U20CS110 Date

Expt. No. 03 **Amplitude Modulation** Page No. 10

Aim: To study amplitude modulated (AM) technique, modulation index (m), draw waveforms, spectra and trapezoidal display. Illustrate the observed AM signals for double sideband with and without carrier by changing m as: $m>1$, $m<1$ and $m=1$ and draw it. Use virtual mode with appropriate software.

Apparatus - online stimulation tools
1. labalive AM analyser
2. Envelope dettector
3. synchronous detector

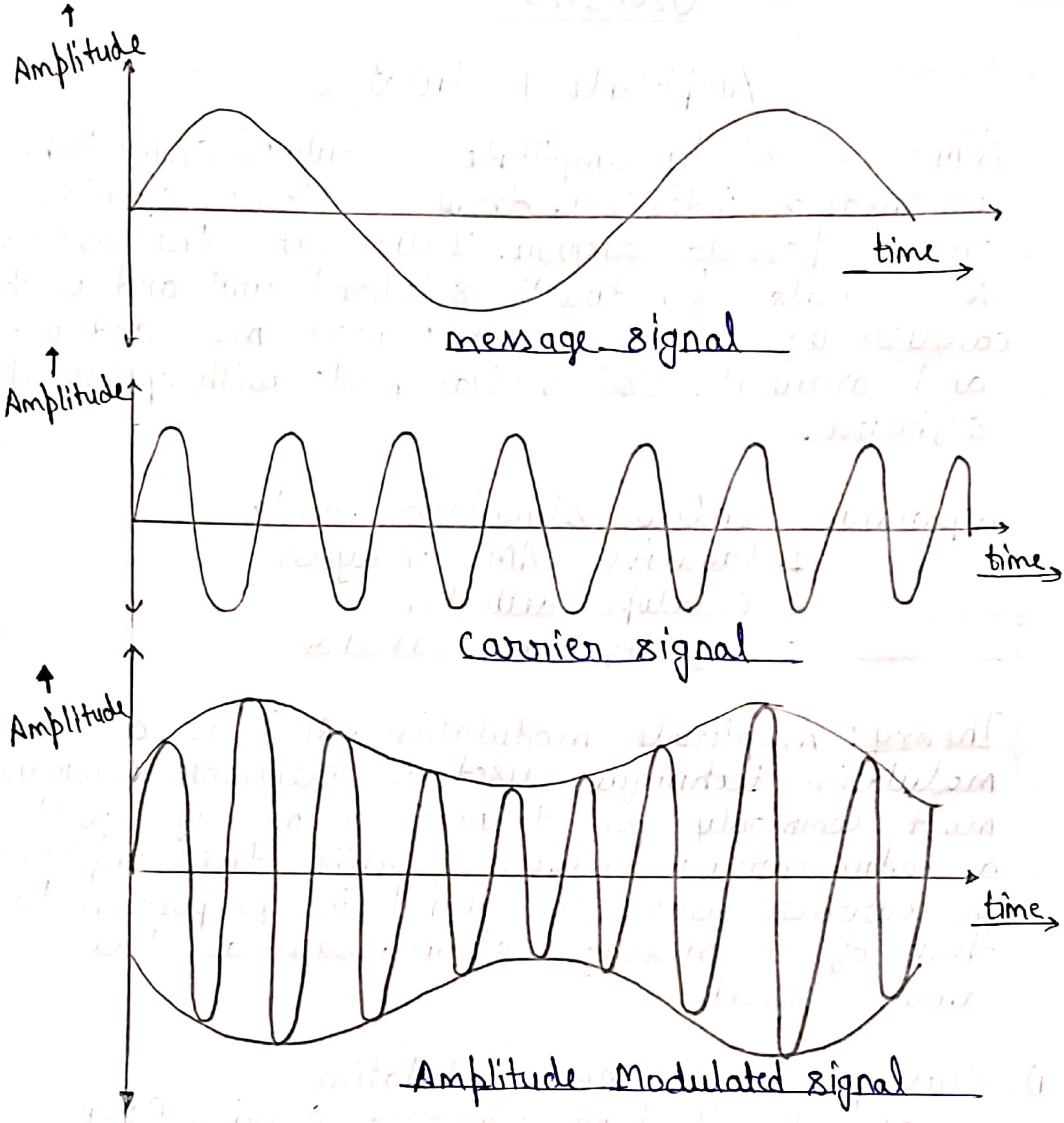
Theory: Amplitude modulation (AM) is a modulation technique used in electronic communication most commonly for transmitting messages with a radio carrier wave. In this, the amplitude of carrier wave is varied in proportion to that of a message signal, such as the audio signal.

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 $m(t)$

Teacher's Signature :

Scanned with CamScanner



Amplitude Modulation of a sinusoidal wave

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

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

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

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

$$s(t) = A_c[1 + m \cos(2\pi f_m t)] \cos(2\pi f_c t)$$

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

3) Measurement of 'm'

- The magnitude of 'm' can be measured directly from the AM signal itself
- 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; $b = A_c - A_m$

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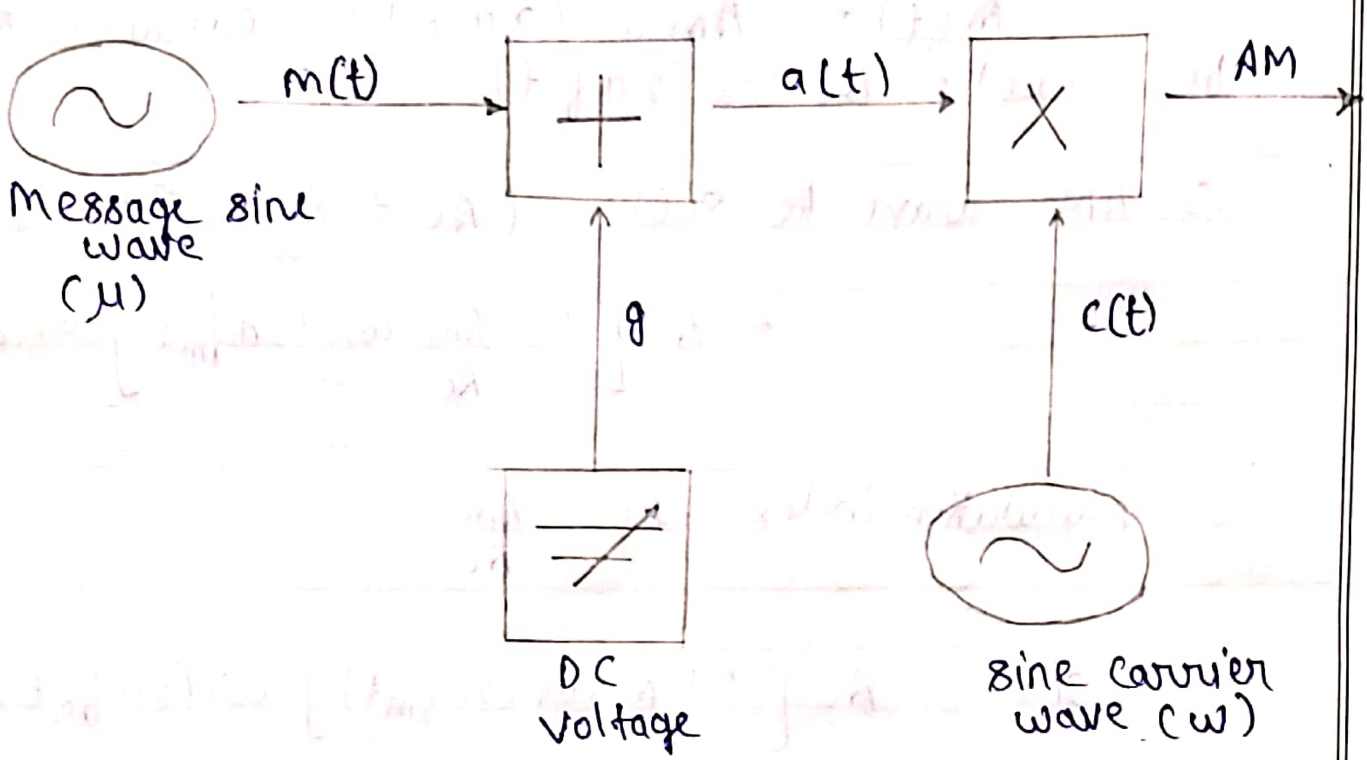
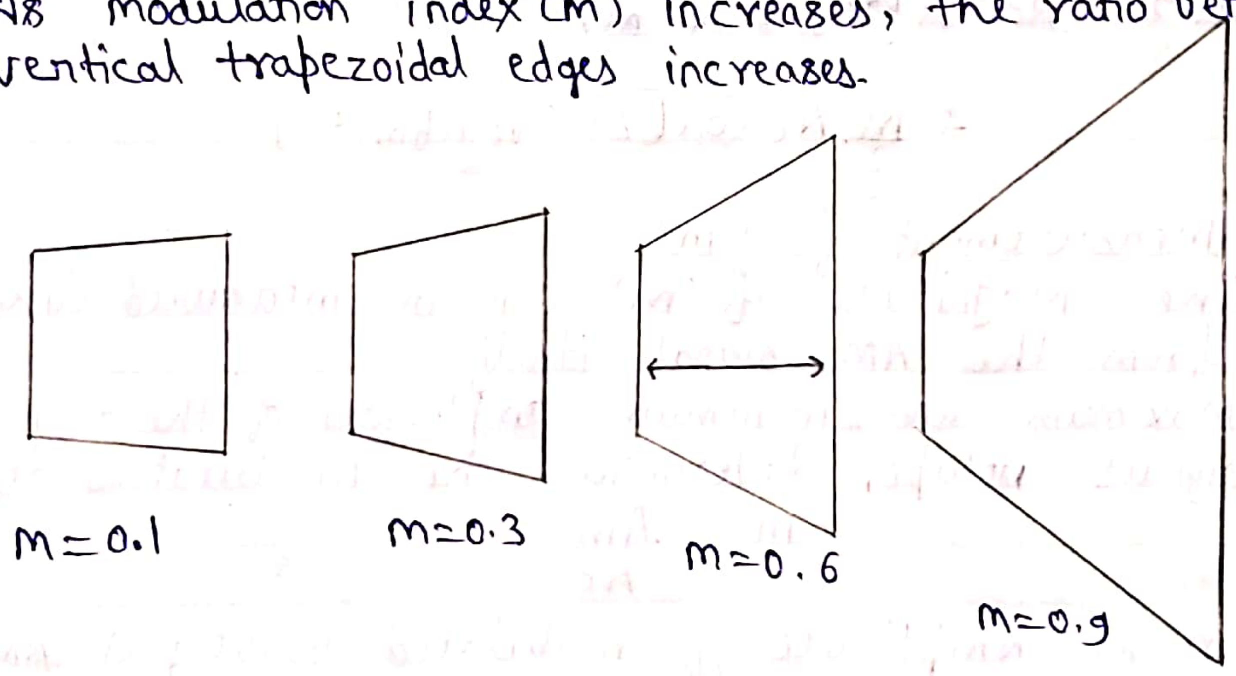
Block Diagram :-



Trapezoidal Display

As modulation index (m) increases, the ratio between vertical trapezoidal edges increases.



- The Trapezoid width is unaffected by modulation depth

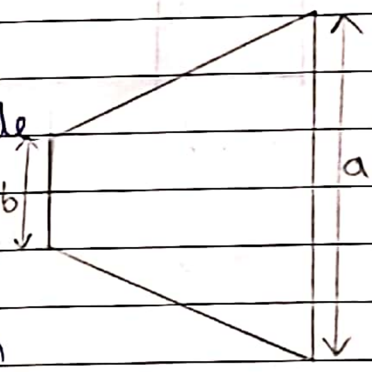
$$\therefore A_c = \frac{a+b}{2}, \quad A_m = \frac{a-b}{2}$$

$$\boxed{m = \frac{(a-b)}{(a+b)}}$$

4) Envelope detector :- The non-coherent detection doesn't require a carrier recovery circuit. In its simplified form, it consists of rectifier diode and a low pass filter

5) Synchronous detector: AM without a carrier envelope detection can't be deployed because the transmitted signals envelope changes sign. transmit spectrum of DSB-SC.

Trapezoid Method
We can calculate 'm' in the time domain using an oscilloscope and the trapezoid method.



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

- The modulating index is then calculated from the vertical edge length using

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

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Observation

1) Double sideband with carrier (DC offset = ON)

m = modulation index

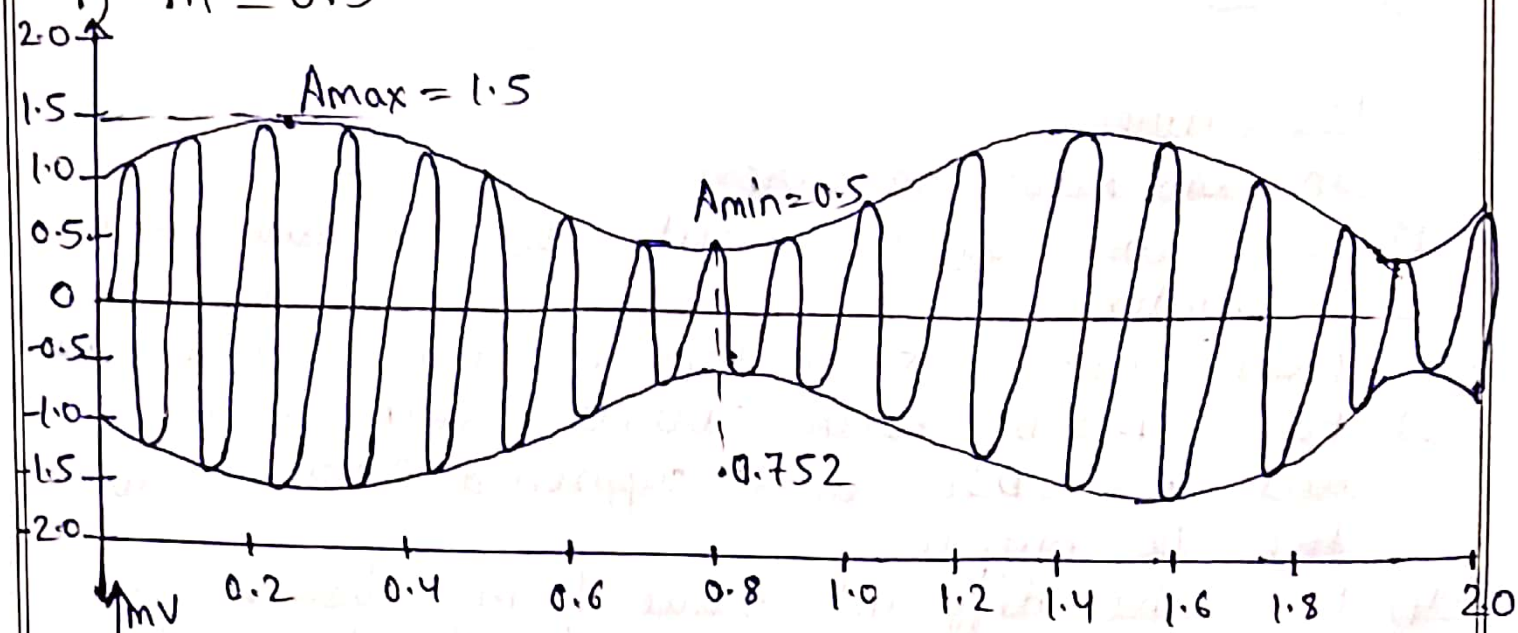
Sr. No.	relation	m (modulation index)
①	$m<1$	0.5
		0.8
②	$m=1$	1.0
③	$m>1$	1.2
		1.5

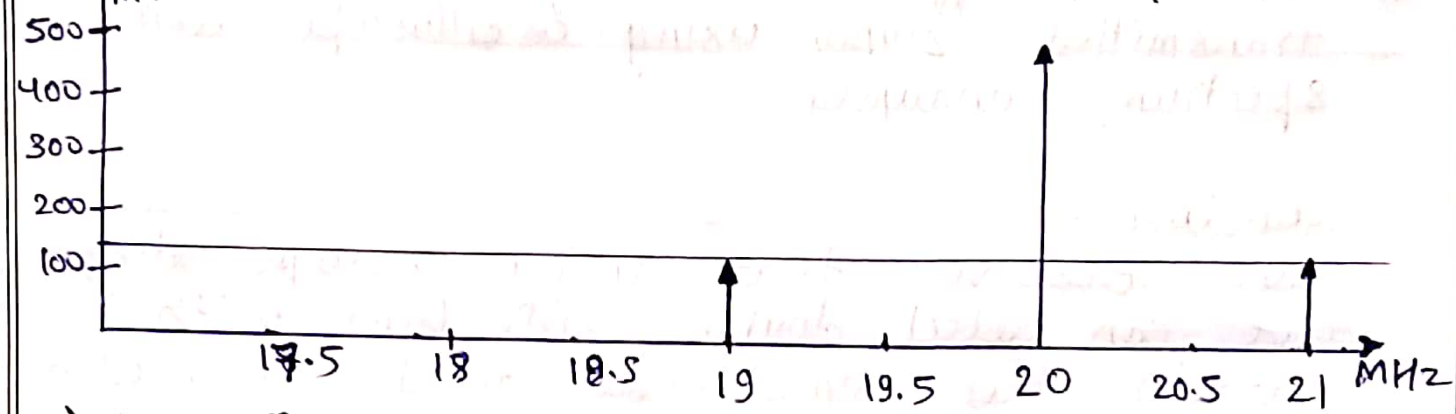
2) Double sideband carrier (DC offset = off)

S. No.	relation	m (modulation index)
①	$m<1$	0.5
		0.8
②	$m=1$	1.0
③	$m>1$	1.2
		1.5

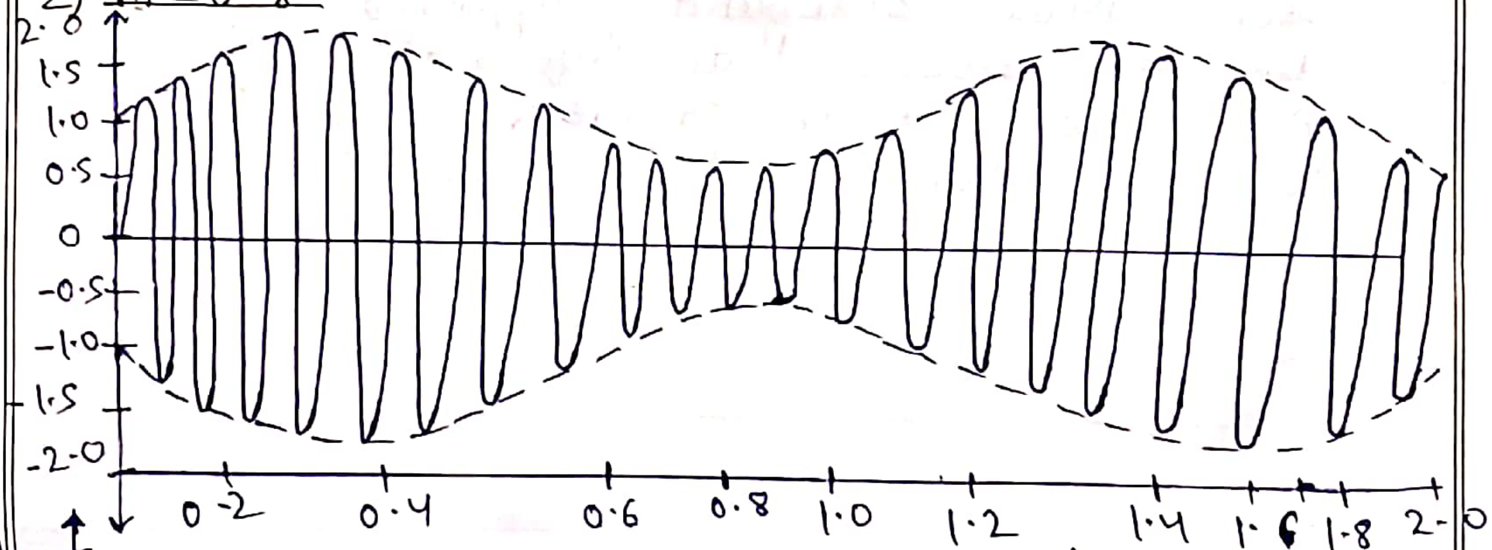
Double side band with Carrier

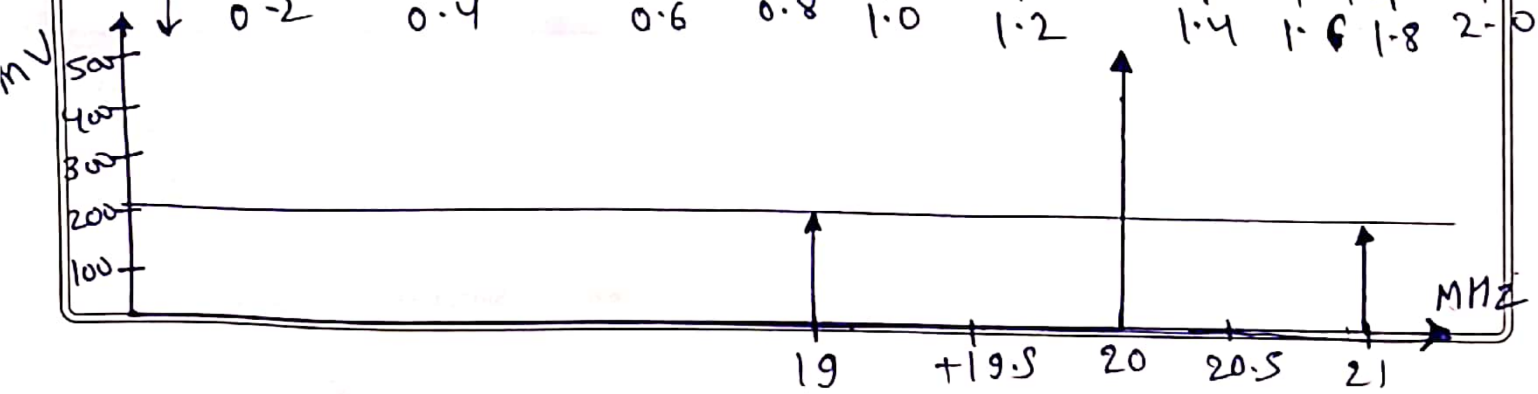
1) M = 0.5



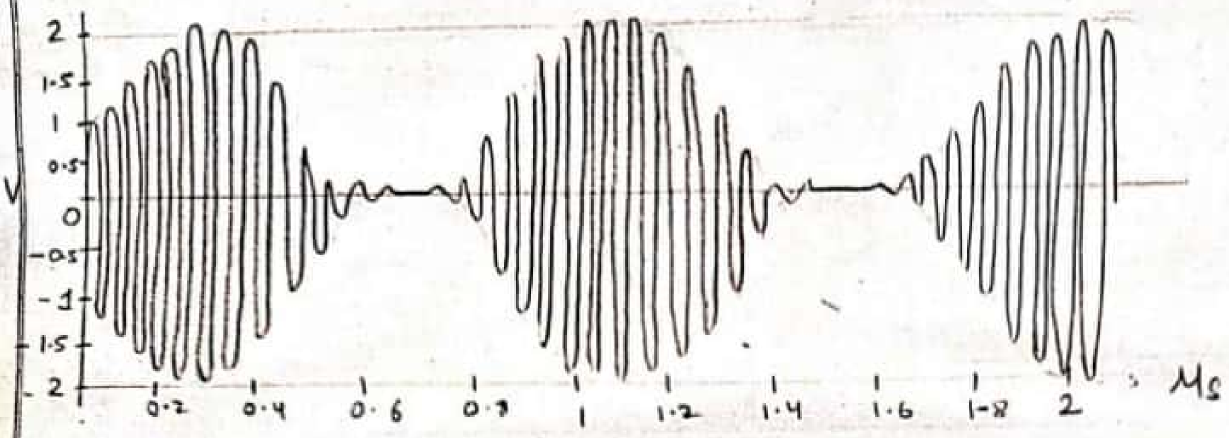


2) M = 0.8

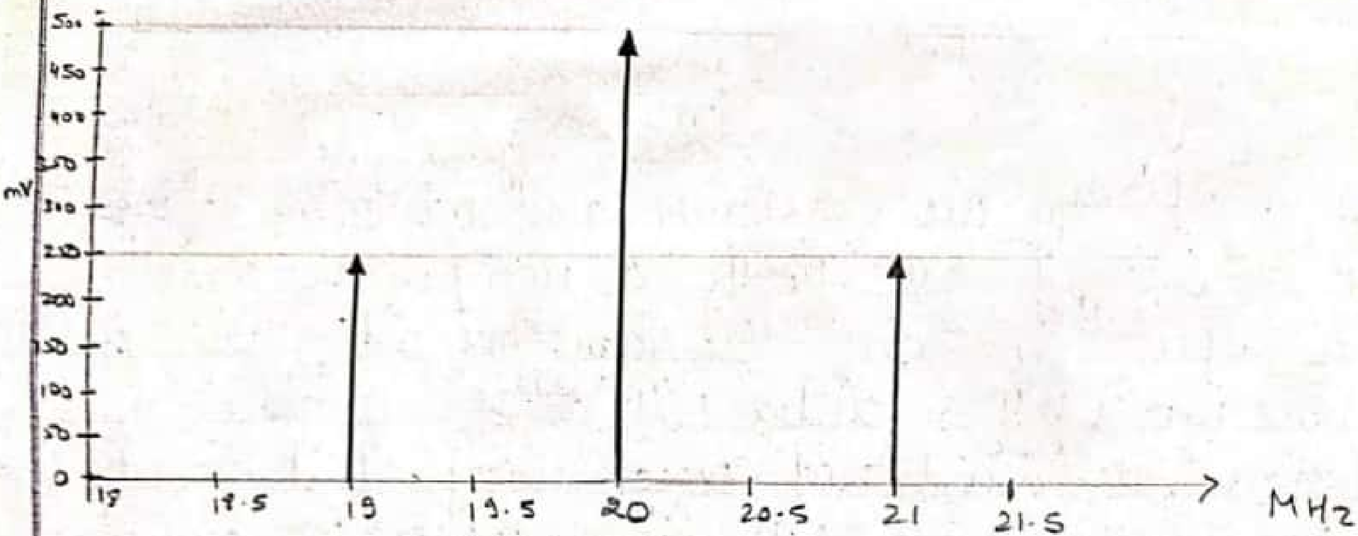




3) m = 1

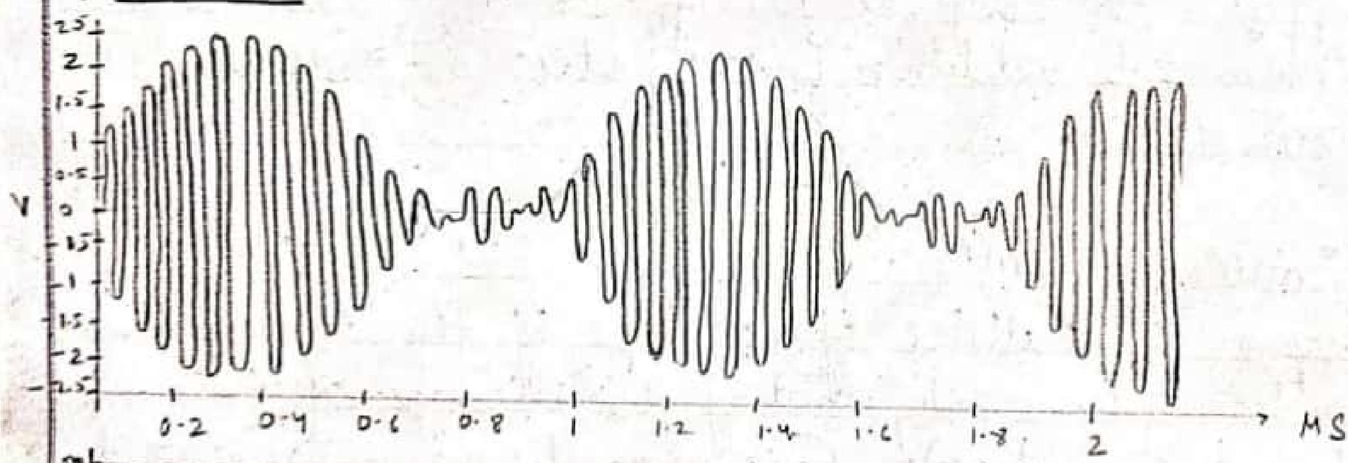


V
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Ms

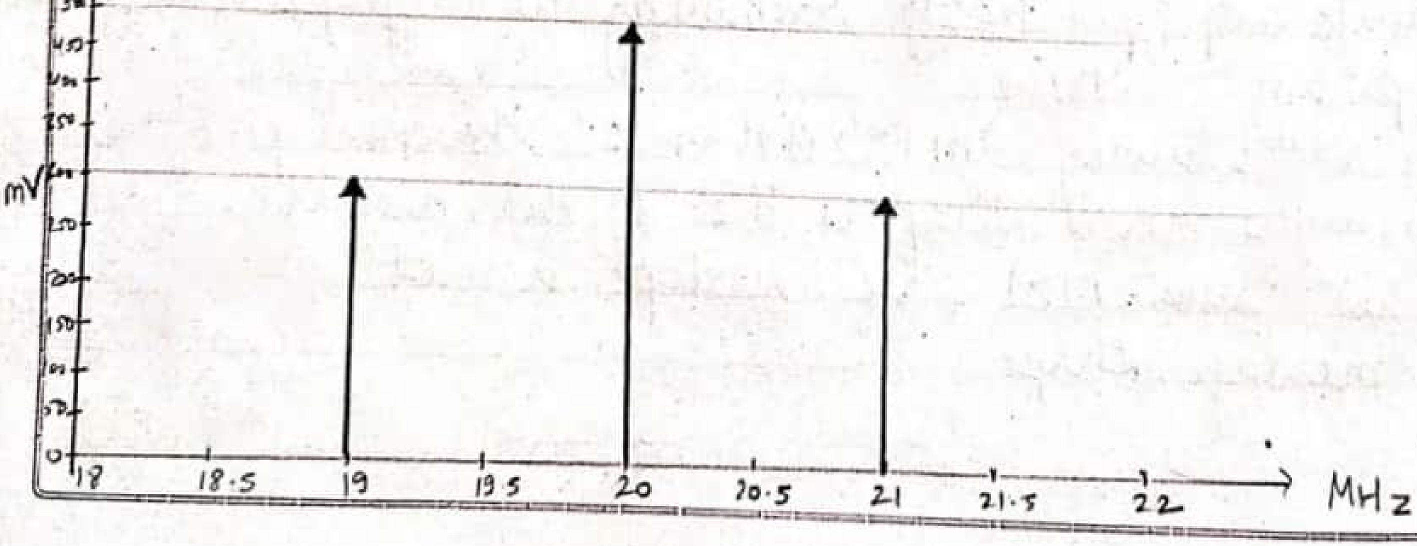


mV
500
450
400
0
18
18.5
19
19.5
20
20.5
21
21.5
MHz

4) m = 1.2

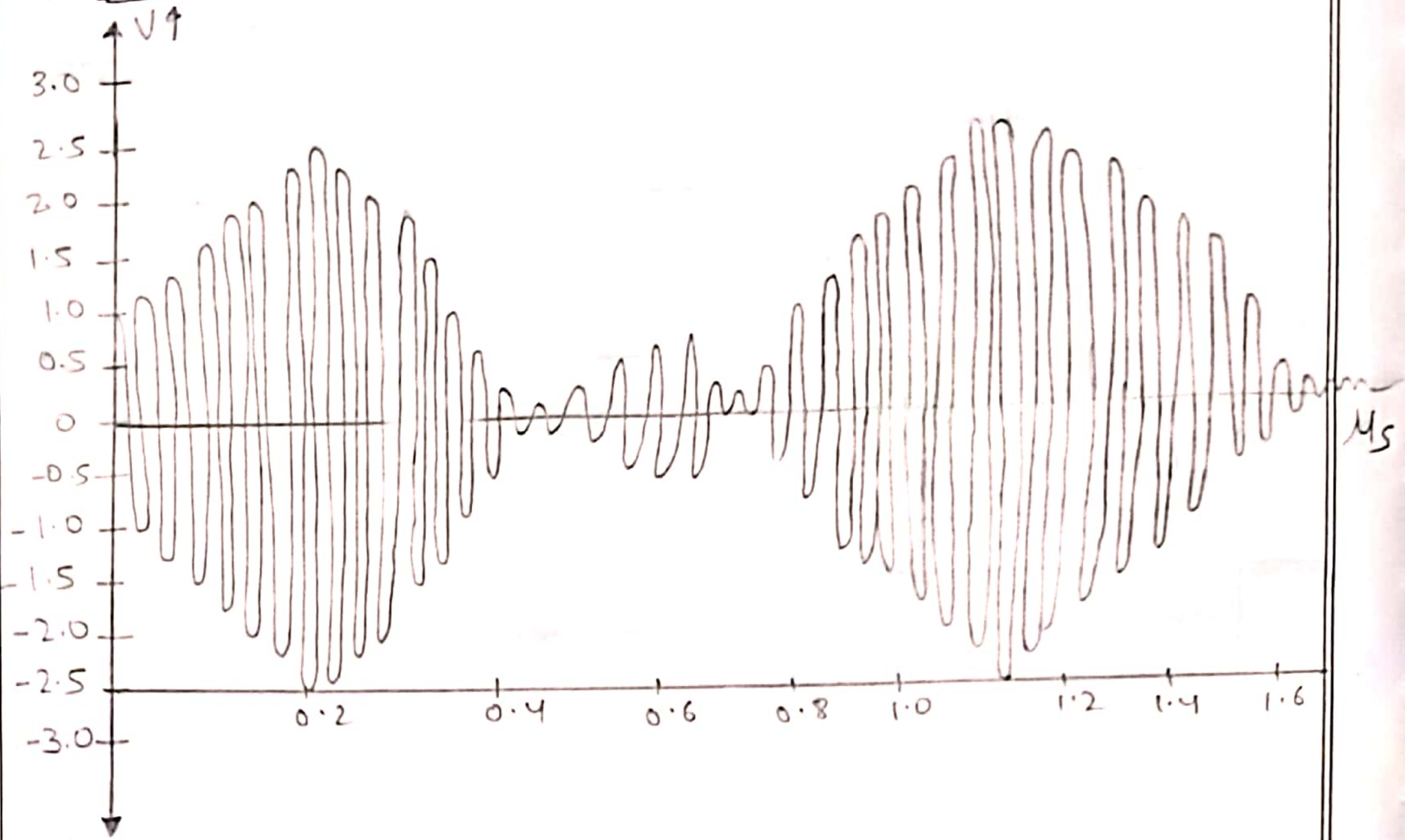


V
2.5
2
1.5
1
0.5
0
-1
-1.5
-2
-2.5
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
MS

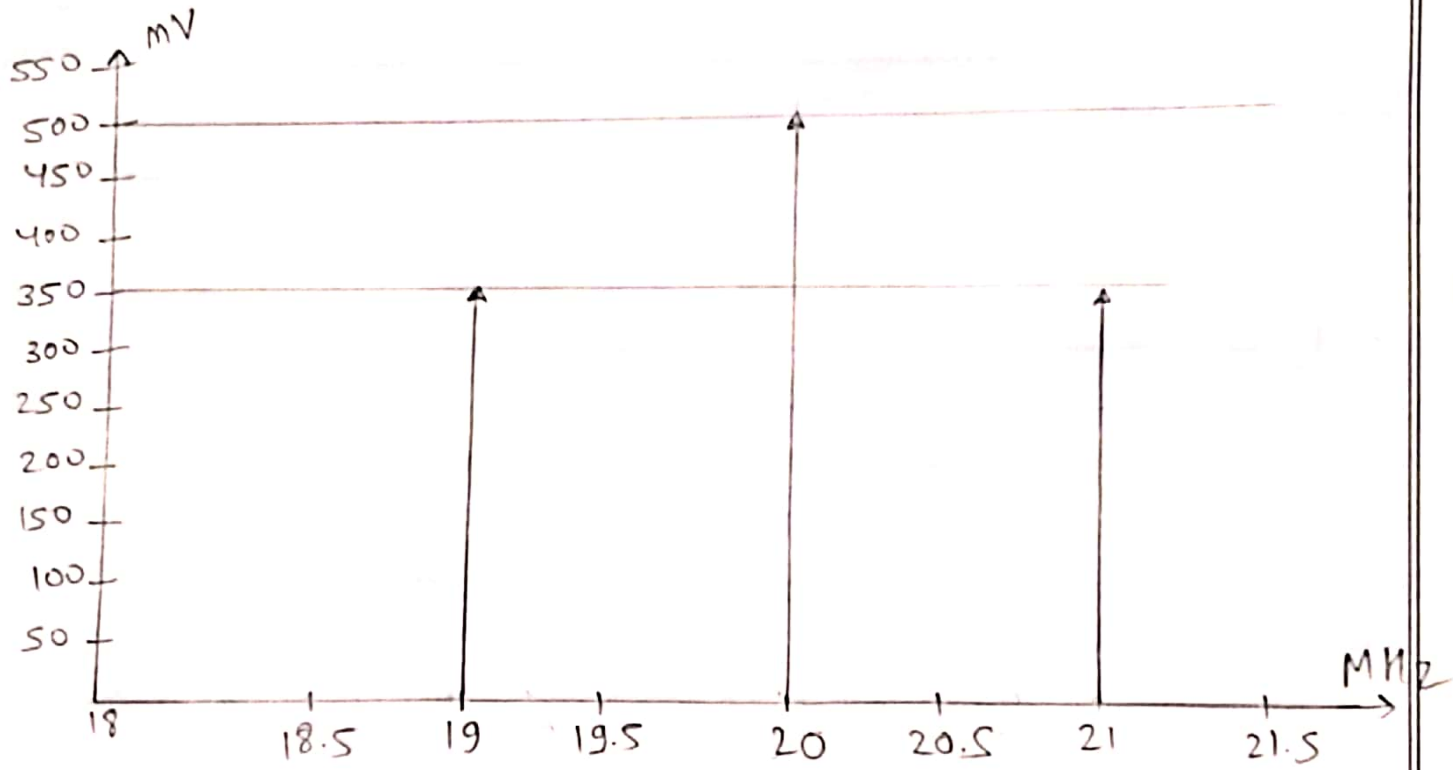


mV
450
0
18
18.5
19
19.5
20
20.5
21
21.5
22
MHz

5) M = 1.5



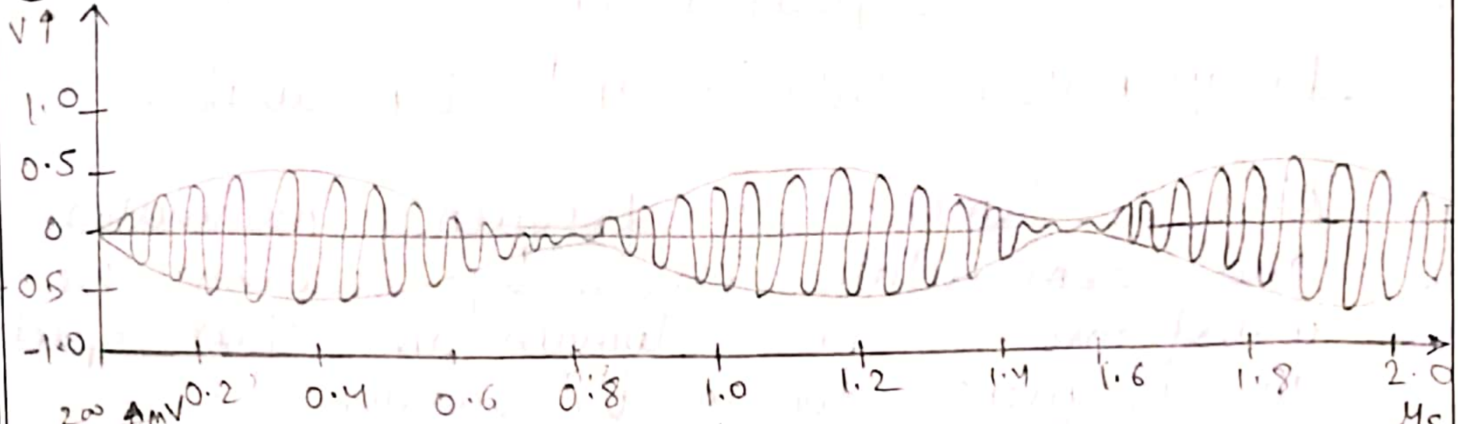
V
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
µs

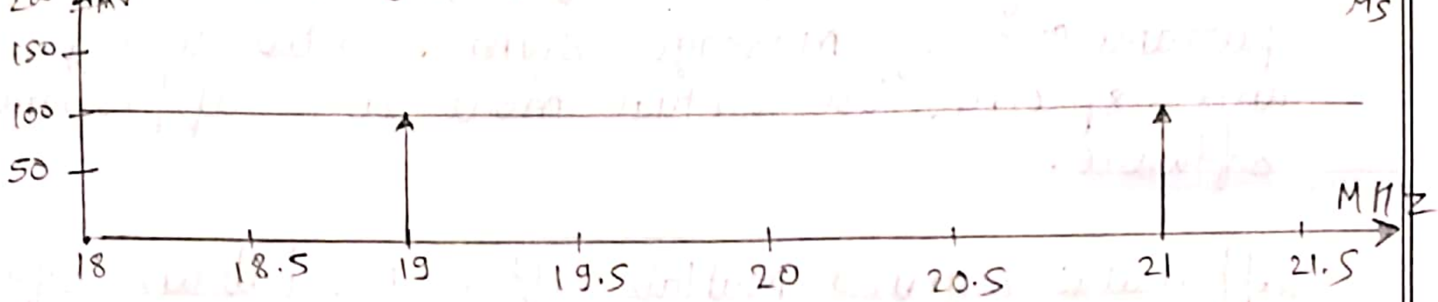


mV
550
500
450
400
350
300
250
200
150
100
50
18
18.5
19
19.5
20
20.5
21
21.5
MHz

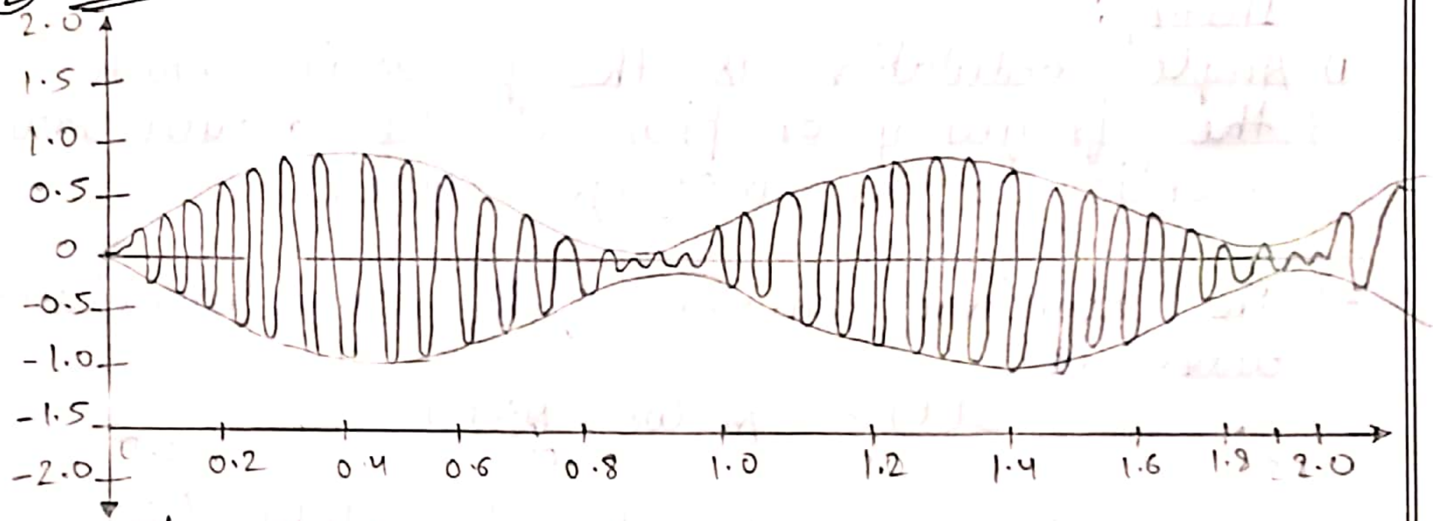
Double Sideband Suppressed Carrier:

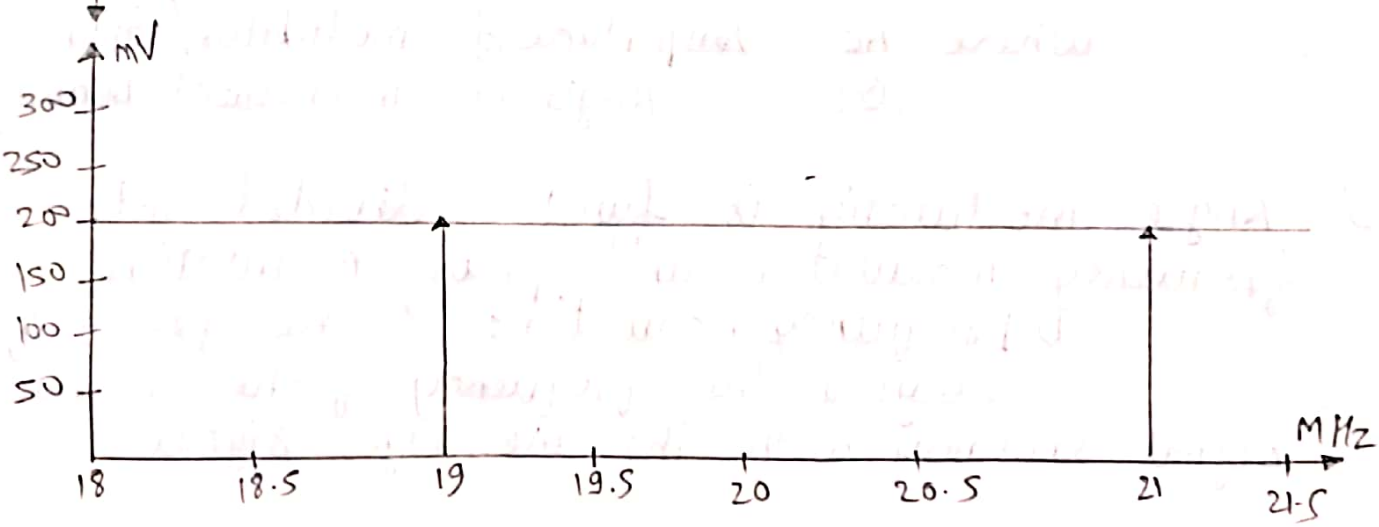
① m = 0.5



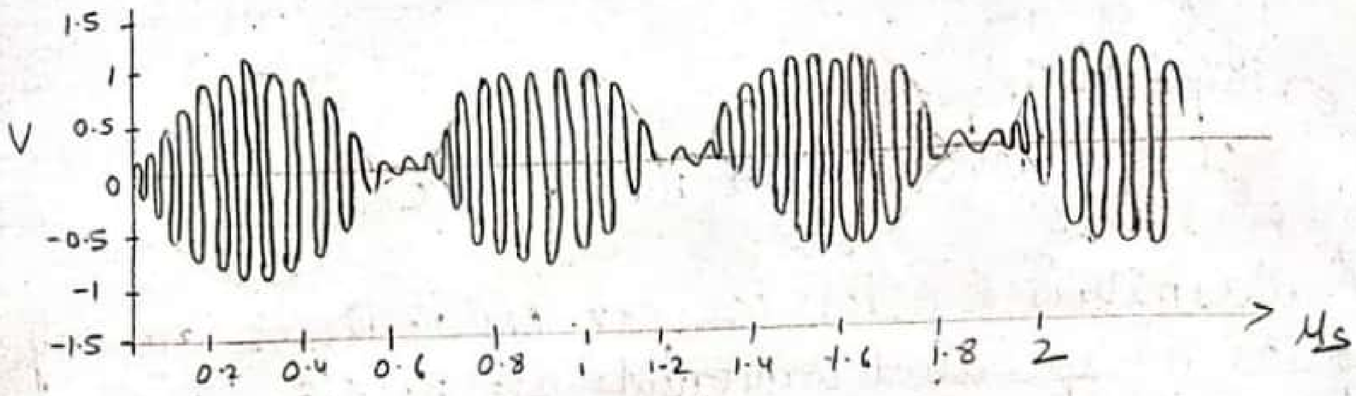


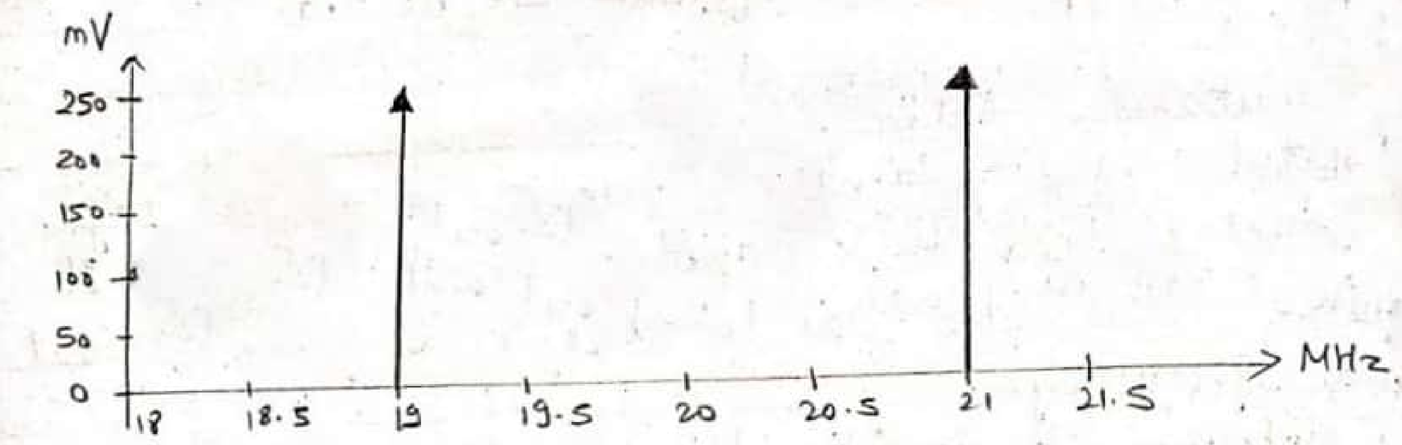
② m = 0.8



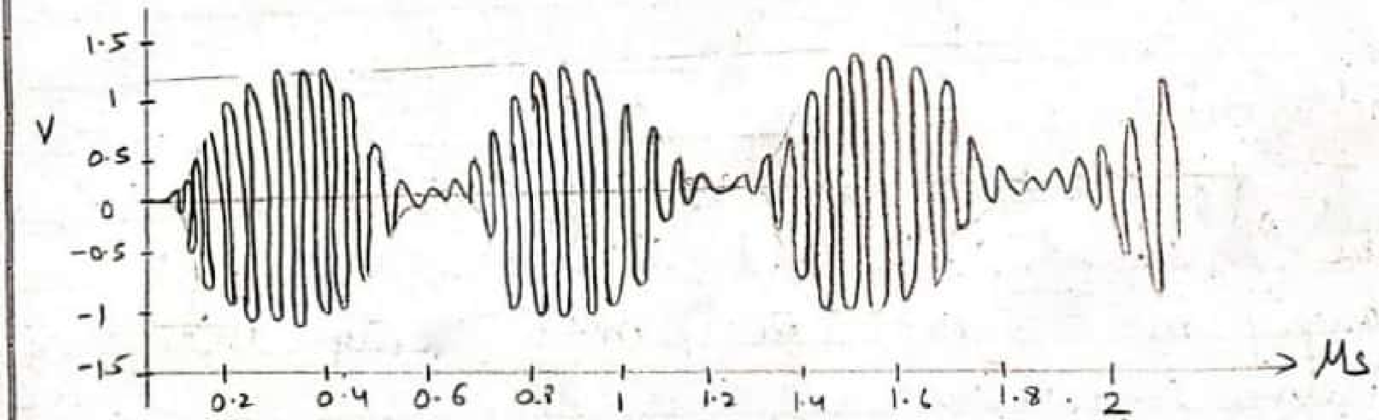


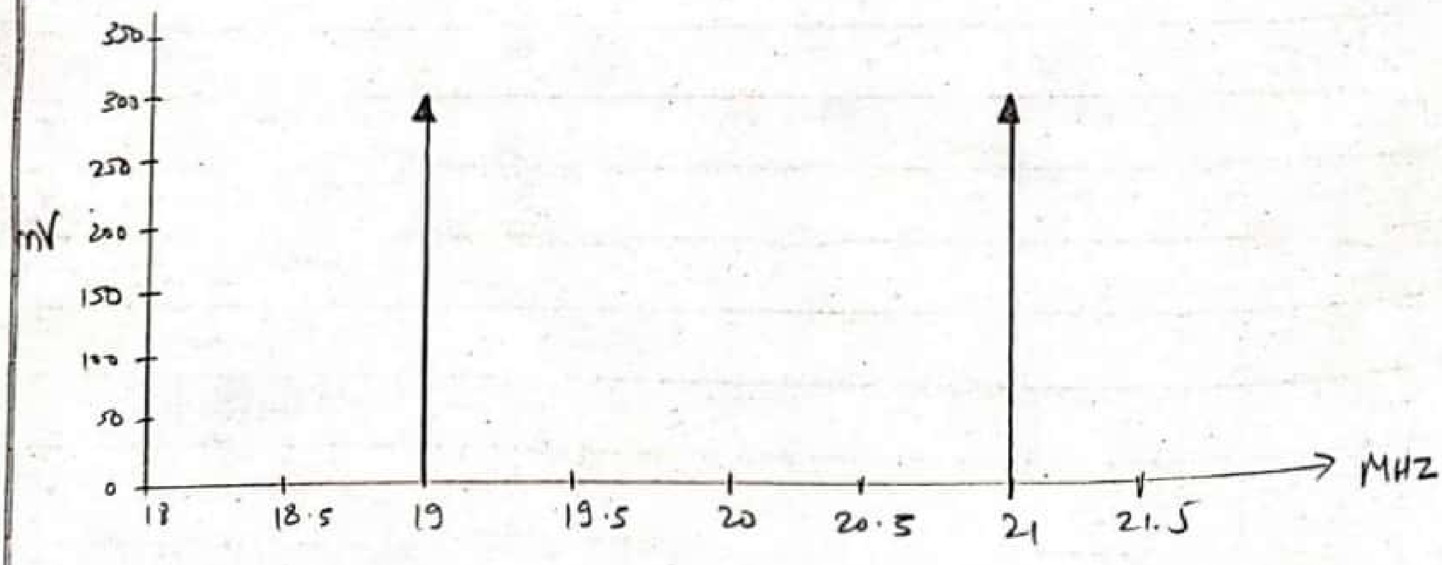
3) m = 1


1.5
1
0.5
0
-0.5
-1
-1.5
V
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
µs

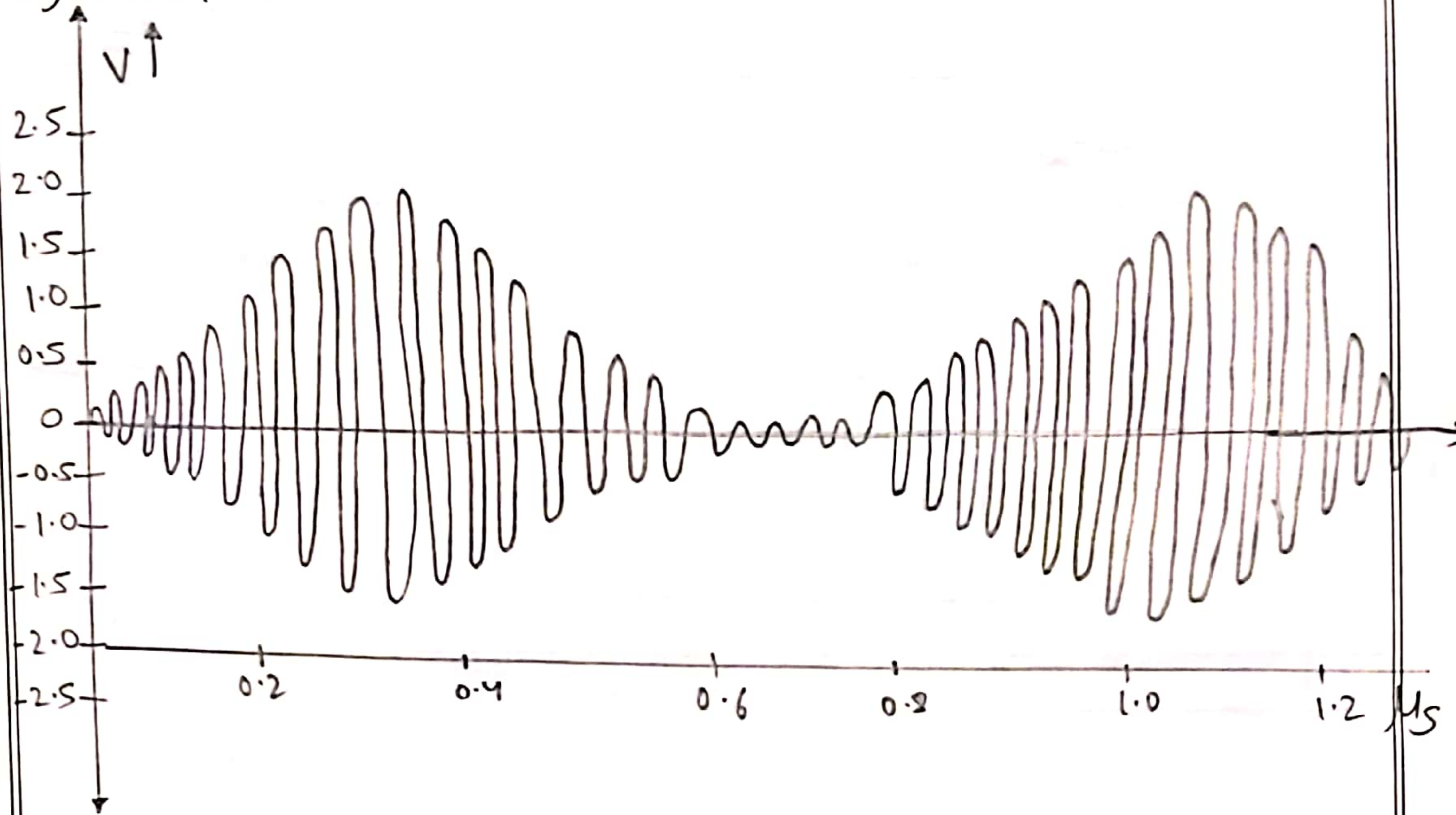

mV
250
200
150
100
50
0
18
18.5
19
19.5
20
20.5
21
21.5
MHz

4) m = 1.2

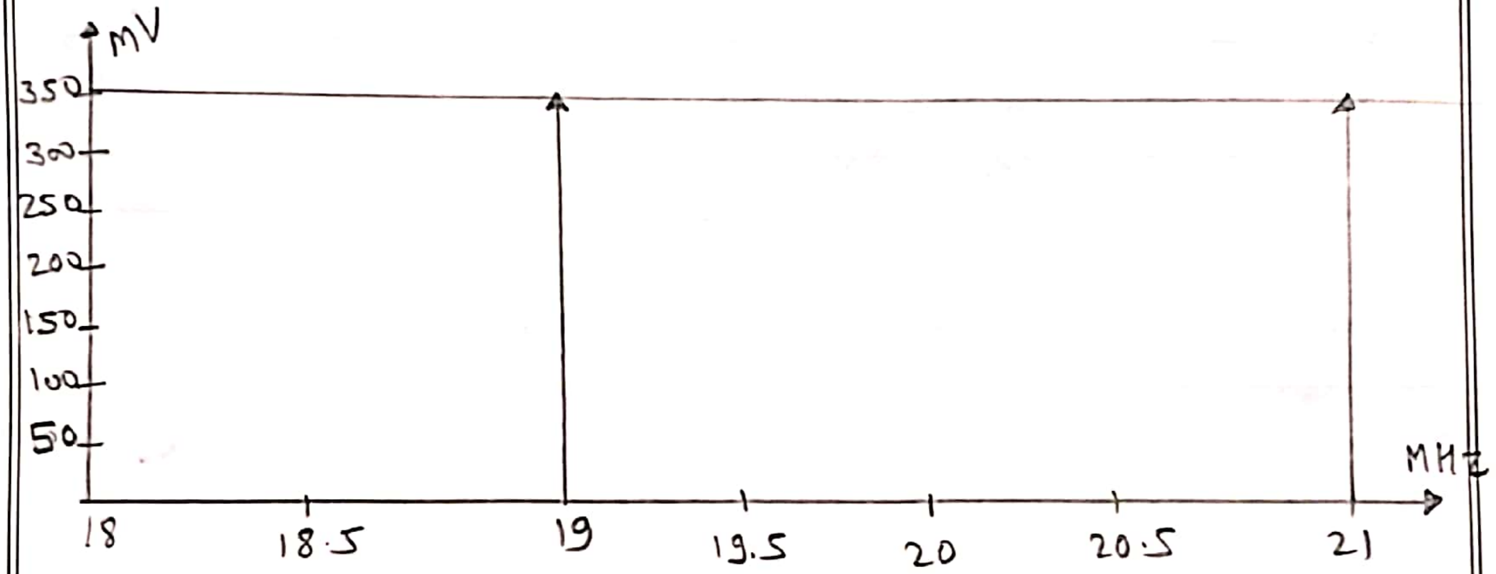

1.5
1
0.5
0
-0.5
-1
-1.5
V
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
µs


350
300
250
200
150
100
50
0
mV
18
18.5
19
19.5
20
20.5
21
21.5
MHZ

5) m = 1.5



V
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
-2.0
-2.5
0.2
0.4
0.6
0.8
1.0
1.2
μs



mV
350
300
250
200
150
100
50
18
18.5
19
19.5
20
20.5
21
MHz

U20CS110

Date

Expt. No. 03

Page No. 13

Procedure

In lab-Alive software

1) We will first execute the AM analyser simulator
2) Then click on Ŝ in the AM modulation window.
3) For D.S.B with carrier click on D.C. and for DSB with suppressed carrier off the DC output.
4) For the different value of m observe the transmitted signal using oscilloscope and spectrum analyser

Conclusion

we observe that using envelope detector we can detect double side band with carrier but synchronous detector is needed for double sideband suppressed carrier. We also observe that information lies in sidebands and in carrier. Using DBS, we can minimize the power usage.

Teacher's Signature :