[U17CS012]

EXPERIMENT 3 :

AMPLITUDE MODULATION

> AIM : Study of an Amplitude modulated (A.M.) 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

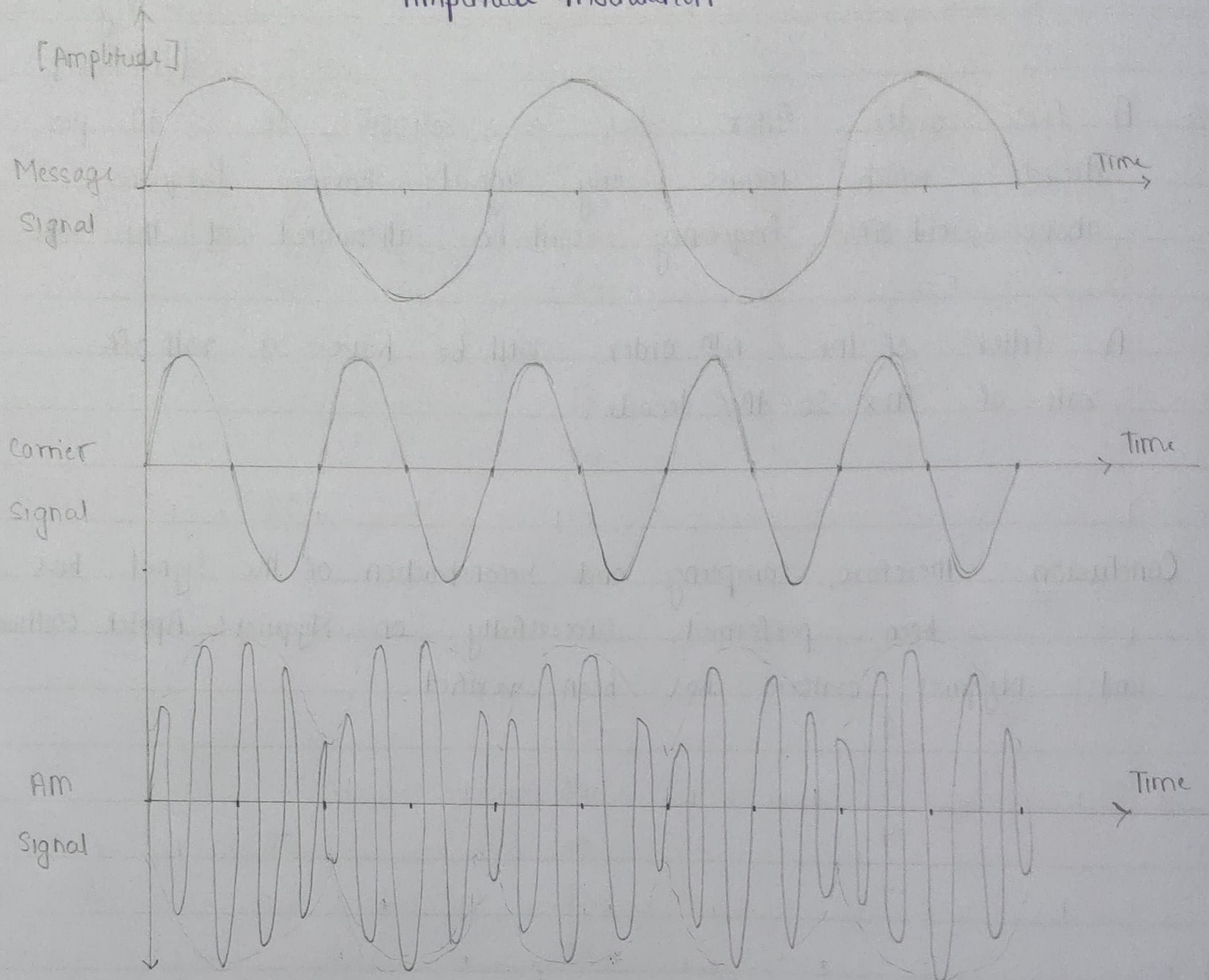
$$s(t) = [A_c + A_m \cos(2\pi f_m t)] \cos(2\pi f_c t)$$

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

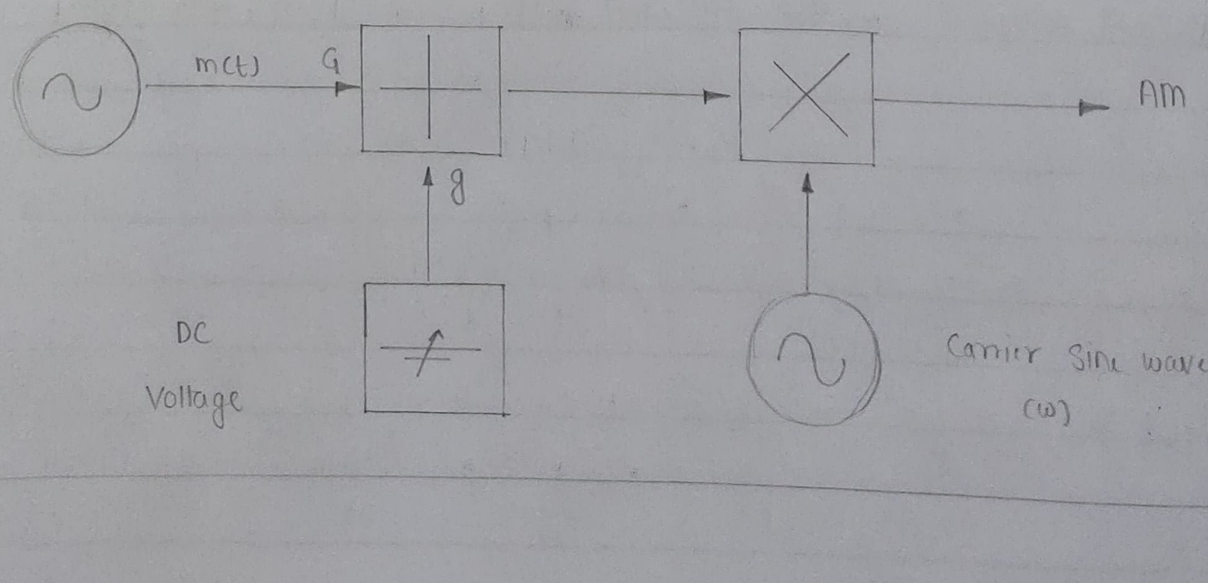
Modulation index $= m = \frac{A_m}{A_c}$

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

Amplitude Modulation



Schematic Block diagram for AM, T_x and R_x



3.) Measurement of 'm'

- The magnitude of 'm' can be measured directly from the Am display itself.
- maximum and minimum amplitudes of the Transmission signals ~~enev~~ 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, $b = A_c - A_m$

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

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

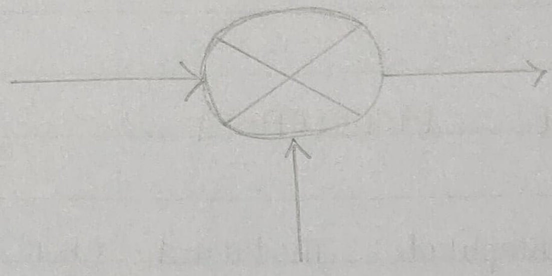
4.) Envelope Detector

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

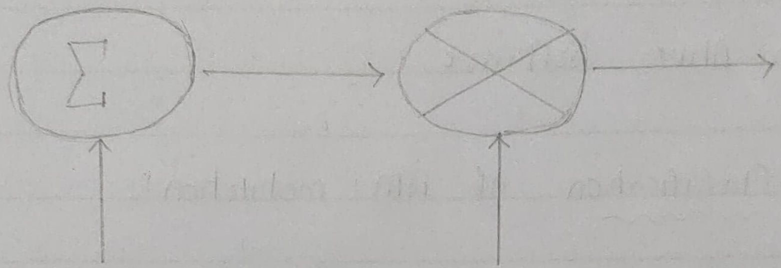
5.) Synchronous detector

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

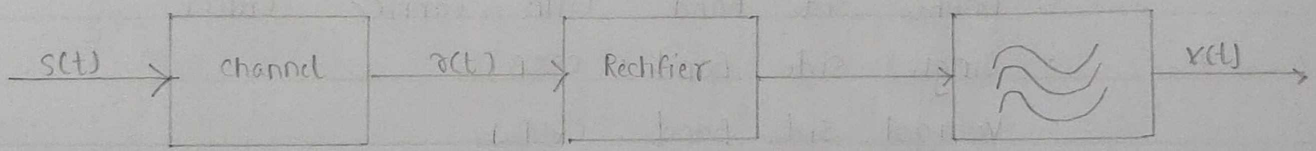
DSB - SC



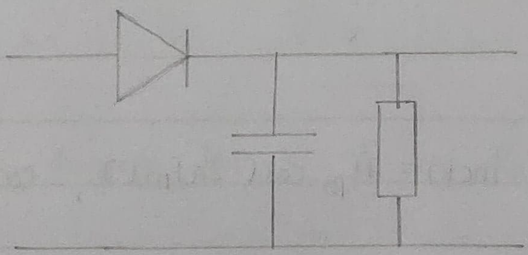
AM



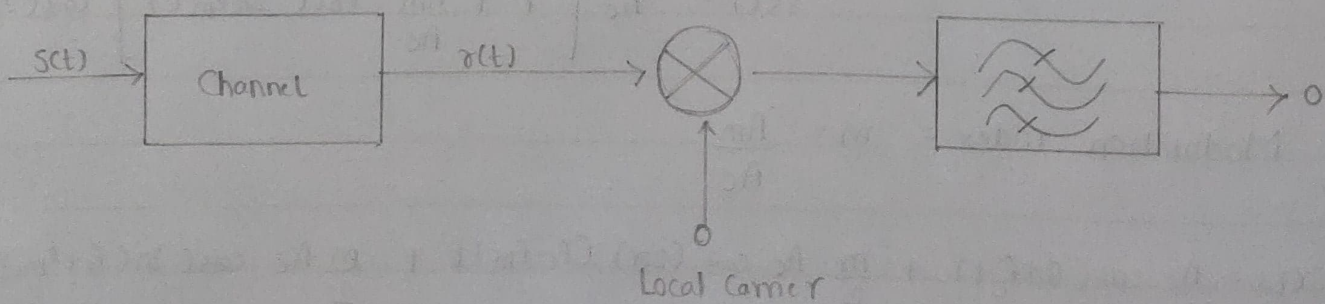
Envelope Detector



Rectifier
(Diode, capacitor)



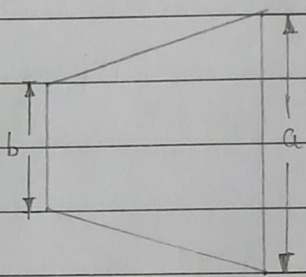
Synchronous Detector



6.) 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 : modulating signal



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

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

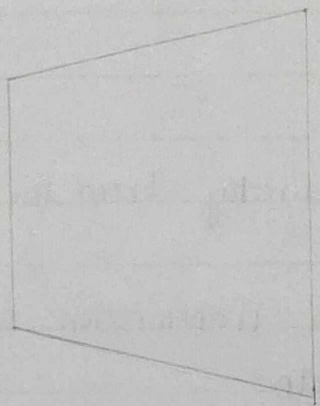
> **PROCEDURE:** In this online mode of practical, we perform the experiment on Labaliva application.

1.) We will first execute the AM analyser simulator

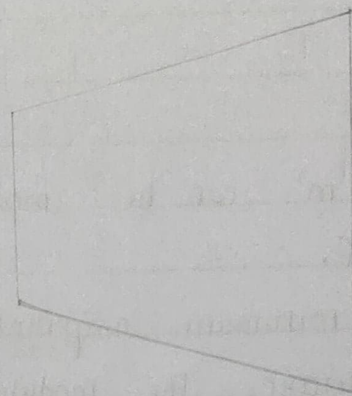
2.) After executing the AM analyser simulator, click on the $\hat{S}$ in the AM modulation window.

3.) For D.S.B. with carrier click on the D.C. and For D.S.B. with suppressed carrier off the D.C output

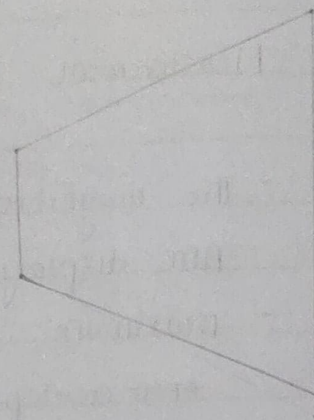
Trapezoid width is unaffected by modulation depth.



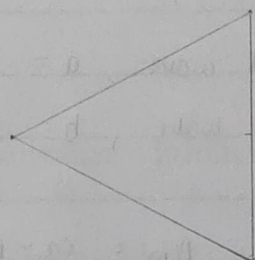
m = 0.1



m = 0.3

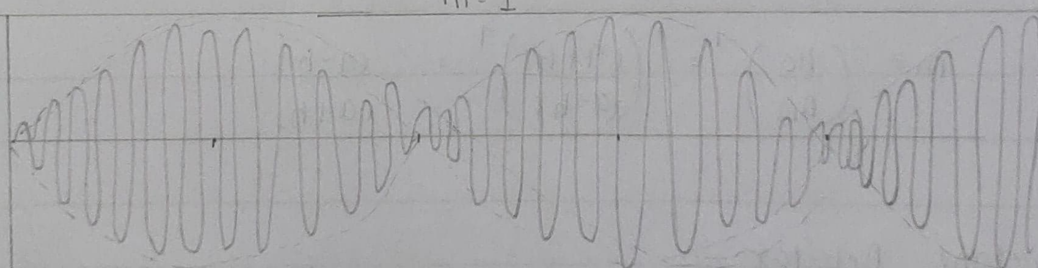


m = 0.5

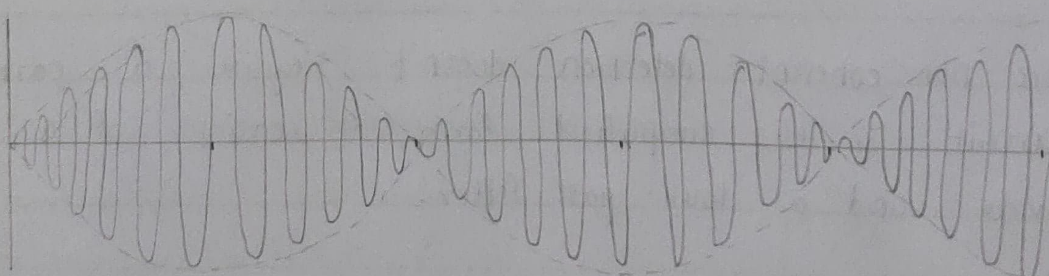


m = 1

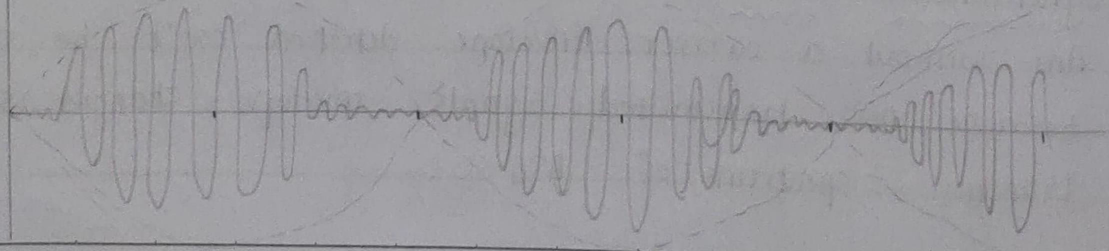
Modulation Index = 0.5 (m<1)



Modulation Index = 1 (m = 1)



Modulation Index = 1.5 (m > 1)



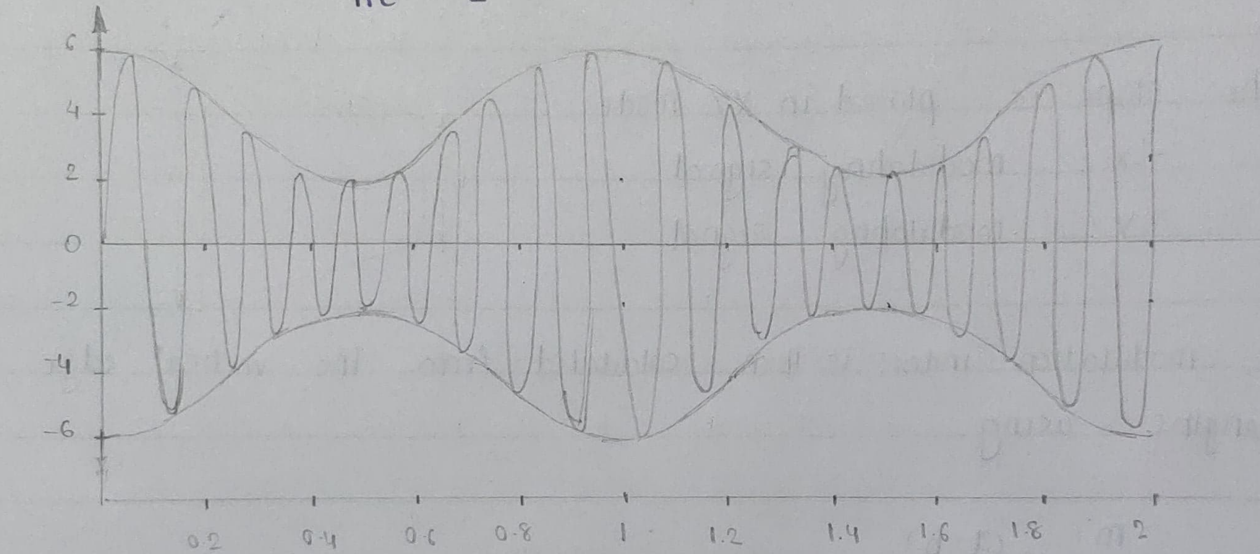
Observation

DOUBLE SIDE BAND WITH CARRIER

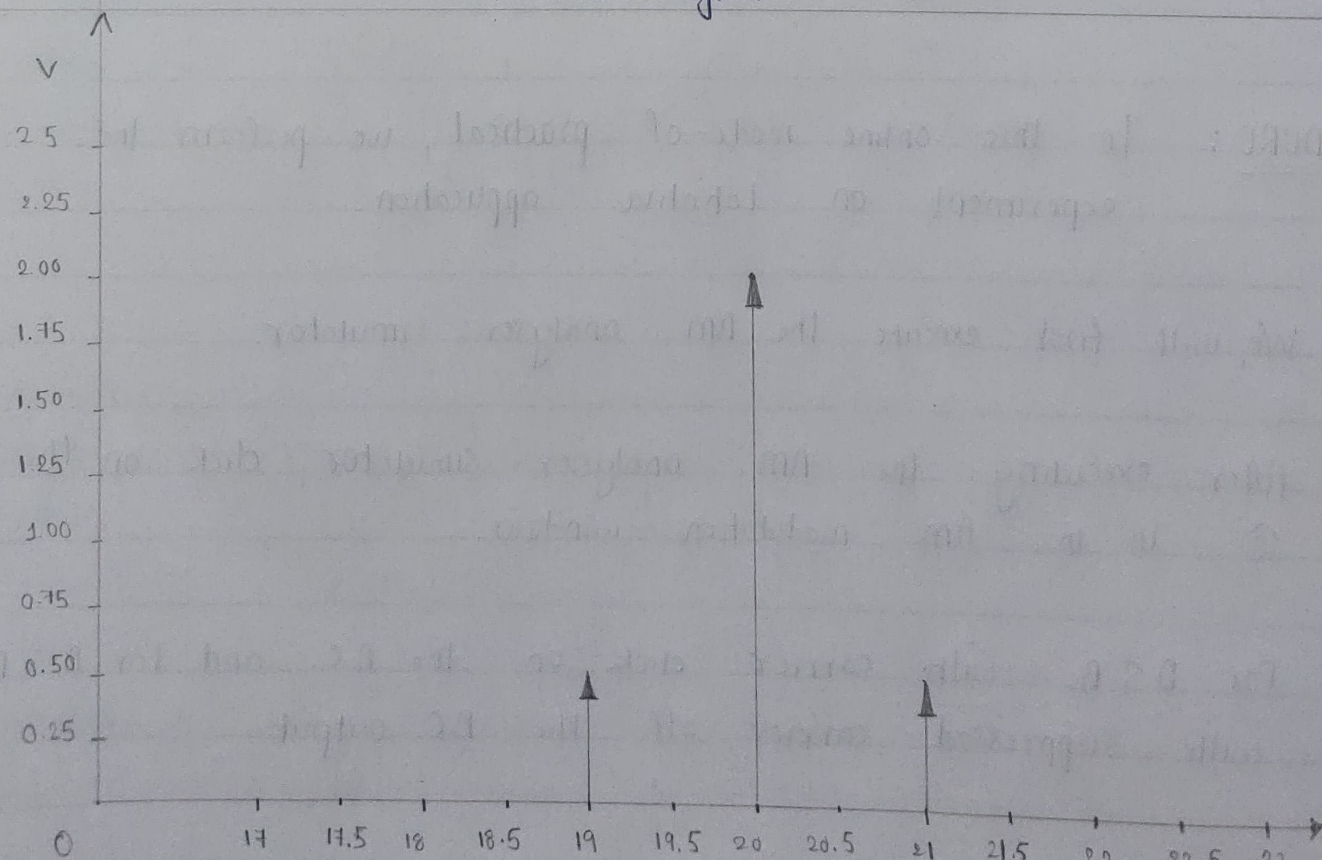
a) $m<1$

Message =	$A_m = 1V$	$f_m = 1 MHz$	(Cosine)
Carrier =	$A_c = 2V$	$f_c = 20 MHz$	(cosine)
$\hat{s}$ =	$A = 2V$	$f = 1 MHz$	(DC on)

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



Transmitted signal

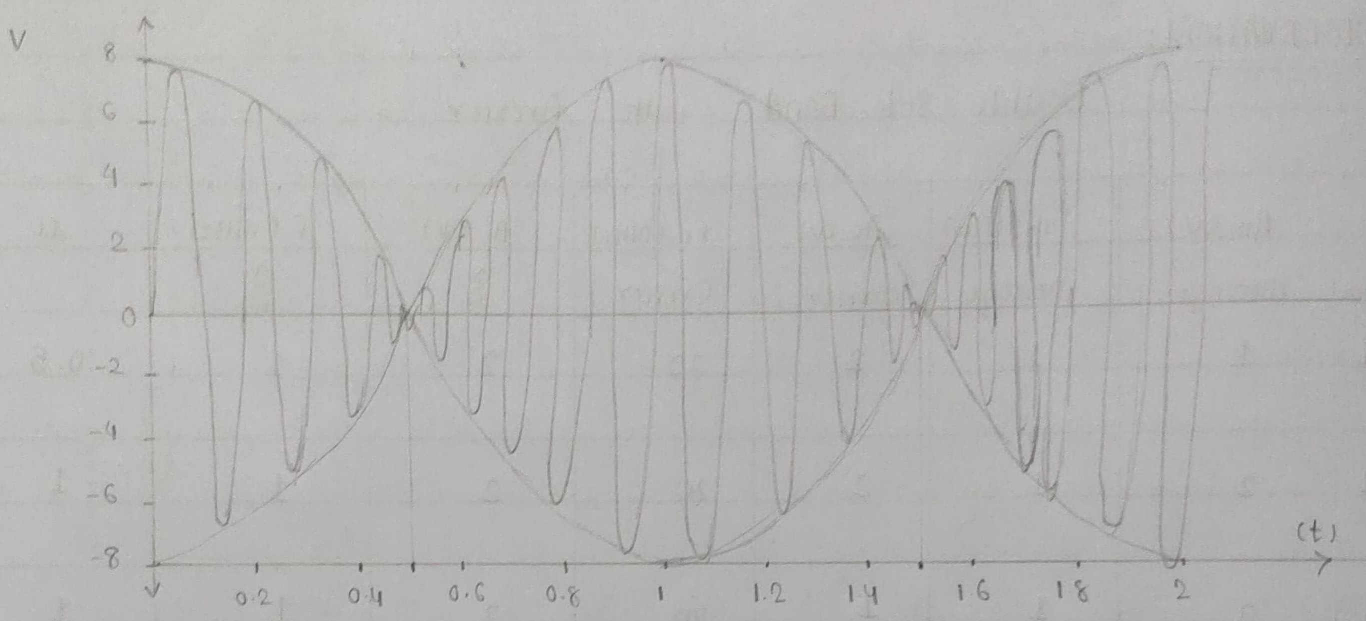


Spectrum

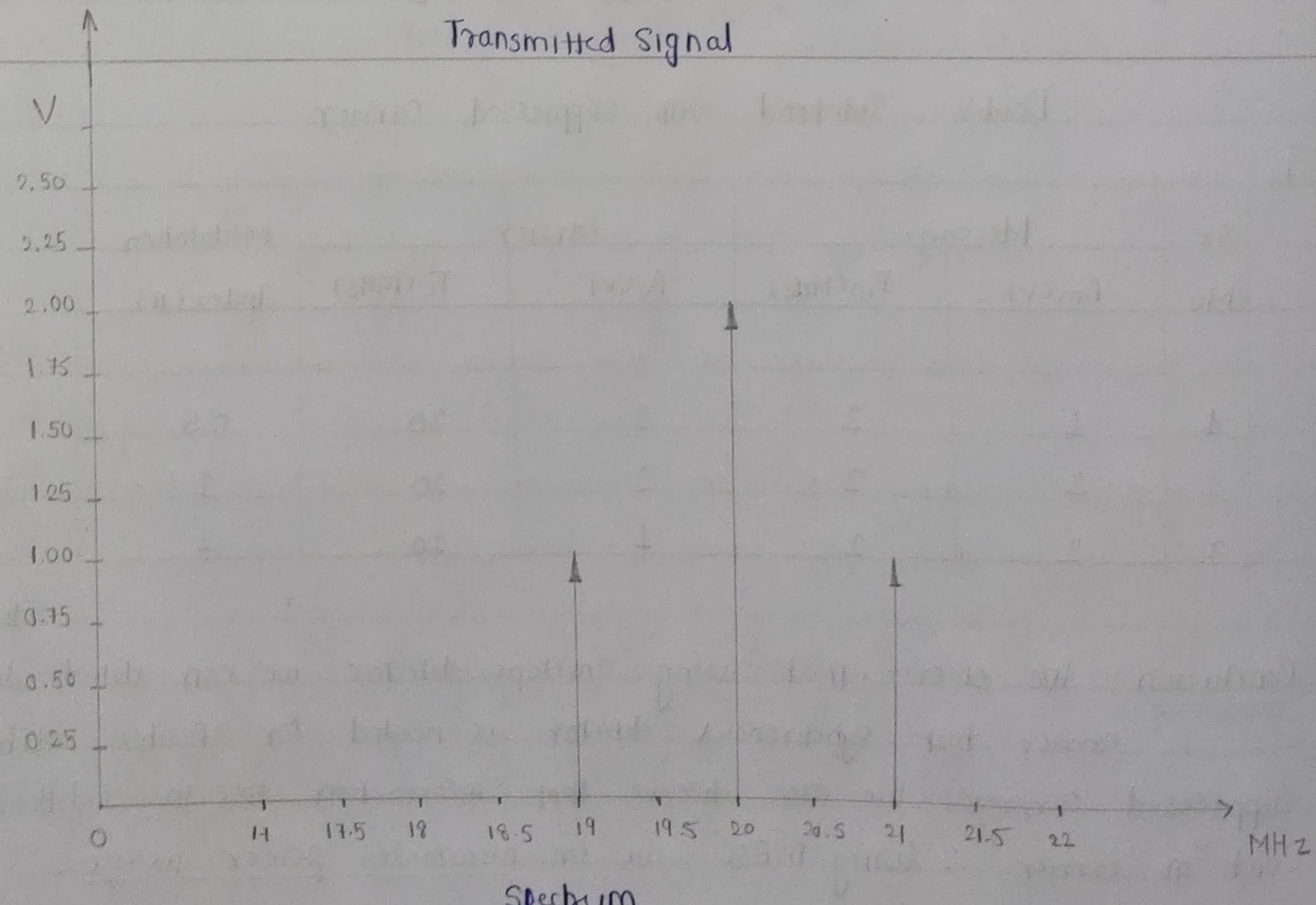
(b) m = 1

Message	$A_m = 2V$	$f_m = 1MHz$	(cosine)
Carrier	$A_c = 2V$	$f_c = 20 MHz$	(cosine)
$\hat{\delta}$	$A = 2V$	$F = 1 MHz$	(DC on)

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



Transmitted Signal

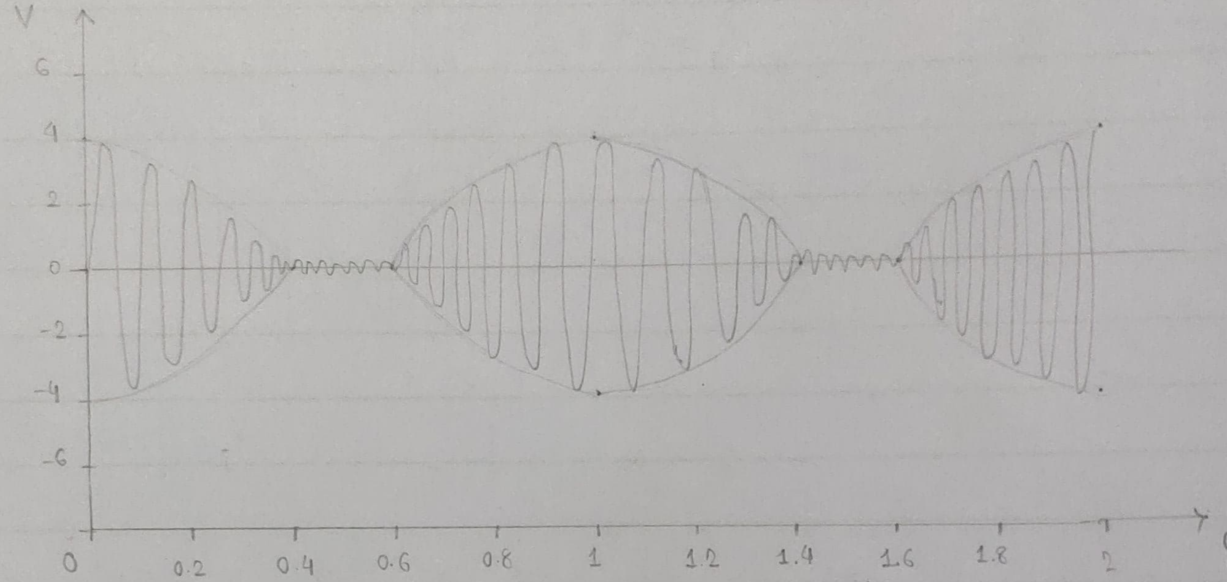


Spectrum

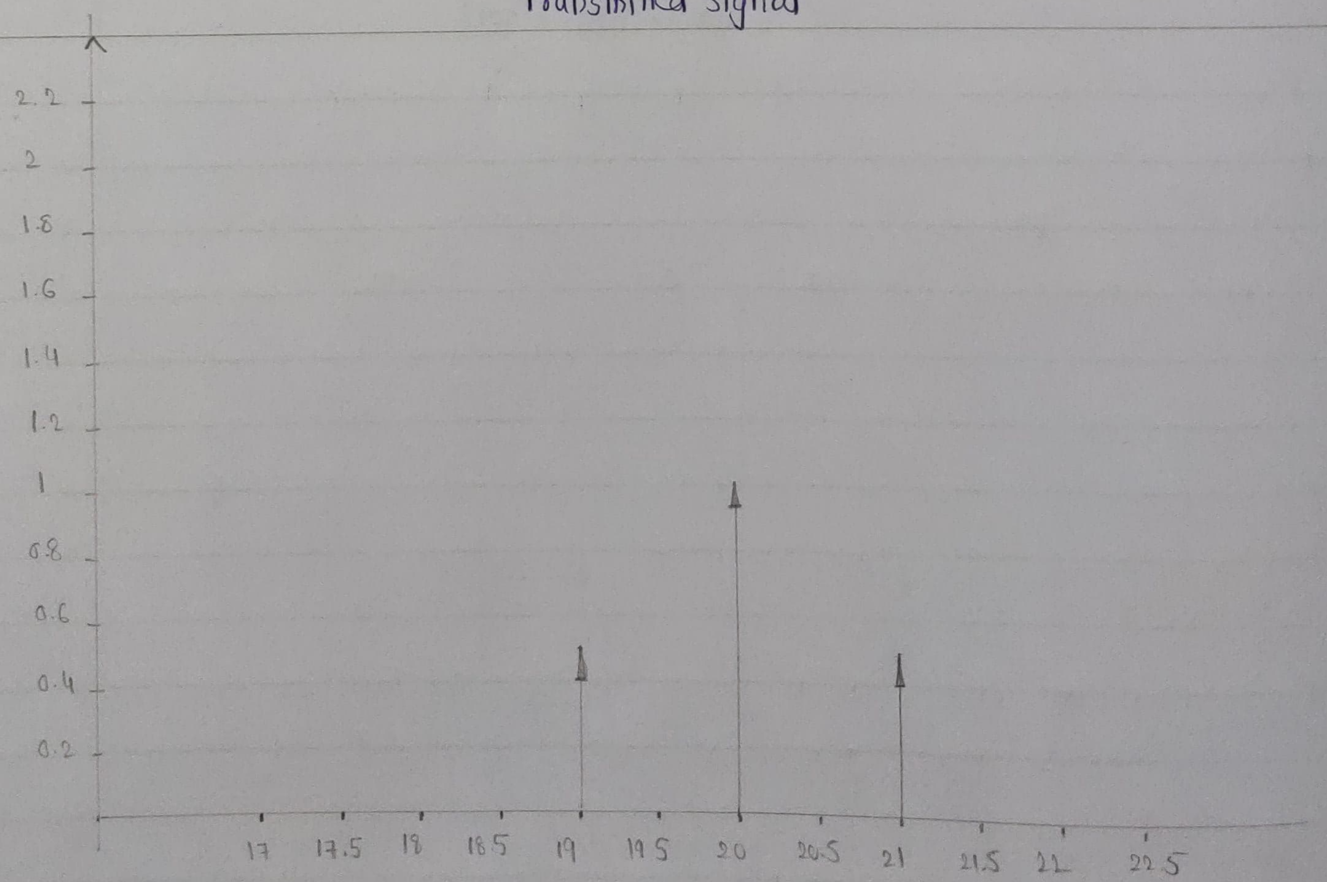
c) $m > 1$

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 ~~cosine~~)

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



Transmitted Signal



Spectrum

DOUBLE SIDEBAND SUPPRESSED CARRIER [DC OFFSET OFF]

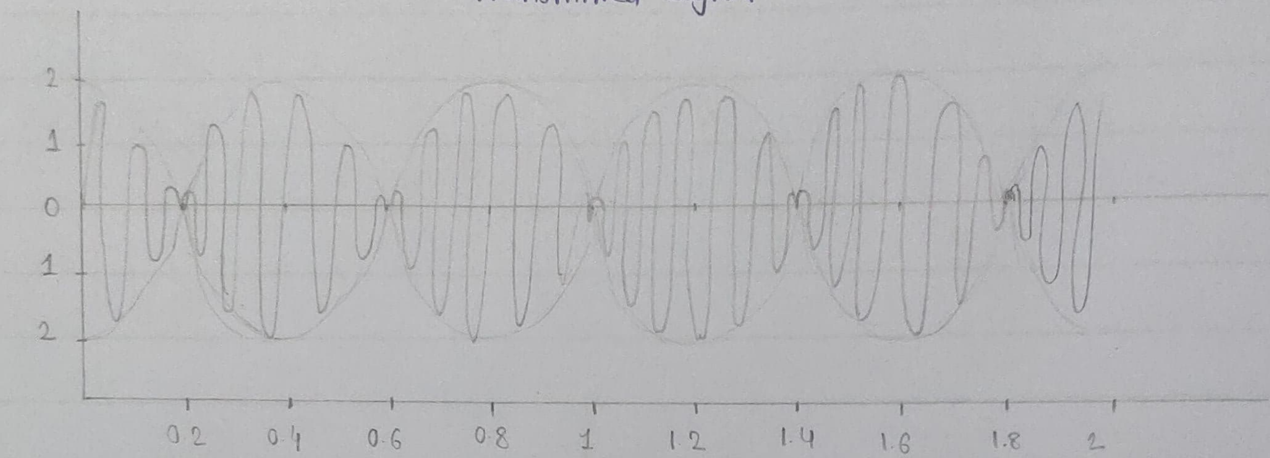
a) $m<1$

Message $A_m = 1V$ $F_m = 2 MHz$ (cosine)

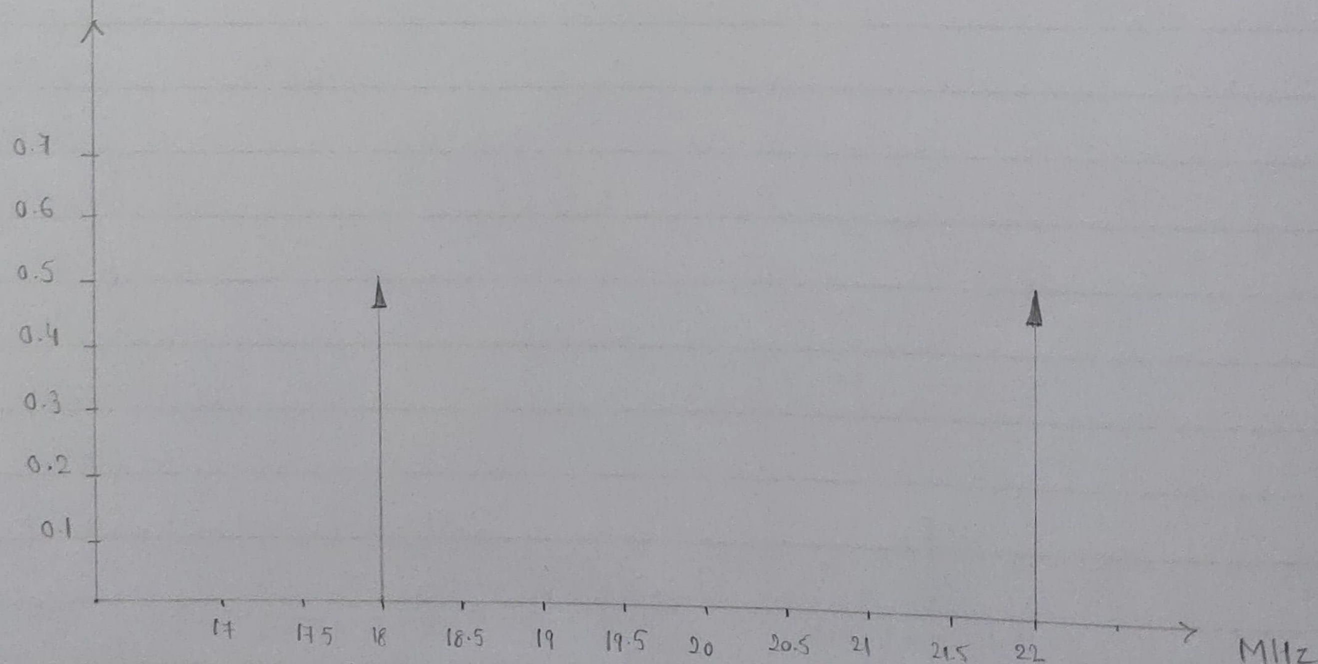
Carrier $A_c = 2V$ $F_c = 20 MHz$ (cosine)

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

Transmitted signal



Spectrum

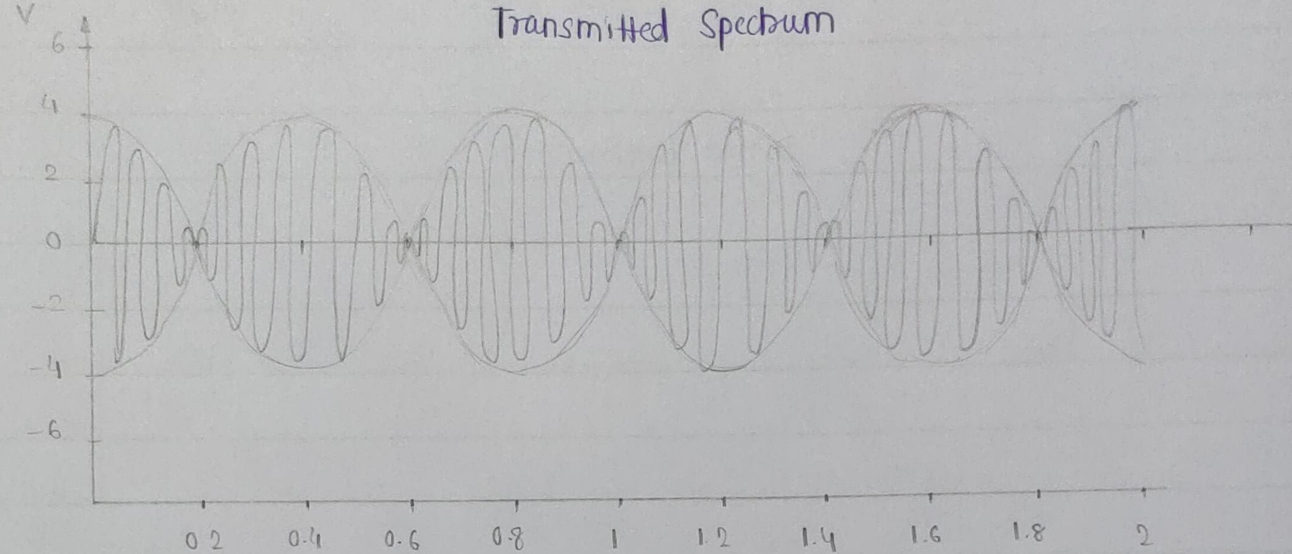


b) m = 1 Message $A_m = 2V$ $F_m =$ 2 MHz (cosine)

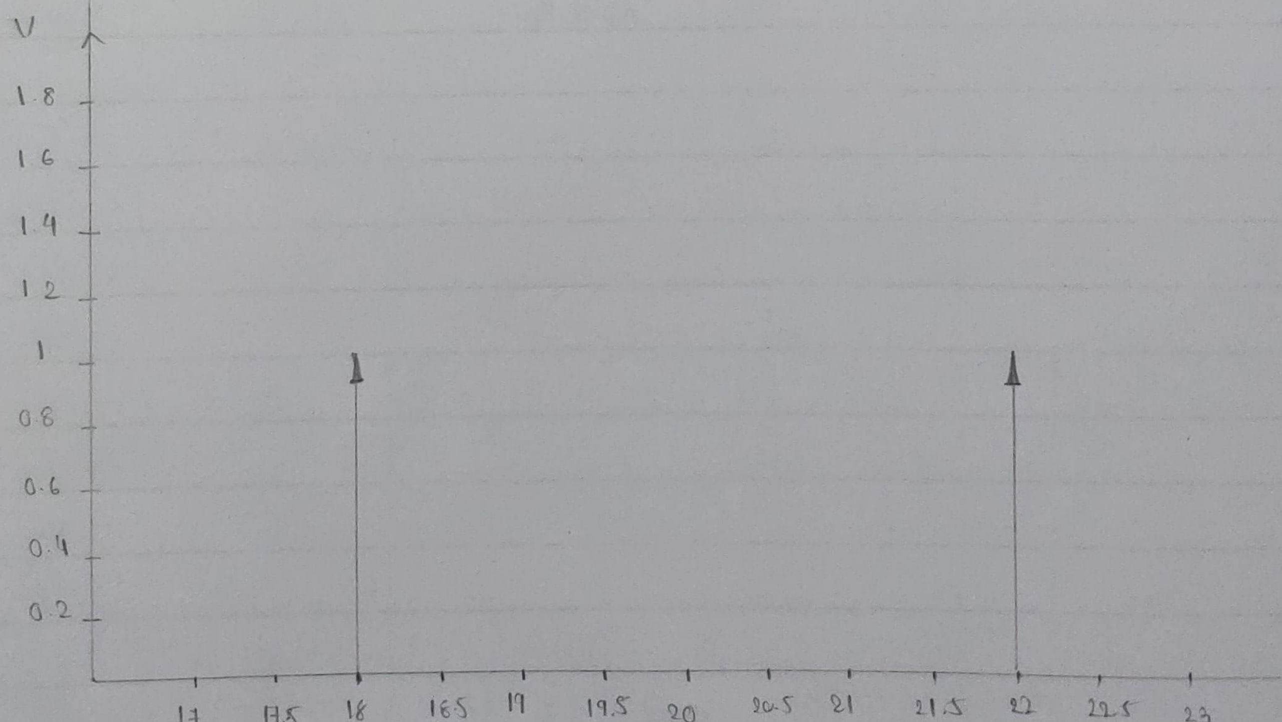
Carrier $A_c = 2V$ $F_c =$ 20 MHz (cosine)

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

Transmitted Spectrum



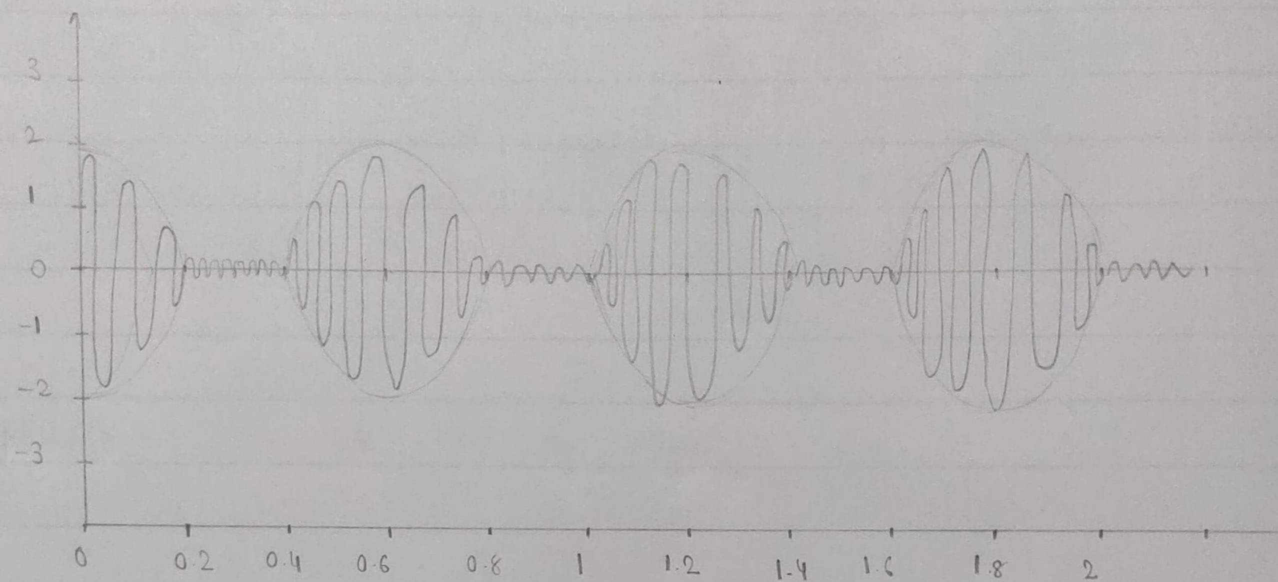
Spectrum



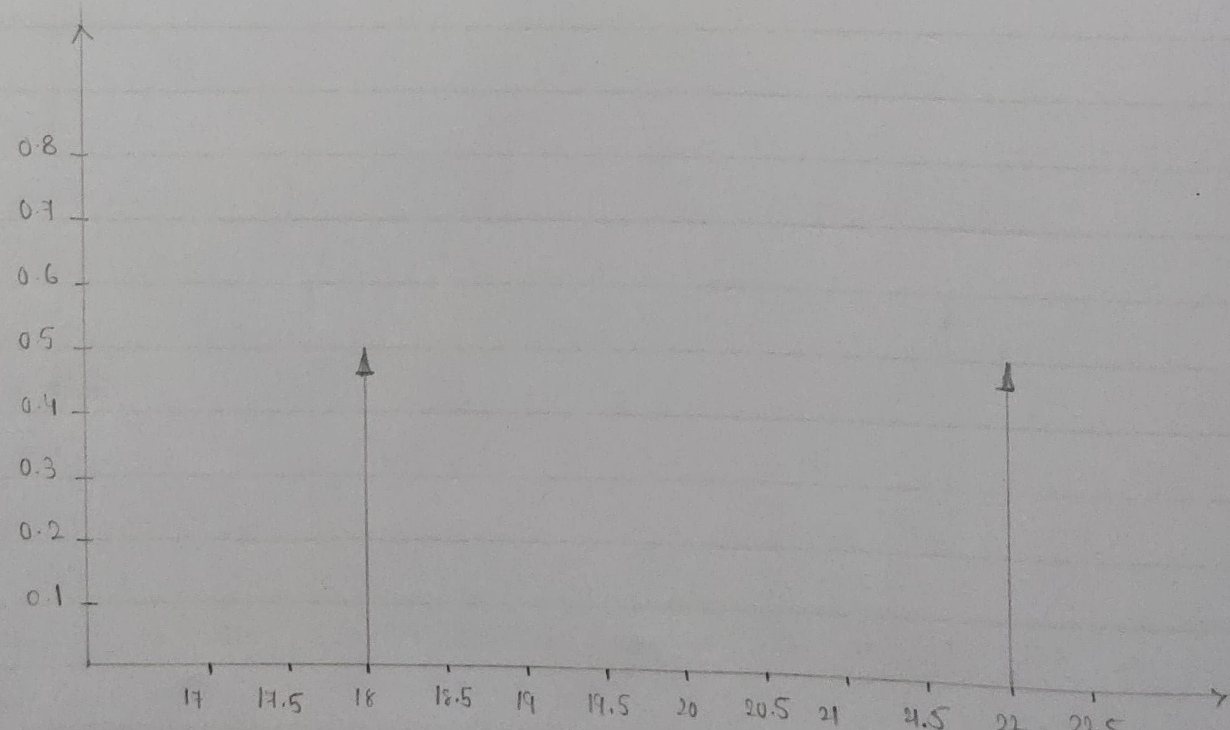
c) $m > 1$ Message $A_m = 2V$ $F_m = 2\,kHz$ (cosine)

Carrier $A_c = 1V$ $F_c = 20\,kHz$ (cosine)

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



Transmitted signal



Spectrum

4.) For the different value of m observe the transmitted signal using oscilloscope and spectrum analyzer.

OBSERVATION:

Double Side Band with Carrier

Sr. No.	Am (V) Message	Fm (MHz) Message	Ac (V) carrier	Fc (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	1

Double Sideband with suppressed Carrier

Sr No.	Message		Carrier		Modulation
	Am (V)	Fm (MHz)	Ac (V)	Fc (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. ∴ Using DSBSC, we can minimize power usage.

Teacher's Signature: