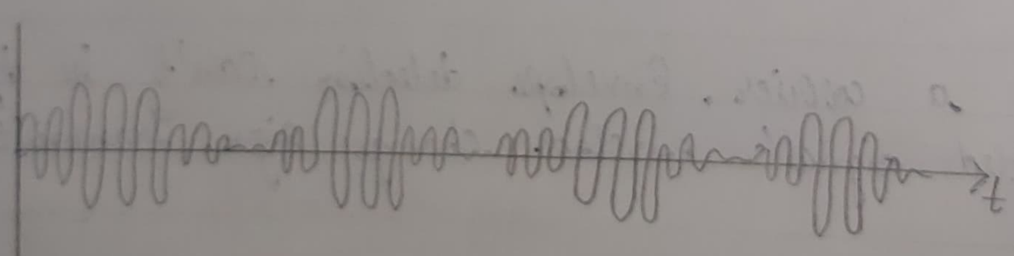
$m = 0.5$

$m = 1$

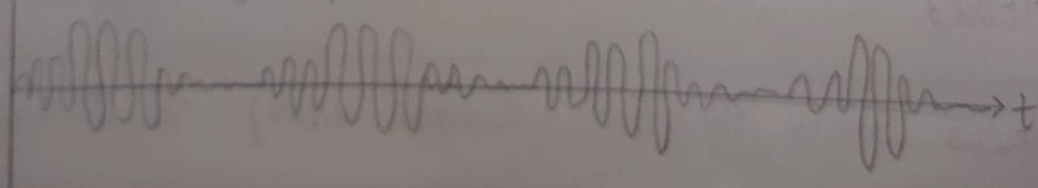
Modulation Index = 0.5 ($m < 1$)



Modulation Index = 1



Modulation Index = 1.5 ($m > 1$)



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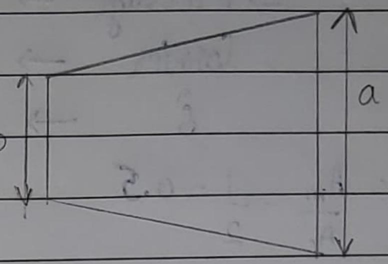
AIM :

the traperoid method

- The scope is placed in XY mode
  - X: modulating signal
  - Y: modulating signal



- The modulation index is then calculated from the vertical edge lengths using.

$$m = \frac{a-b}{a+b}$$

PROCEDURE In this online mode of practical, we perform the experiment on labAlive application.

1. We will first execute the AM analyser simulator.

2. After executing the AM analyser simulator, click on the $\hat{s}$ in the AM modulator window,

3. For D.S.B. with carrier, click on the D.C. and for D.S.B. with suppresed carrier off the D.C. Output.

4. For the different value of m observe the transmitted signal. using Oscilloscope and spectrum analyser.

Observation

Double sideband with carrier

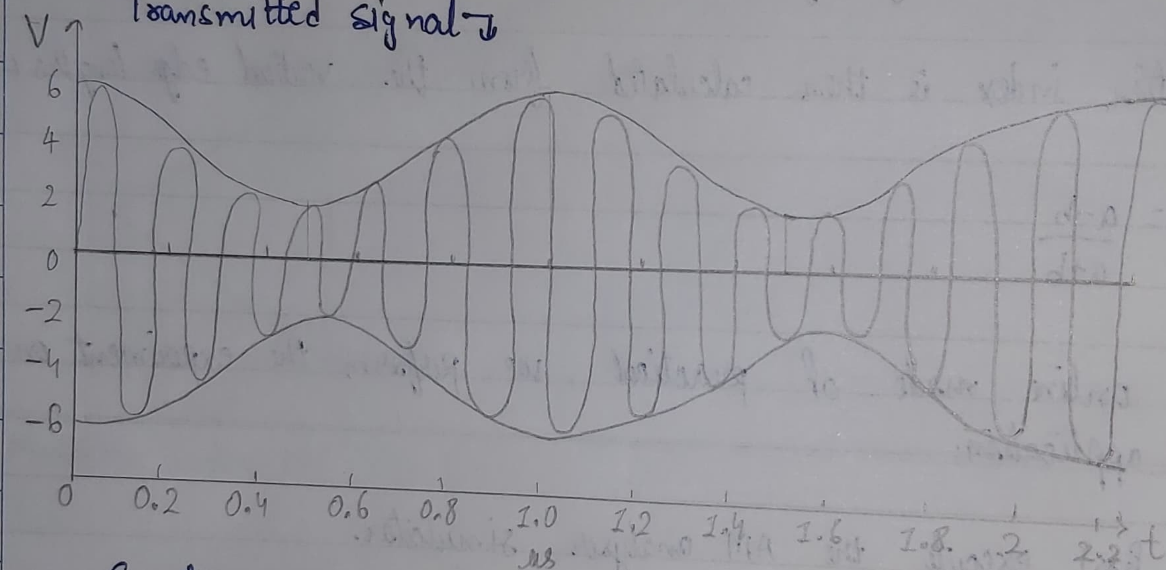
a) $m<1$ $\Rightarrow$ Message $\rightarrow$ $A_m = 1V$ $f_m = 1MHz$ (Cosine)

Carrier $\rightarrow$ $A_c = 2V$ $f_c = 20MHz$ (Cosine)

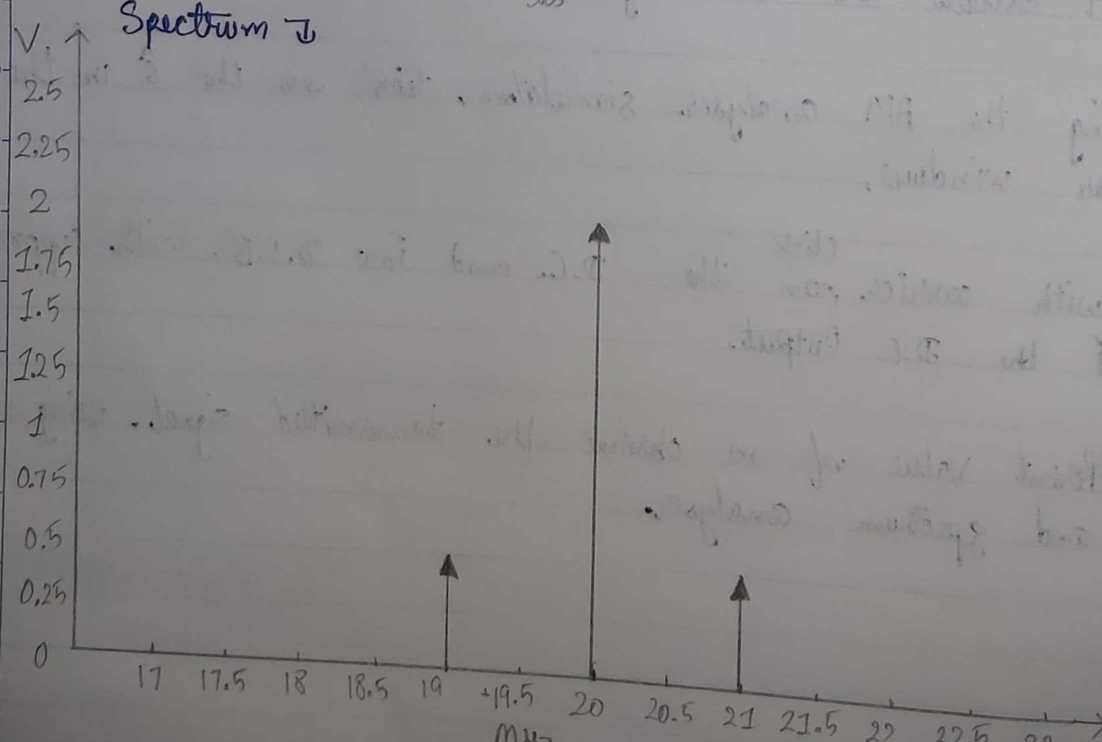
$\hat{S}$ $\rightarrow$ $A = 2V$ $f = 1MHz$ (DC on)

$$\mu = \frac{A_m}{A_c} = \frac{1}{2} = 0.5$$

Transmitted signal ↓



Spectrum ↓



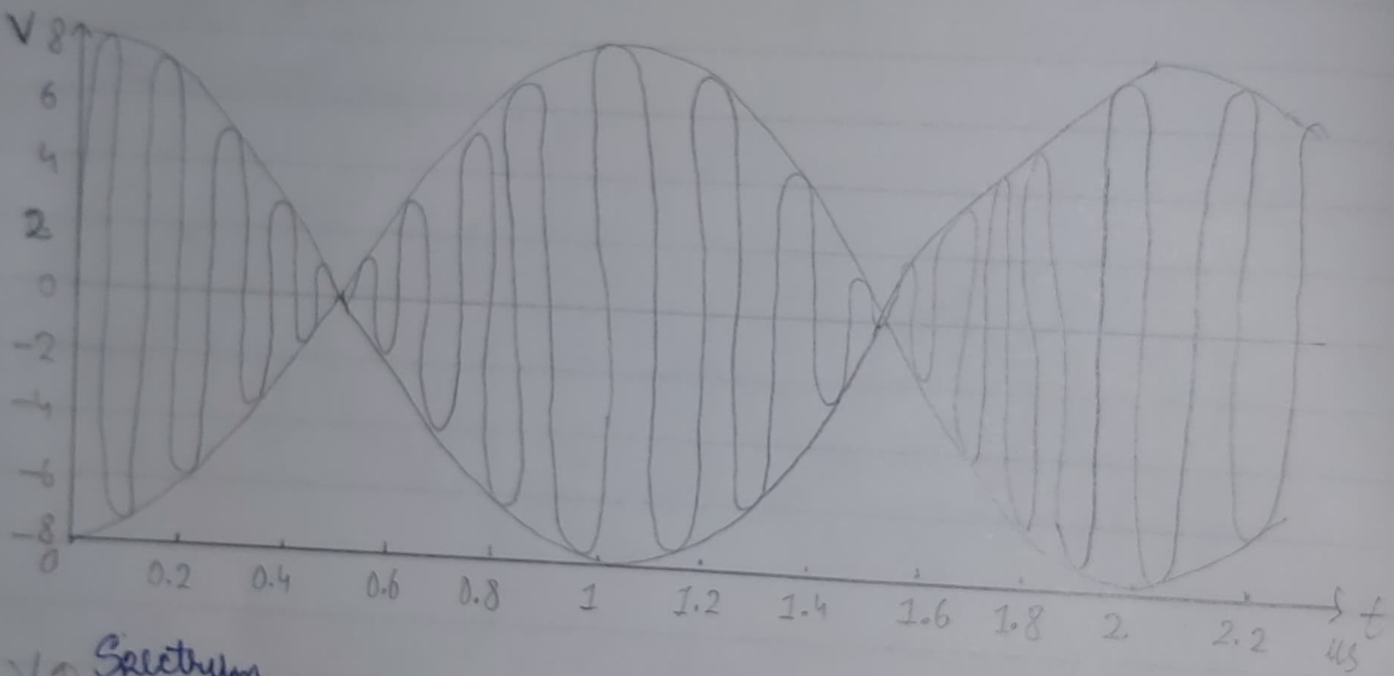
b) m = 1. ⇒ Message ⟶ $A_m = 2V$ $f_m = 1MHz$ (Cosine)

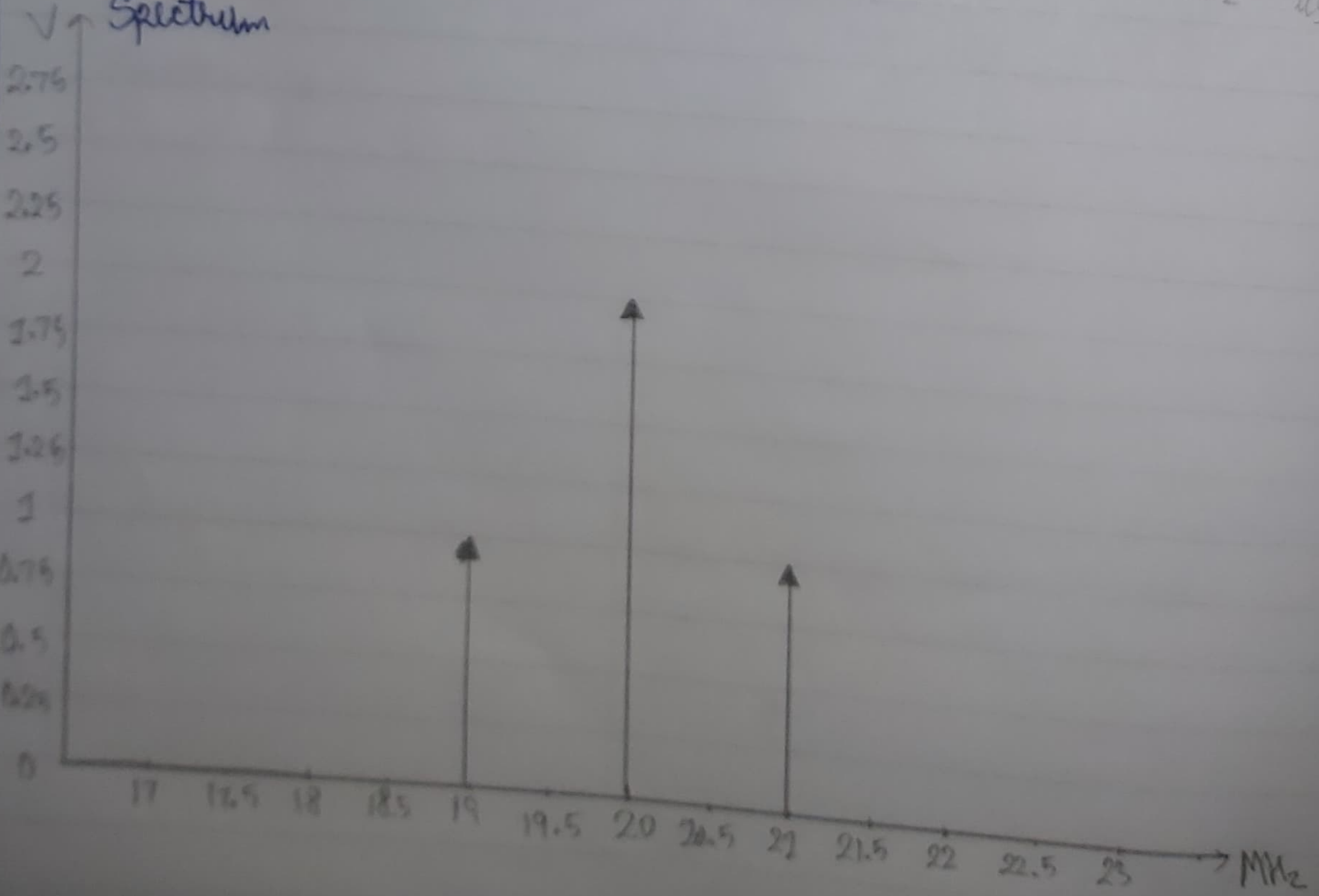
Carrier ⟶ $A_c = 2V$ $f_c = 20MHz$ (Cosine)

$\hat{s}$ ⟶ $A = 2V$ $f = 1MHz$ (DC on)

$\mu = \frac{A_m}{A_c} = 1$

Transmitted signal ⟶





c) $m > 1$

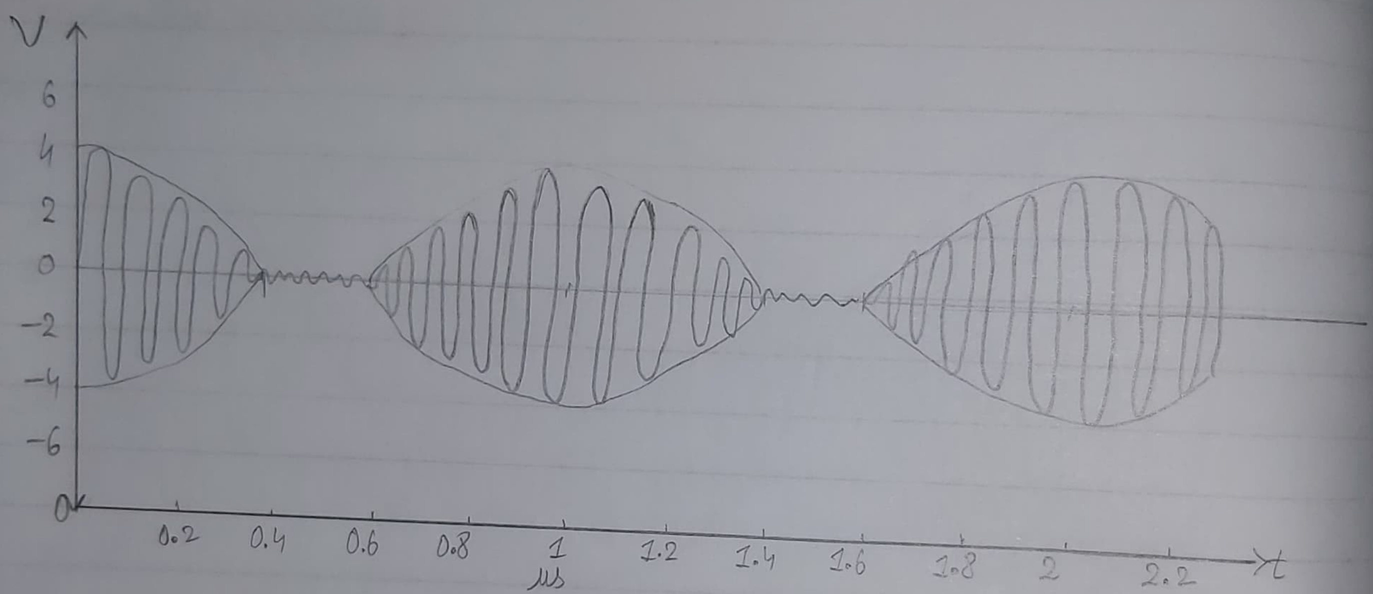
Message → $A_m = 2V$ $f_m = 1 MHz$ (Cosine)

Carrier → $A_c = 1V$ $f_c = 20 MHz$ (Cosine)

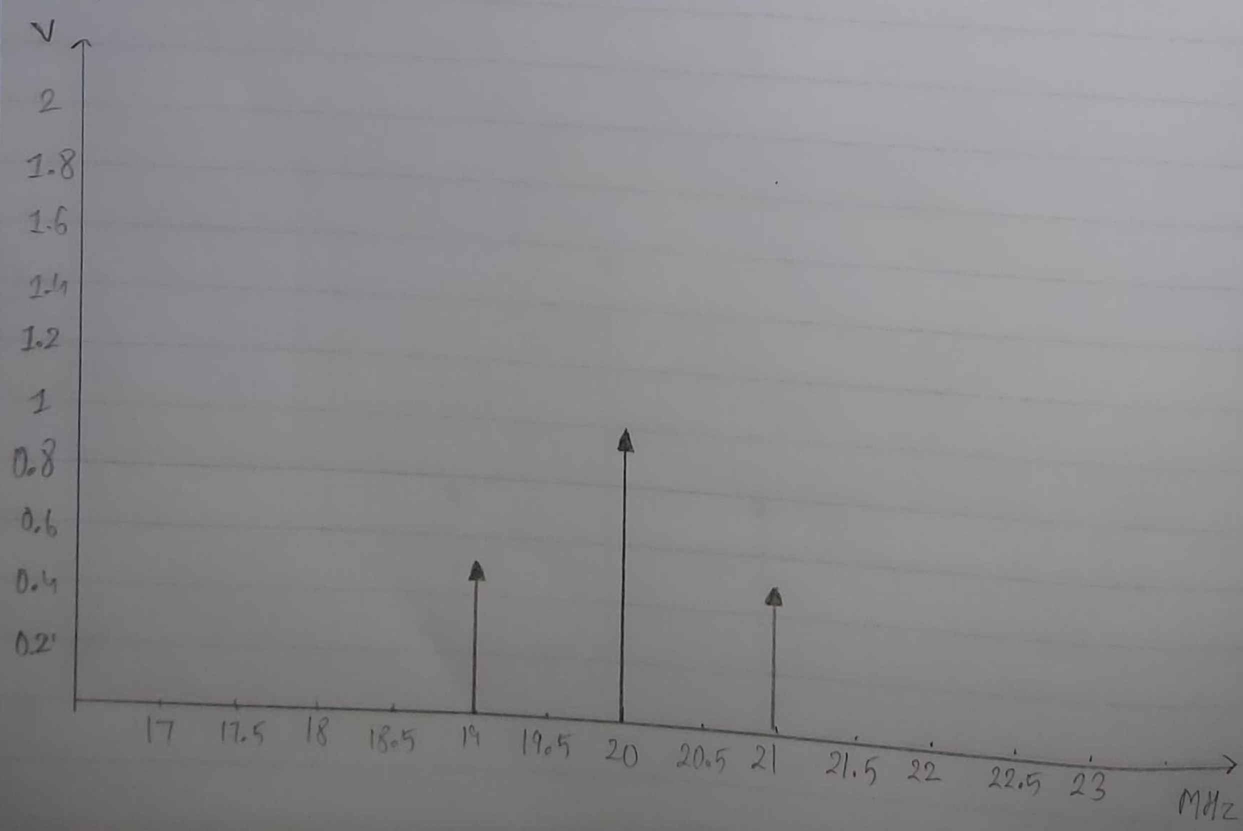
$\hat{S}$ → $A = 2V$ $F = 1 MHz$ (DC on)

$$m = \frac{A_m}{A_c} = \frac{2}{1} = 2$$

Transmitted signal ⇁



Spectrum ⇁



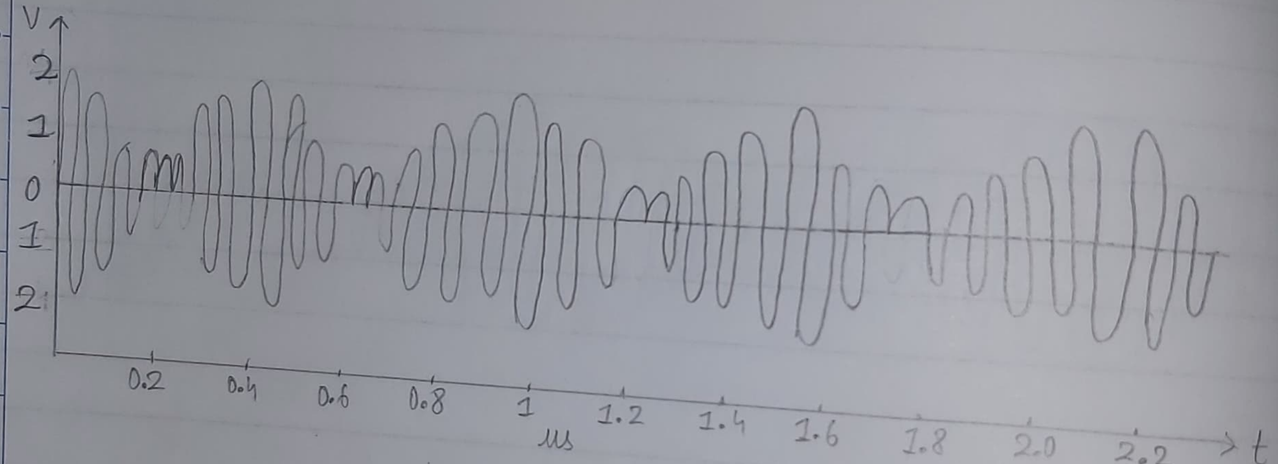
Double Sideband Suppressed Carrier. [DC offset off]

a) $m < 1$ $\Rightarrow$ Message $\rightarrow$ $A_m = 1V$ $f_m = 2\,MHz$ (Cosine)

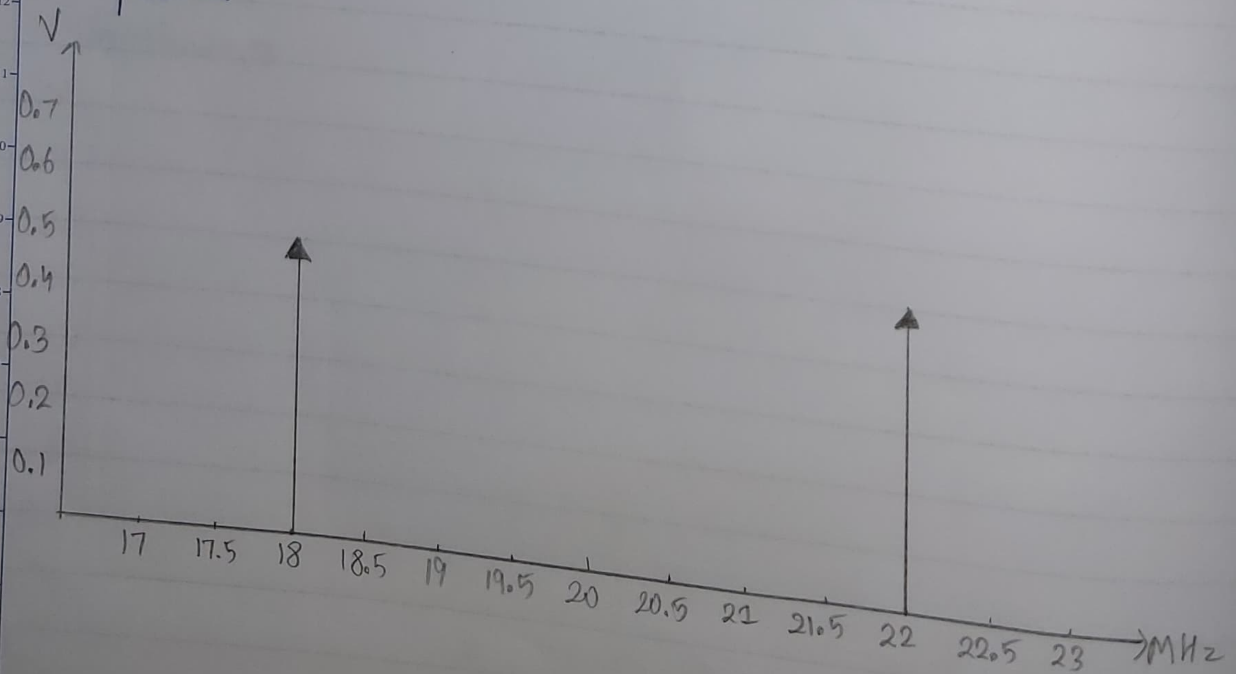
Carrier $\rightarrow$ $A_c = 2V$ $f_c = 20\,MHz$ (Cosine)

$$\mu = \frac{A_m}{A_c} = 0.5$$

Transmitted signal ↓



Spectrum

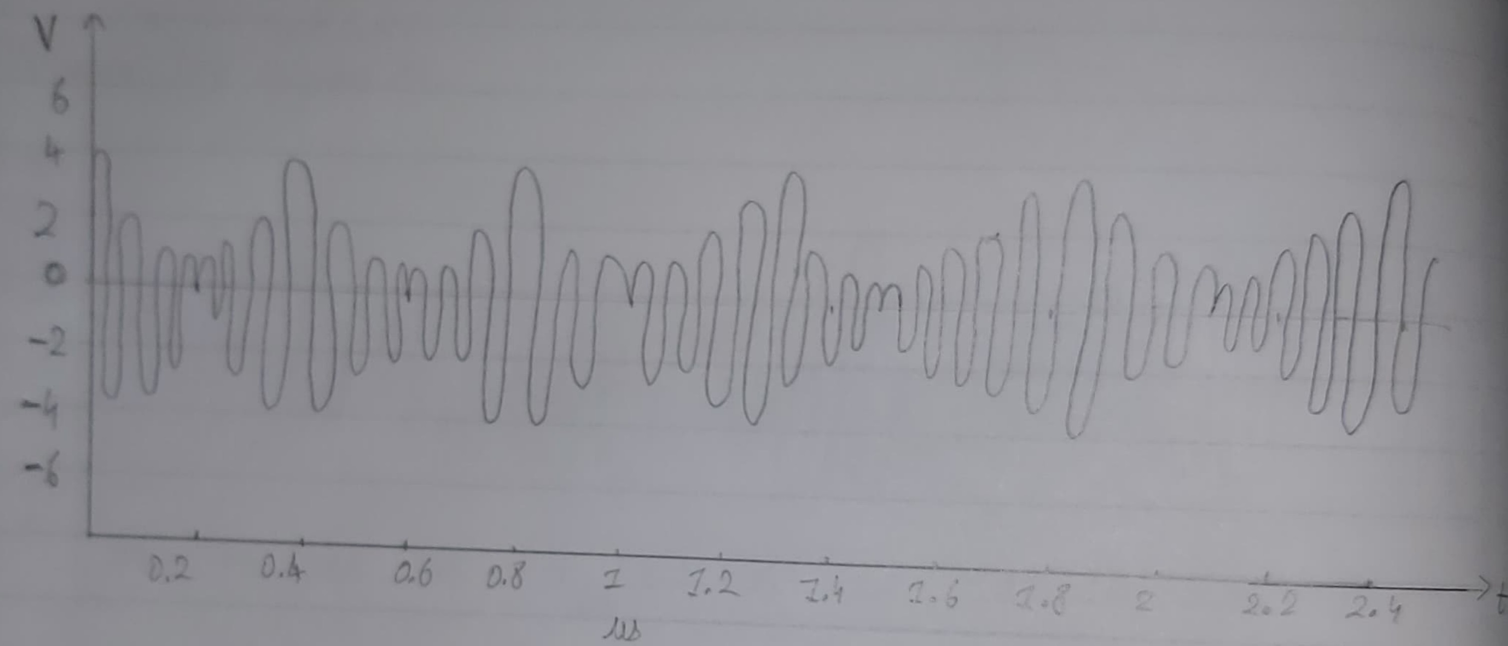


b) $m = 1 \Rightarrow$ Message $\rightarrow A_m = 2V$ $f_m = 2MHz$ (Cosine)

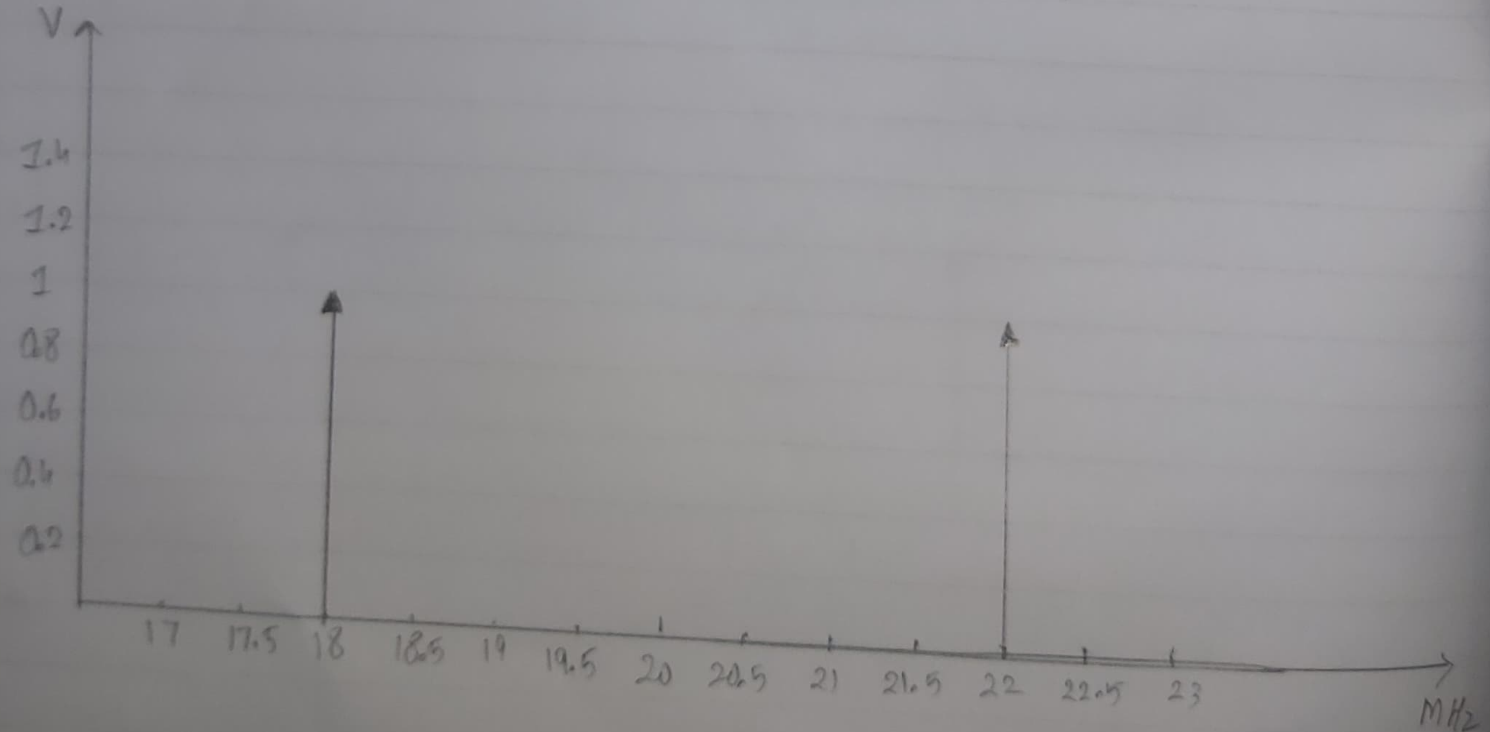
Carrier $\rightarrow A_c = 2V$ $f_c = 20MHz$ (Cosine)

$$\mu = \frac{A_m}{A_c} = \frac{2}{2} = 1$$

Transmitted signal :-



Spectrum

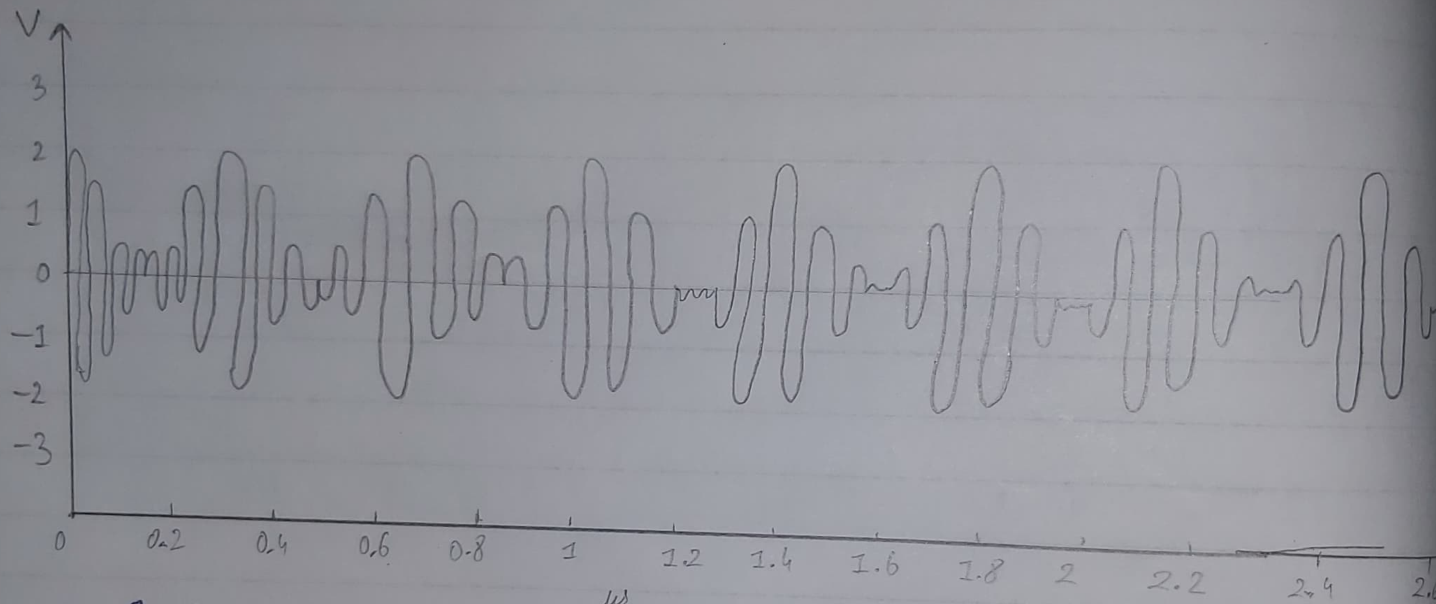


C) $m > 1$ $\Rightarrow$ Message $\Rightarrow$ $A_m = 2V$ $f_m = 2\,kHz$ (Cosine)

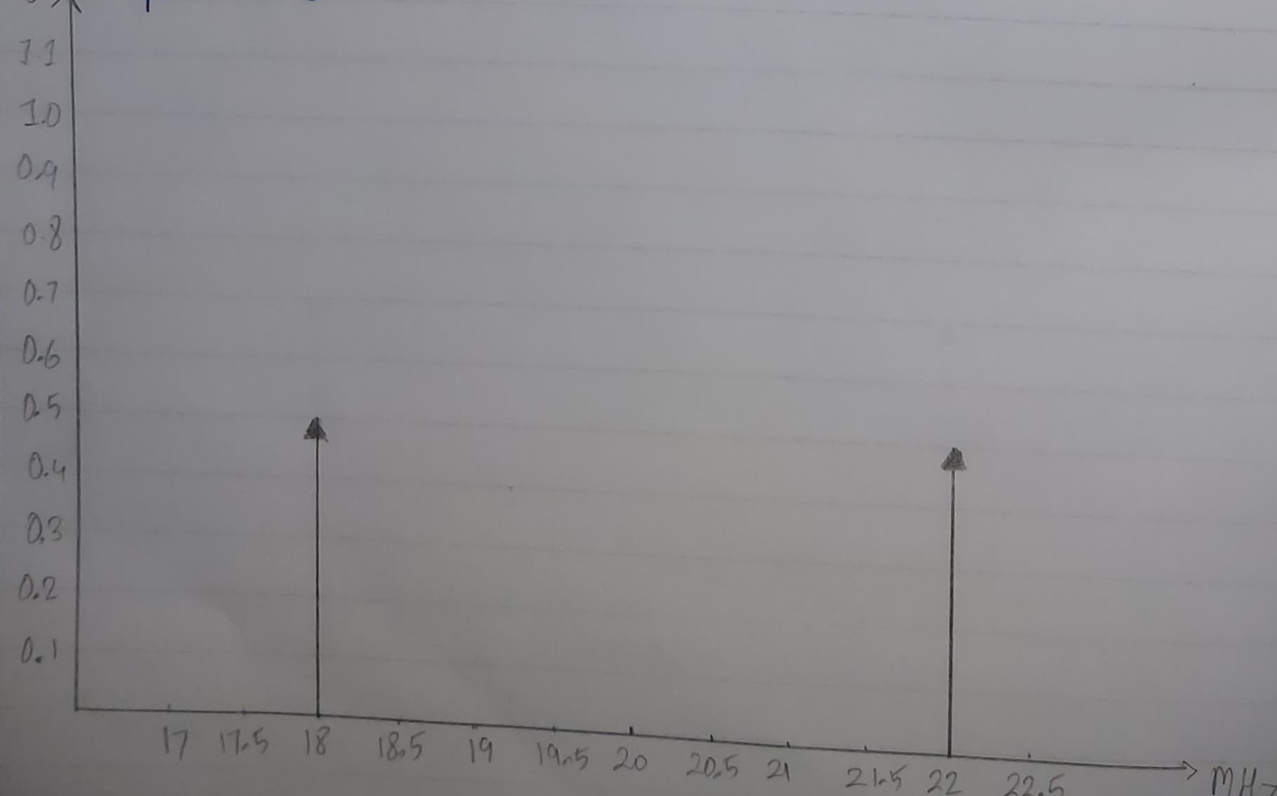
Carrier $\Rightarrow$ $A_c = 1V$ $f_c = 20\,kHz$ (Cosine)

$$\mu = \frac{A_m}{A_c} = \frac{2}{1} = 2$$

Transmitted signal :



Spectrum :



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AIM :

OBSERVATION.

Double Sideband with Carrier.

Sr. No.	A_m (V) Message	F_m (MHz) Message	A_c (V) Carrier	F_c (MHz) Carrier	A (V) $\hat{\delta}$	F (MHz) $\hat{\delta}$	μ
1	1	1	2	20	2	1	0.5
2	2	1	2	20	2	1	1
3	2	1	1	20	2	1	2

Double Sideband with Suppressed Carrier

Sr. No.	Message		Carrier		Modulation
	A_m (V)	F_m (MHz)	A_c (V)	F_c (MHz)	Index (μ)
1	1	2	2	20	0.5
2	2	2	2	20	1
3.	2	2	1	20	2

CONCLUSION: We observe that using Envelope Detector we can detect Double Sideband with Carrier but Synchronous detector is needed for Double Sideband Suppressed carrier. We also observe that information lies in sidebands and in carrier. So Using DSBSC we can minimize our power usage.