UIU PORTAL

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Note courtesy: Moumita Kabir

17.10.16

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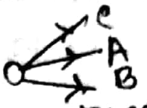
(I) Connection orientied → phone call (letter)

(II) Connection less → email

(I) Broadcast
(II) Point-to-point transmition] Information transmision



Broadcast : user broadcast করলে সবার কাছে msg যাবে।

Point-to-point : সবার কাছে যাবে না, pariticular একজনের কাছে যাবে। then point-to-point যাবে।

o → A → B → C → D

Network → follow করে layered architecture

(component ways আলাদা করা যাবে।

~~সুবিধা~~ : (I) part by part error ~~b~~ বের করা যাবে।
(II) Data transfer, communication system.
(III) part by part update করা যাবে।
(IV) সম্পূর্ণ code কে ~~আলাদা করা~~ debug করার ~~স~~ লাগেনা। easily ~~নির্দিষ্ট~~ জায়গায় ~~ট~~ debug করা যায়।

particular ~~rank~~ level এর ~~oppo~~ oposite machine এর same part এর সাথে communication করতে পারবে।

Layerd Architecture :

(i) OSI (ii) TCP/IP

(7 ठि layerd)

Important

The principles of designing a layered architecture :

(1) A layer should be created where a different abstraction is needed.

(2) Each layer should perform a well-defined function

(3) The function of each layer should be chosen with an eye toward defining internationally standardized protocols.

(4) The layer boundaries should be chosen to minimize the information flow across the interfaces.

(5) The number of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity and small enough that the architecture does not become unwiedly.

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Network layer:

- shortest path বের করা (routing)
- source থেকে destination এ ~~কিভাবে দিবে নিয়ে যাবে~~
- logical addressing করে।
- heterogeneous network
- ~~বড়কে~~ packet কে ছোট ছোট packet.

Transport layer:

- এক জায়গা থেকে অন্য জায়গায় data sequence maintain করা যাচ্ছে কিনা। Security
- delivary টা error free ~~কিনা~~। error correction
- sequentially
- no loss হয়েছে কিনা / dulicate
- connectionless / connection
- সবাই use করতে পারবে।

12345 → 1234... errorfree

parity bit check

0	1010

odd = 0
even = 1

Session layer:

- দুইটা user এর মধ্যে conversation end ; start ~~কন্ট্রোল~~ করবে।

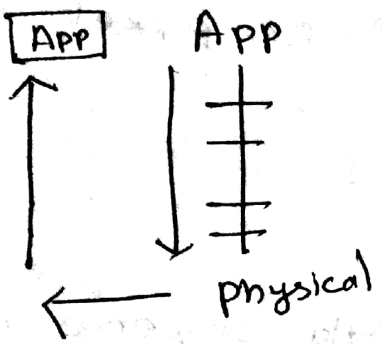
Presentation layer:

- data low – higher ~~level~~ level msg reliable আকারে present করা
- msg আদান প্রদান করার সময় কিছু chang করা হবে compress করা

Application layer:

- user এর সাথে inter connection করে

OSI In Action:



7 টা নতুন Header যোগ হবে।

physical layer:

- bit generate হচ্ছে কিনা, gap আছে কিনা।

Data-link layeer:

simplex, hulfplex, duplex, point-to-point.

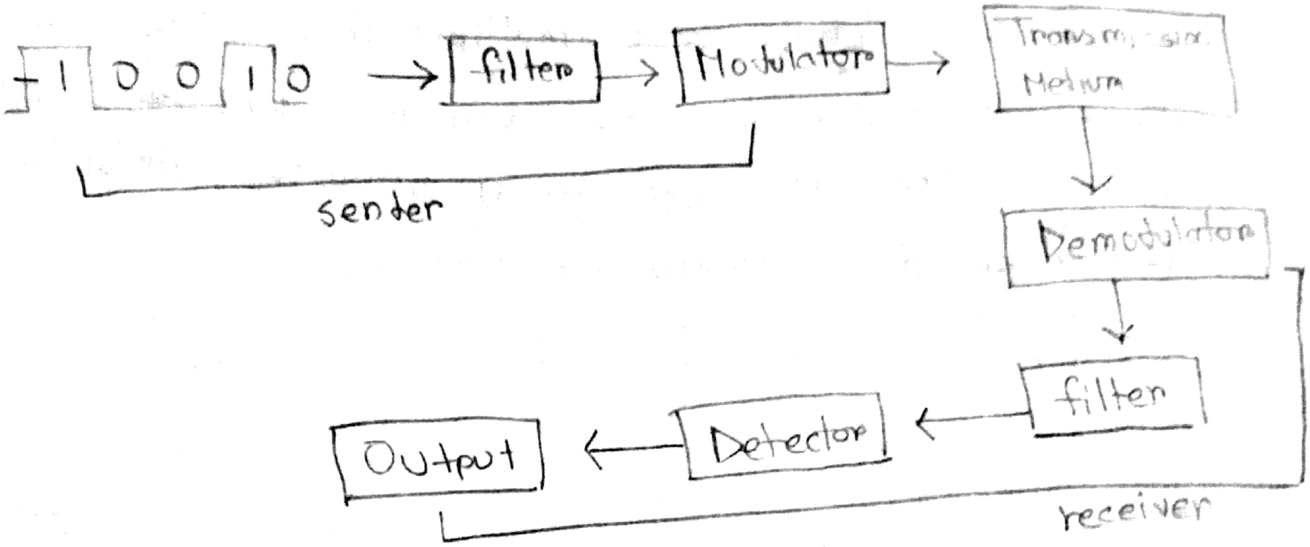
~~OS~~

TCP/IP:

4 টা layer

Problems in ~~P2P~~ point-to-point communication:

→ Noise
→ Interference
→ Physical limit
→ transmission may distord the signal



Data transmission block diagram

error :

$$\text{error ditection} = \frac{\text{How many bits are changed}}{\text{total bit}} \times 100\%$$

$$= \frac{6}{8} \times 100\% \quad \underline{\underline{\text{Ans}}}$$

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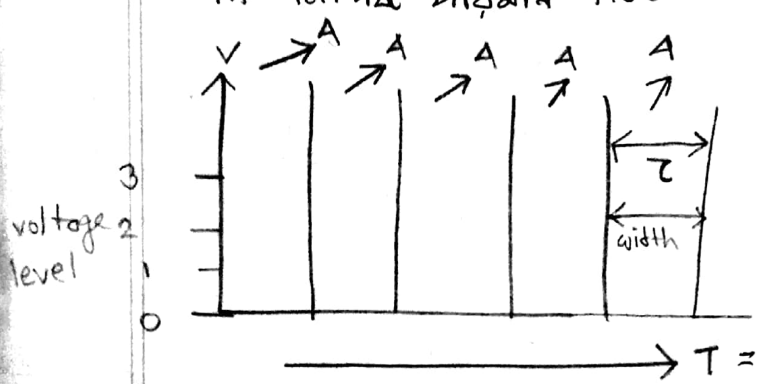
information pass করার সময় synosoidal wave use করা হয়

Straight line থাকলে ~~সকল~~ multiple info flow করা যায় না

~~infinite~~ fluctuation দিলে তত বেশী msg send করতে পারব

infinite fluctuation দেয়া হয় না because প্রতিটা layer

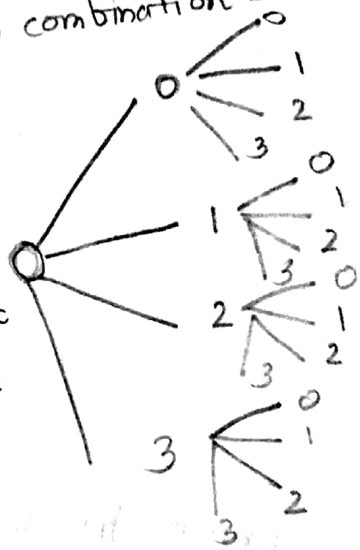
~~কি~~ ~~নির্দিষ্ট~~ পরিমাণ fluctuation নিতে হয়।



$T = 20 sec$

T/τ

Total combination $= 4^5$



number of (#) combination $= n$ $= 4^5$

n = voltage level

T = Time

τ = width

$\# \text{info} = \frac{T}{\tau} \log_2 n$

Capacity $= \frac{\text{info}}{T} = \frac{1}{\tau} \log_2 n$ → Band width

given system

$\frac{20}{4} \log_2 4 = 10$

$\frac{1}{4} \log_2 4 = 0.5$

যত level হবে (voltage)

\# info $\frac{20}{4} \log_2 3 = 7.9$

\# capacity $\frac{1}{4} \log_2 3 = 0.4$

combination $3^{20/4} = 3^5 = 243$

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Slot ফাকা থাকে : $\frac{T}{\tau} - 1$

$\# \text{ of slot} = \frac{T}{\tau}$

com = 4^4 =

\# probable info = $\frac{20}{2.5} \log_2 4$ =

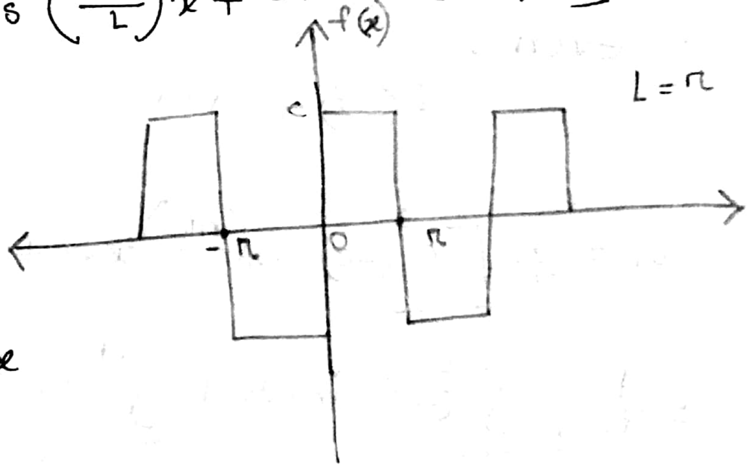
\# capacity = $\frac{1}{2.5} \log_2 4$ =

Fourier

$$f(x) = a_0 + \sum_{n=1}^{N} \left[a_n \cos\left(\frac{n\pi}{L}\right)x + b_n \sin\left(\frac{n\pi}{L}\right)x \right]$$

period, $p = 2L$

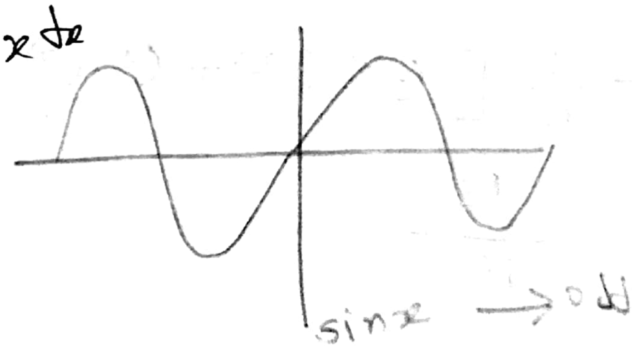
$L = \pi$



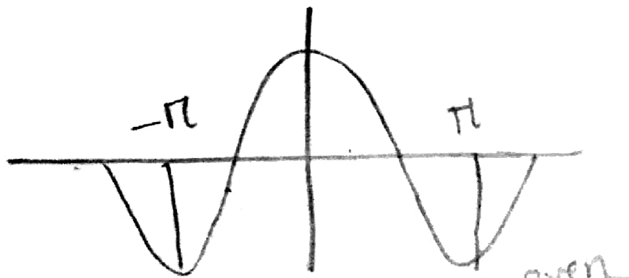
$$a_0 = \frac{1}{2L} \int_{-L}^{L} f(x)\,dx$$

$$a_n = \frac{1}{L} \int_{-L}^{L} f(x) \cos\left(\frac{n\pi}{L}\right)x\,dx$$

$$b_n = \frac{1}{L} \int_{-L}^{L} f(x) \sin\left(\frac{n\pi}{L}\right)x\,dx$$



$\sin x \longrightarrow$ odd



$\cos x \longrightarrow$ even

$\sin x \quad -c$

$-\cos x \quad 0$

$$a_0 = \frac{1}{2\pi}\left[\int_{-\pi}^{0}(-c)\,dx + \int_{0}^{\pi}(c)\,dx\right]$$

$$= 0$$

$$a_1 = \frac{1}{\pi}\left[\int_{-\pi}^{0}(-c)\cos\left(\frac{n\pi}{L}\right)x\,dx + \int_{0}^{\pi}(c)\cos\left(\frac{n\pi}{L}\right)x\,dx\right]$$

$$= \frac{1}{\pi}\left[\int_{-\pi}^{0}(-c)\cos x\,dx + \int_{0}^{\pi}(c)\cos x\,dx\right]$$

even :

$$f(-x) = f(x)$$

odd:

$$f(-x) = -f(x)$$

$$b_1 = \frac{1}{\pi}\left[\int_{-\pi}^{0}(-c)\sin\left(\frac{n\pi}{L}\right)x\,dx + \int_{0}^{\pi}(c)\sin\left(\frac{n\pi}{L}\right)x\,dx\right]$$

$$= \frac{1}{\pi}\left[\int_{-\pi}^{0}(-c)\sin x\,dx + \int_{0}^{\pi}(c)\sin x\,dx\right]$$

$$= \frac{1}{\pi}\left[(-c)(-2) + (c)(2)\right]$$

$$= \frac{4c}{\pi}$$

$$b_2 = \frac{1}{\pi}\left[\int_{-\pi}^{0}(-c)\ \sin 2x\, dx + \int_{0}^{\pi}(c)\ \sin 2x\, dx\right]$$

$$= \frac{1}{\pi}\left[-c \times \left[\frac{-\cos 2x}{2}\right]_{-\pi}^{0} + c\ \left[\frac{-\cos 2x}{2}\right]_{0}^{\pi}\right]$$

$$= \frac{1}{\pi}\left[\frac{c}{2}\left(\cos(2\times 0) - (\cos 2\times\pi)\right) + \frac{c}{2}\left((-\cos(2\times\pi) + (\cos(2\times 0))\right)\right]$$

$$= \frac{1}{\pi}\left[\left(\frac{c}{2}\ (1 - 1)\right) + \left(\frac{c}{2}\ (-1+1)\right)\right]$$

$$= \frac{1}{\pi}\ \left(\cancel{\tfrac{c}{2}}\ 0\right)$$

$$= 0 \quad \underline{\text{Ans}}$$

$-\frac{4}{\pi}t \quad \cos 2nt \quad + \frac{4}{\pi}t \qquad n\pi/\times\frac{2}{\pi}$

$-4/\pi \quad \sin 2nt/2n \quad \frac{4}{\pi}$

$0 \quad -\cos\frac{2nt}{4n^2} \quad 0$

$$a_n = \frac{1}{2l}\int_{-l}^{l} f(x)\cos\left(\frac{n\pi}{l}\right)x\,dx$$

$$= \frac{1}{\frac{\pi}{2}}\int_{-\frac{\pi}{2}}^{\pi/2} f(x)\cos\left(\frac{n\pi}{\pi/2}\right)x\,dx$$

$$= \frac{2}{\pi}\int_{-\pi/2}^{\pi/2} f(x)\cos(2n)x\,dx.$$

$$= \frac{2}{\pi}\left[\int_{-\pi/2}^{0} -\frac{4}{\pi}t\cos 2nt\,dt + \int_{0}^{\pi/2}\frac{4}{\pi}t\cos 2nt\,dt\right]$$

$$= \frac{2}{\pi}\left[\left(-\frac{4}{\pi}t \times \sin\frac{2nt}{2n} - \frac{4}{\pi}\cos\frac{2nt}{4n^2}\right)_{-\frac{\pi}{2}}^{0} + \left(\frac{4}{\pi}t\sin\frac{2nt}{2n} + \frac{4}{\pi}\cos\frac{2nt}{4n^2}\right)_{0}^{\frac{\pi}{2}}\right]$$

$\frac{2}{\pi}\times$

$$\cancel{= \frac{2}{\pi}\left[\left(0 - \frac{4}{\pi}\times\frac{1}{4n^2}\right) - \left(0 - \frac{4}{\pi}\times\right.\right.}$$

$$= \frac{2}{\pi}\left[\left(-\frac{4}{\pi}t \times \frac{\sin 2t}{2} - \frac{4}{\pi}\cos\frac{2t}{4}\right)_{-\pi/2}^{0} + \left(\frac{4}{\pi}t\,\frac{\sin 2t}{2} + \frac{4}{\pi}\,\frac{\cos 2t}{4}\right)_{0}^{\pi/2}\right]$$

$-\frac{4}{\pi}\times\frac{1}{4}$

$$= \frac{2}{\pi}\left[\left(0 - \frac{4}{\pi}\times\frac{1}{4}\right) - (0 + 0)\right. = \cancel{\frac{2}{\pi}\times\frac{4}{\pi}\times\frac{1}{4}} - \frac{4}{\pi^2}$$

$$= -\frac{4}{\pi^2}$$

Ans

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$-\frac{4}{\pi}t$	$\sin 2nt$	$\frac{4}{\pi}t$
$-4/\pi$	$-\cos 2nt/2n$	$\frac{4}{\pi}$
0	$-\sin 2nt/4n^2$	0

$$b_n = \frac{1}{L}\int_{-L}^{L} f(x)\,\sin\left(\frac{n\pi}{L}\right)t\,dt$$

$$= \frac{1}{\pi/2}\int_{-\pi/2}^{\pi/2} f(x)\,\sin 2nt\,dt$$

$$= \frac{1}{\pi/2}\left[\int_{-\pi/2}^{0} -\frac{4}{\pi}t\,\sin 2nt\,dt + \int_{0}^{\pi/2}\frac{4}{\pi}t\,\sin 2nt\,dt\right]$$

$$= \frac{2}{\pi}\left[\left(+\frac{4}{\pi}t\cdot\cos 2nt/2n - \frac{4}{\pi}\,\frac{\sin 2nt}{4n^2}\right)_{-\frac{\pi}{2}}^{0} + \left(-\frac{4}{\pi}t\,\cos 2nt/2n + \frac{4}{\pi}\,\frac{\sin 2nt}{4n^2}\right)_{0}^{\pi/2}\right]$$

$$b_1 = \frac{2}{\pi}\left[\left(\frac{4}{\pi}t\,\frac{\cos 2t}{2} - \frac{4}{\pi}\,\frac{\sin 2t}{4n^2}\right)_{-\frac{\pi}{2}}^{0} + \left(-\frac{4}{\pi}t\,\frac{\cos 2t}{2\pi} - \frac{4}{\pi}\,\frac{\sin 2t}{4\pi^2}\right)_{0}^{\pi/2}\right]$$

$$= \frac{2}{\pi}\left[\left(0 - 0\right) - \left(0 - \frac{4}{\pi}\times\frac{1}{4\pi^2}\right) + \left(0 - \frac{4}{\pi}\times\frac{1}{4n^2}\right) - \left(0 - 0\right)\right]$$

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$$= \frac{2}{\pi}\left(\frac{4}{\pi}\times\frac{1}{4\pi^2} - \frac{4}{\pi}\times\frac{1}{4\pi^2}\right)$$

$$= 0 \quad \underline{\underline{\text{Ans}}}$$

$$a_0 = \frac{1}{\pi}\int_{-\pi/2}^{\pi/2} f(x)\,dx$$

$$= \frac{1}{\pi}\left[\int_{-\pi/2}^{0} -\frac{4}{\pi}t\,dt + \int_{0}^{\pi/2}\frac{4}{\pi}t\,dt\right]$$

$$= \frac{1}{\pi}\left[-\frac{4}{\pi}\times\left[\frac{t^2}{2}\right]_{-\pi/2}^{0} + \frac{4}{\pi}\left[\frac{t^2}{2}\right]_{0}^{\pi/2}\right]$$

$$= \frac{1}{\pi}\left[-\frac{4}{\pi}\times\left(0 - \frac{\frac{\pi^2}{4}}{2}\right) + \frac{4}{\pi}\,\frac{\pi^2/4}{2}\right]$$

$$= \frac{1}{\pi}\left(+\frac{4}{\pi}\times\frac{\pi^2/4}{2} + \frac{4}{\pi}\,\frac{\pi^2/4}{2}\right)$$

$$= \frac{1}{\pi}\left(\frac{\cancel{4}}{\cancel{\pi}}\times\frac{\cancel{\pi^2}\,\pi}{\cancel{8}\,2} + \frac{\cancel{4}}{\cancel{\pi}}\times\frac{\cancel{\pi^2}\,\pi}{\cancel{8}\,2}\right)$$

$$= \frac{1}{\pi}\times\left(\frac{\pi}{2} + \frac{\pi}{2}\right)$$

$$= \frac{1}{\pi}\,\frac{2\pi}{2} = 1 \quad \underline{\underline{\text{Ans}}}$$

Complex Fourier

$$\cos x = \frac{e^{-ix} + e^{ix}}{2} \qquad \sin x = \frac{e^{ix} - e^{-ix}}{2i}$$

$$f(x) = a_0 + \sum_{n=1}^{\infty} [a_n \cos nx + b_n \sin nx]$$

$$= a_0 + \sum_{n=1}^{\infty} \left[a_n \left(\frac{e^{inx} + e^{-inx}}{2}\right) + b_n \left(\frac{e^{inx} - e^{-inx}}{2i}\right)\right]$$

$$= a_0 + \sum_{n=1}^{\infty} \left[\left(\frac{a_n - ib_n}{2}\right) e^{inx} + \left(\frac{a_n + ib_n}{2}\right) e^{-inx}\right]$$

$$= \sum_{n=-\infty}^{\infty} \underbrace{c_n e^{inx}}_{\text{complex Fourier Coefficient}}$$

$$c_n = \begin{cases} a_0 & n = 0 \\ (a_n - ib_n)/2 & n = 1, 2, 3 \ldots \\ (a_n + ib_n)/2 & n = -1, -2, -3 \end{cases}$$

$$c_n = \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{inx} f(x)\, dx \qquad \boxed{= \frac{1}{T} \int_{-T/2}^{T/2} f(t)\, e^{j\omega t}\, dt}$$

$$c_n = \frac{1}{2\pi} \int_{-\pi}^{\pi} \frac{4}{\pi} t\, e^{inx}\, dx$$

$$\frac{4}{\pi} t \quad e^{inx}$$

$$\frac{4}{\pi} \xrightarrow{+} \frac{e^{inx}}{in}$$

$$- \quad \frac{e^{inx}}{(in)^2}$$

$$0$$

$$= \frac{1}{2\pi} \left[\frac{4}{\pi} t \frac{e^{inx}}{in} - \frac{4}{\pi} \times \frac{e^{inx}}{(in)^2}\right]_{-\pi}^{\pi}$$

$$= \frac{1}{2\pi} \left[\left(\frac{4}{\pi} \times \pi \frac{e^{in\pi}}{in} - \frac{4}{\pi} \times \frac{e^{in\pi}}{(in)^2}\right) \cancel{- \left(\frac{4}{\pi} \times\right.} \right.$$

$$\left. - \left(\frac{4}{\pi} \times -\pi \frac{e^{in(-\pi)}}{in} - \frac{4}{\pi} \times \frac{e^{in(-\pi)}}{(in)^2}\right)\right]$$

$$= \frac{1}{2\pi} \left[4 \frac{e^{in\pi}}{in} - \frac{4}{\pi} \frac{e^{in\pi}}{(in)^2} + 4 \frac{e^{in(-\pi)}}{in} + \frac{4}{\pi} \frac{e^{in(-\pi)}}{(in)^2} - \right.$$

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$\sin x = \frac{e^{ix} - e^{-ix}}{2i}$

$\cos x = \frac{e^{ix} + e^{-ix}}{2}$

$e^{ix} = \cos x + i\sin x$

$e^{-ix} = \cos x - i\sin x$

Real → complex convention :

$$f(x) = 5\cos x + 12\sin x$$

$$= 5 \cdot \left(\frac{e^{ix} + e^{-ix}}{2}\right) + 12\left(\frac{e^{ix} - e^{-ix}}{2i}\right)$$

$\frac{1}{i} = -i$

$$= \frac{5}{2}e^{ix} + \frac{5}{2}e^{-ix} + \frac{6}{i}e^{ix} - \frac{6}{i}e^{-ix}$$

$$= \left(\frac{5}{2} - \frac{6}{i}\right)e^{ix} + \left(\frac{5}{2} - \frac{6}{i}\right)e^{-ix} \quad \underline{\underline{\text{Ans}}}$$

$$= \left(\frac{5}{2} + \frac{6i^2}{i}\right)e^{ix} + \left(\frac{5}{2} + \frac{6i^2}{i}\right)e^{-ix}$$

$$f(x) = 7 + 4\cos x - 8\sin(2x) + 10\cos 24x$$

$$= 7 + 4\left(\frac{e^{ix} + e^{-ix}}{2}\right) - 8\left(\frac{e^{i2x} - e^{-i2x}}{2i}\right) + 10\left(\frac{e^{i24x} + e^{-i24x}}{2}\right)$$

$$= 7 + 2e^{ix} + 2e^{-ix} + 4ie^{i2x} - 4e^{-i2x} + 5e^{i24x} + 5e^{-i24x}$$

$$= \left(2e^{-ix} - 4ie^{-i2x} + 5e^{-i24x}\right) + 7 + \left(2e^{ix} + 4ie^{i2x} + 5e^{i24x}\right)$$

C_{-n} $\qquad$ c_0 $\qquad$ c_n

$c_{-1} = 2$

$c_{-2} = -4i$

$c_{-3} = 5$

$c_1 = 2$

$c_2 = 4i$

$c_3 = 5$

2.11.16

e^{inx}

Fourier to complex:

$7 + 4\cos x - 8\sin(2x) + 10\cos(24x)$

$= 7 + 4\left(\frac{e^{ix}+e^{-ix}}{2}\right) - 8\left(\frac{e^{i2x}-e^{-i2x}}{2i}\right) + 10\left(\frac{e^{i24x}+e^{-i24x}}{2}\right)$

$= \underbrace{2e^{-ix}}_{C_{-1}=2} - \underbrace{4ie^{-2x}}_{C_{-2}=-4i} + \underbrace{5e^{-i24x}}_{C_{-24}=5} + \underbrace{7}_{C_0=7} + \underbrace{2e^{ix}}_{C_1=2} + \underbrace{4ie^{i2x}}_{C_2=4i} + \underbrace{5e^{i24x}}_{C_{24}=5}$

~~$(3+4i)e^{-i2x} + (3-4i)e^{i2x}$~~

$C_{-2} = (3+4i)$
$C_2 = (3-4i)$

Complex to Fourier:

$(3+4i)e^{-i2x} + (3-4i)e^{i2x}$

$= 3e^{-i2x} + 4ie^{-2x} + 3e^{i2x} - 4ie^{2x}$.

$= 3(\cos 2x - i\sin 2x) + 4i(\cos 2x - i\sin 2x) - 4i(\cos 2x + i\sin 2x)$
$+ 3(\cos 2x + i\sin 2x)$

$= 3\cos 2x - 3i\sin 2x + 4i\cos 2x + 4\sin 2x + 3\cos 2x +$
$3\sin 2x - 4i\cos 2x + 4\sin 2x$

$= 6\cos 2x + 8\sin 2x$

$e^{-ix} = (\cos x - i\sin x)$

$e^{ix} = (\cos x + i\sin x)$

Signal :

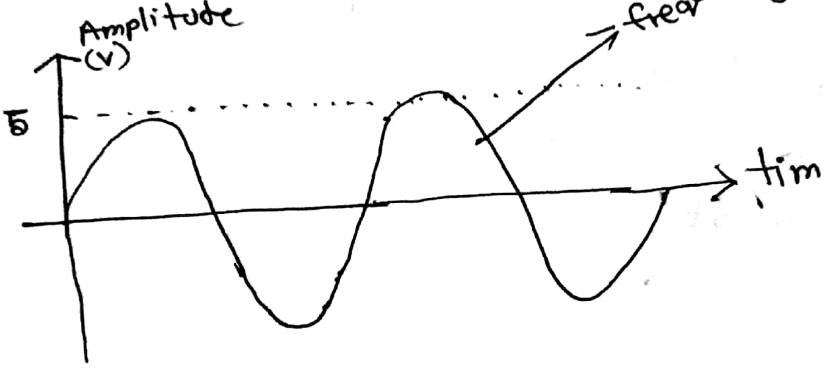
(i) Frequency domain

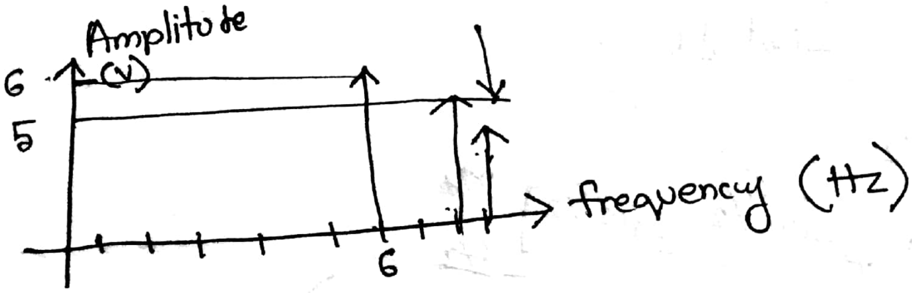
(ii) Time domain

Why Frequency domain is better than Time domain ?

⟹ Easy to represent, just by a single spike.

⟹ Can ~~not~~ plot ~~more~~ than one ~~cwir~~ sine wave.





Time ← $F(x) =$

↓

frequency ← $F(\omega) =$

~~$f(t)$~~ $=$

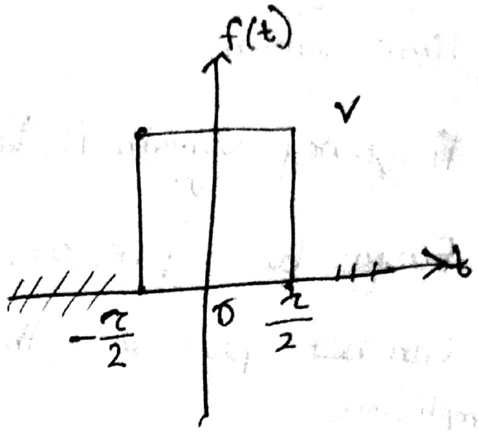
$e^{ix} = \cos x + \sin x$

Fourier transform:

$$f(t) = \sum_{n=-\infty}^{\infty} C_n e^{-i\omega t} dt$$

⇓ transform

$$F(w) = \int_{-\infty}^{\infty} f(t) e^{-i\omega t} dt$$



$$f(t) = V \quad |t| < \frac{\tau}{2}$$
$$= 0 \quad |t| > \frac{\tau}{2}$$

$$F(\omega) = \int_{-\infty}^{\infty} f(t) e^{-i\omega t} dt$$

$$= \int_{\tau/2}^{\tau/2} V e^{-i\omega t} dt$$

$$= V \int_{-\tau/2}^{\tau/2} e^{-i\omega t} dt$$

$$= \frac{V}{-i\omega} \left[e^{-i\omega \tau/2} - e^{i\omega \tau/2} \right]_{-\tau/2}^{\tau/2}$$

$$= \frac{V}{-i\omega} \left[\cos\left(-\frac{\omega\tau}{2}\right) + i\sin\left(-\frac{\omega\tau}{2}\right) - \cos\left(\frac{\omega\tau}{2}\right) - i\sin\left(\frac{\omega\tau}{2}\right) \right]$$

$$= -\frac{V}{i\omega}\left(-2i\sin\frac{\omega\tau}{2}\right)$$

$$= \boxed{V\tau} \frac{\sin\left(\frac{\omega\tau}{2}\right)}{\frac{\omega\tau}{2}}$$

constant term peak value

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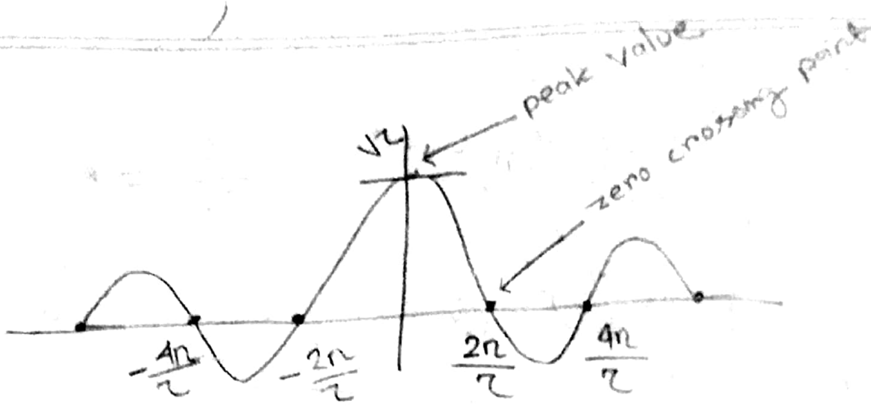

$$\boxed{\frac{\omega\tau}{2} = x}$$

$$\Rightarrow \cancel{x} = \omega = \frac{2x}{\tau}$$

Here,

$$x = \pi, 2\pi$$

$$\omega = \frac{2\pi}{\tau}, \frac{4\pi}{\tau}$$

Bandwidth $\boxed{B = \frac{\omega}{2\pi}}$

$$= \frac{2\pi/\tau}{2\pi} = \frac{1}{\tau}$$

$$F(\omega) = \frac{2\tau V}{\pi} \frac{\cos(\omega\tau/2)}{1-(\omega\tau/\pi)^2} \qquad \frac{\omega\tau}{2} = x$$

$$= \frac{2\tau V}{\pi} \frac{\cos\left(\frac{\omega\tau}{2}\right)}{1-\left(\frac{\omega\tau}{2}\right)^2 \times \frac{4}{\pi^2}}$$

$$= \frac{2\tau V}{\pi} \frac{\cos x}{1-\frac{4x^2}{\pi^2}} \qquad \left[\begin{array}{l} \frac{\omega\tau}{2} = x \\ \Rightarrow \omega = \frac{2x}{\tau} \end{array}\right]$$

$$x = \cancel{\frac{\pi}{2}},\ 3\pi/2$$

$$\omega = \cancel{\frac{\pi}{\tau}},\ \frac{3\pi}{\tau} = \frac{3\pi/\tau}{2\pi} = 3/2\tau$$

$$\text{peak value} = \frac{2\tau V}{\pi}$$

$$B = \frac{\omega}{2\pi}$$

$$= \frac{3\pi/\tau}{2\pi}$$

$$= \frac{3}{2\tau}$$

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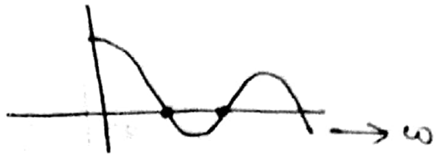
3.11.16

$$F(\omega) = \frac{2\tau V}{\pi} \quad \frac{\cos\left(\frac{\omega\tau}{2}\right)}{1-\left(\frac{\omega\tau}{\pi}\right)^2}$$



(i) Fourier transform
(ii) Peak value
(iii) Zero crossing point
(iv) Bandwidth

A periodic signal representation :

$$\lim_{T_0\to\infty} g_{T_0}(t) = g(t)$$

$$g_{T_0}(t) = \sum_{n=-\infty}^{\infty} D_n e^{j\omega n t} \quad \text{---} \quad (1)$$

$$D_n = \frac{1}{T_0} \int_{-T_0/2}^{T_0/2} g_{T_0}(t) e^{-jn\omega t} \, dt$$

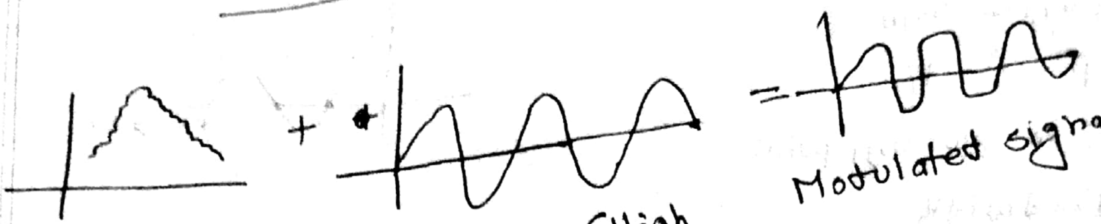
$$G(\omega) = \int_{-\infty}^{\infty} g(t) e^{-j\omega t} \, dt$$

$$\Rightarrow D_n = \frac{1}{T_0} \, G(n\omega_0)$$

From (1) $\Rightarrow$ $$g_{T_0}(t) = \sum_{n=-\infty}^{\infty} G(n\omega_0)$$

$$g(t) = \lim_{T_0\to\infty} g_{T_0}(t) = \lim_{\Delta\omega\to 0} \frac{1}{2\pi} \sum_{n=-\infty}^{\infty} G(n\Delta\omega) e^{(j\Delta\omega t)} \Delta\omega$$

Modulation



Message signal Baseband signal (low frequency) Carrier signal (High frequency)

Why modulation is needed?

⇒ Low frequency of the message signal.

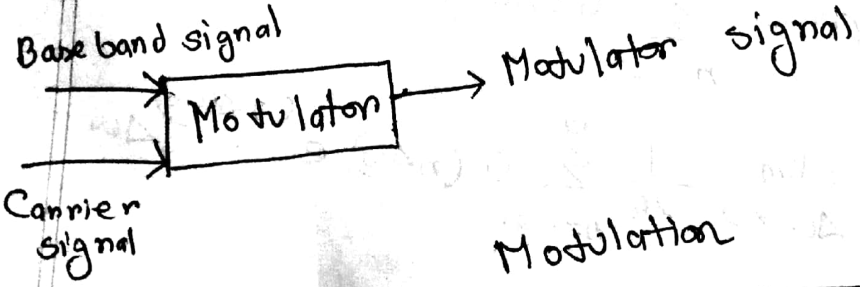
⇒ Deduction of noise

⇒ Multiplexing

⇒ B/W limitations of equipments

⇒ Frequency characteristics of antenna.

⇒ Atmospheric and cable properties.



Modulation

- Amplitude Modulation
- Frequency Modulation
- Phase Modulation

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Modulation:

Some perameter of the carrier signal (Amp, freq, phase) is varied in accordance with the baseband signal. This process is called modulation.

Amplitude modulation :

Disadvantages of amplitude modulation :

→ Low efficiency ~~as~~ is carried by low frequency sidebands.

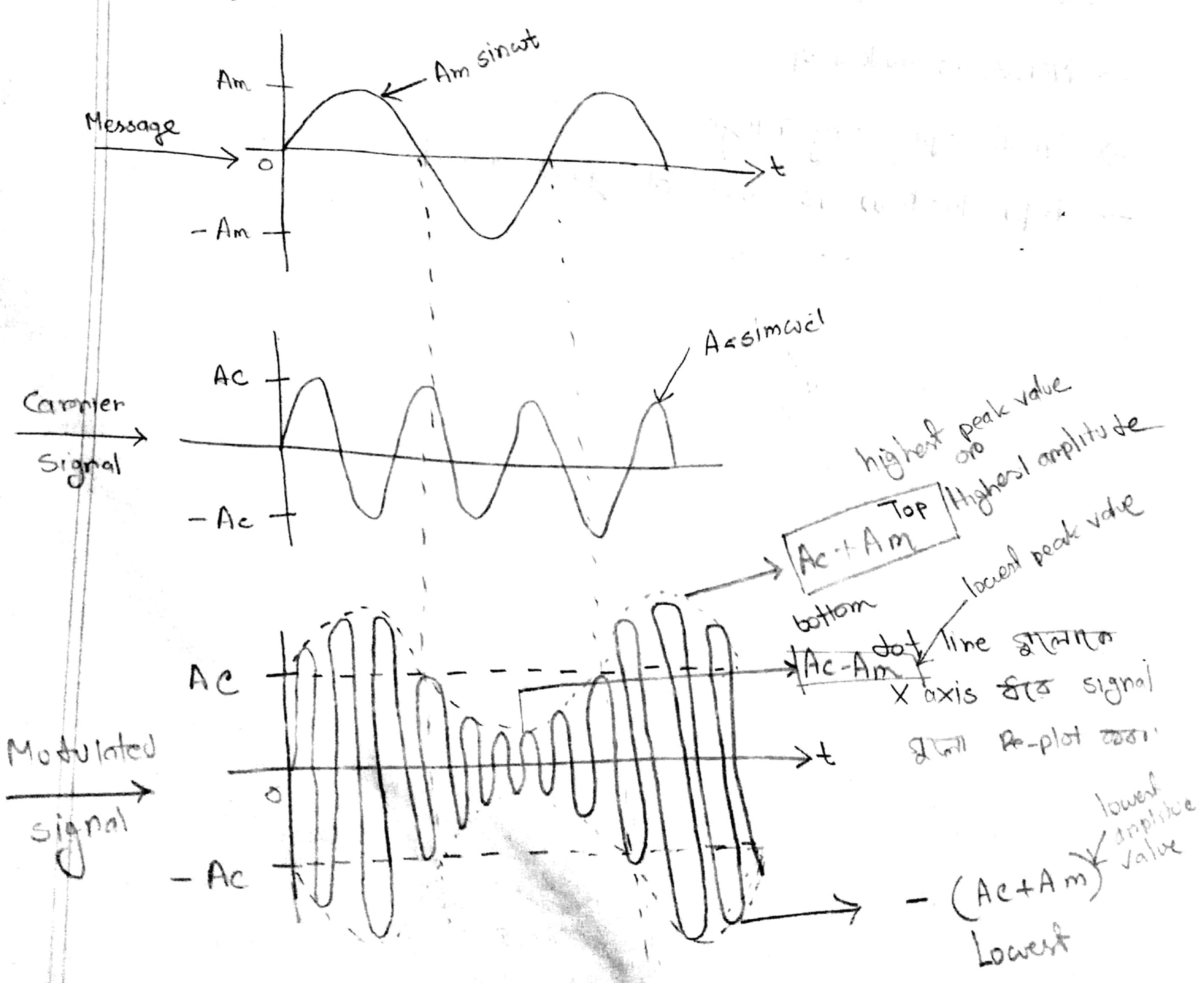
→ Noise is added up.

→ Small operating range

→ Reproduction is not of good quality.

Why ~~digital~~ transmission is needed :

- To make the signal exact.
- Signals can be checked for errors.
- Noise and ~~inter~~ inference are easily filtered out.
- A variety of services can be offered over a signal channel.
- Higher B/W is possible with data compression.



Prove that amplitude modulation signal is a combination of three individual sinusoidal harmonic wave

Let the message is given by,

$m = A_m \sin \omega_m t$

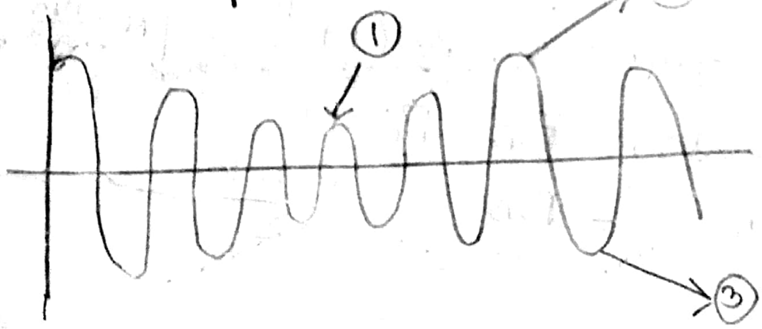
(time X axis; frequency; Amplitude; trigonometric function)

Carrier signal is given by,

$c = A_c \sin \omega_c t$

Then the modulated signal is given by

$$C_m = (A_c + A_m \sin \omega_m t) \sin \omega_c t$$
$$= A_c \sin \omega_c t + A_m \sin \omega_m t \sin \omega_c t$$
$$= A_c \sin \omega_c t + \frac{1}{2} A_m \, 2 \sin \omega_m t \sin \omega_c t$$
$$= A_c \sin \omega_c t + \frac{A_m}{2} \cos(\omega_c - \omega_m)t - \frac{A_m}{2} \cos(\omega_c + \omega_m)t$$
$$= \underbrace{\boxed{A_c} \sin \omega_c t}_{1} + \underbrace{\boxed{\frac{A_m}{2}} \cos(\omega_c - \omega_m)t}_{2} - \underbrace{\frac{A_m}{2} \cos(\omega_c + \omega_m)t}_{3}$$



Modulation index :

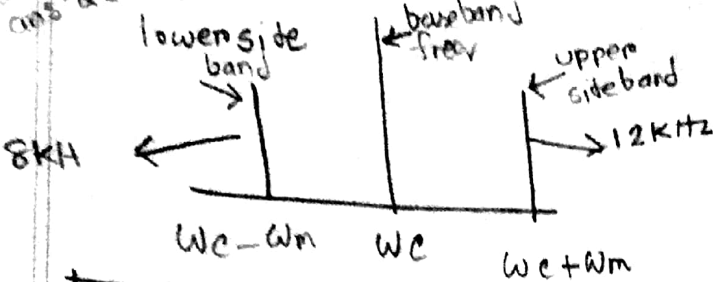
$$M = \frac{A_m}{A_c}$$

$A_m \rightarrow$ message signal

$A_c \rightarrow$ carrier signal

base freq
carrier signal
freq

base sig
reffer message signal



$$\boxed{B/W = 2W_m}$$

ω_m = message signal freqency

(1) $\omega_c - \omega_m = 8$, $\omega_c + \omega_m = 12$

$$\boxed{B/W = 2\,\omega_m}$$

$= 2 \times 2$

$= 4$ KHz **Ans**

$$\cancel{\omega_c} - \omega_m = 8$$
$$\cancel{\omega_c} + \omega_m = 12$$
$$-2\omega_m = \cancel{20}\ -4$$
$$\Rightarrow \omega_m = \cancel{10}\ 4/2$$
$$\Rightarrow \omega_m = 2$$

B/W = (upper – lower) sideband

Power of an AM signal $P_T = P_c\left(1 + \frac{M^2}{2}\right)$ $\boxed{M = \frac{A_m}{A_c}}$

$P_c \rightarrow$ Power of carrier signal

Power in both sidebands, $P_{SB} = P_T - P_c$

$P_T \rightarrow$ modulated signal

" " one " $= \frac{P_{SB}}{2} = \frac{P_T - P_c}{2}$

$\omega_c + \omega_m - \omega_c + \omega_m$

Bandwith = $2\omega_m$

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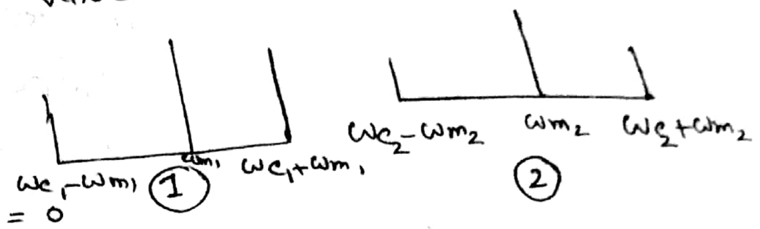
The bandwidth of two radio stations are 40KHz. Determine the message signal frequencies. What are the values of carrier frequensis if the stations are placed side-by-side and the value of the lowest sideband is zero



$2\omega_{m_1} = 40$

$\cancel{\Rightarrow m_1 =}$

$\Rightarrow \omega_{m_1} = 20\text{KHz}$

$\omega_{m_2} = 20\text{KHz}$

$\cancel{\omega_{c_1} + \omega_{m_1} =}$

$\omega_{c_2} - \omega_{m_2} = \omega_{c_1} + \omega_{m_1}$

$\Rightarrow \cancel{\omega_{c_2} - 40 = \omega_{c_1} +} 40$

$\Rightarrow \cancel{\omega_{c_2} = \omega_{c_1} +} 40+40$

$\Rightarrow \cancel{\omega_{c_2} = \omega_{c_1}} + 80$

$\Rightarrow \cancel{\omega_{c_2} - 80} = \omega_{c_1}$

$\Rightarrow 200 + 20 = \omega_{c_2} - \omega_{m_2}$

$\boxed{\Rightarrow \omega_{c_2} = 60}$

$\cancel{\omega_{c_1} - \omega_{m_1} = 0}$

$\Rightarrow \cancel{\omega_{c_1} + 80 - \omega_{m_1}} = 0$

$\Rightarrow$

$\omega_{c_1} - \omega_{m_1} = 0$

$\boxed{\Rightarrow \omega_{c_1} = 20}$

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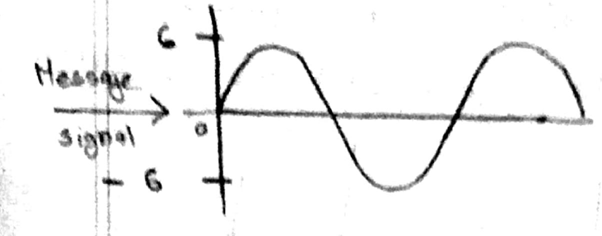
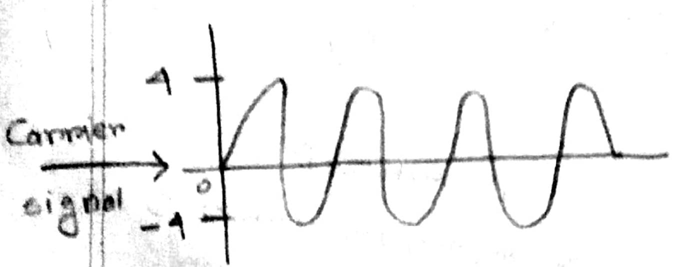
Over Modulation:



over modulation হলে modulated signal এ ~~বিভিন্ন~~ signal এক হয়ে overlap হবে।

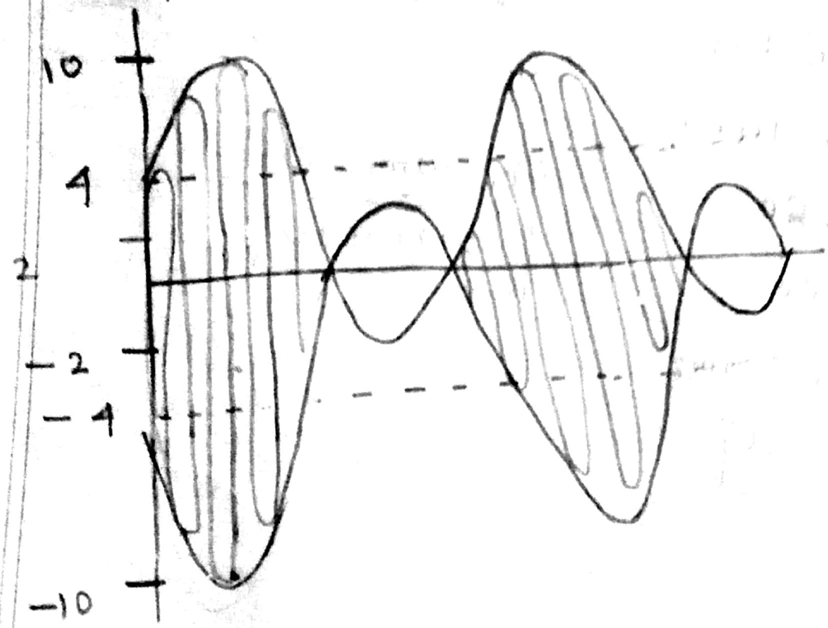


$A_c < A_m$

বাড়ানো দিতে হবে তবে overlap হবে না।

So solving this

$A_c > A_m$



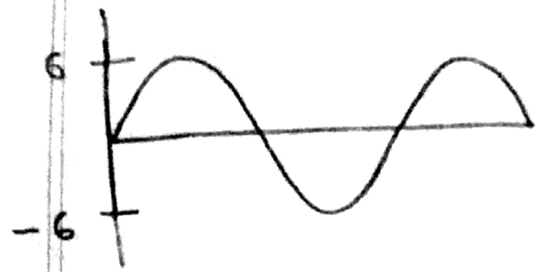
100% হলে তবে overmodulation হবে না।

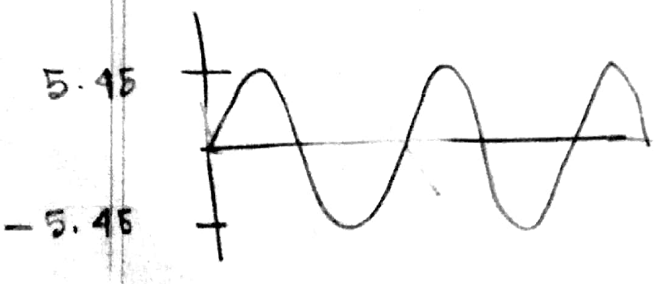
for 110%

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

$\Rightarrow 1.1 = \frac{6}{A_c}$

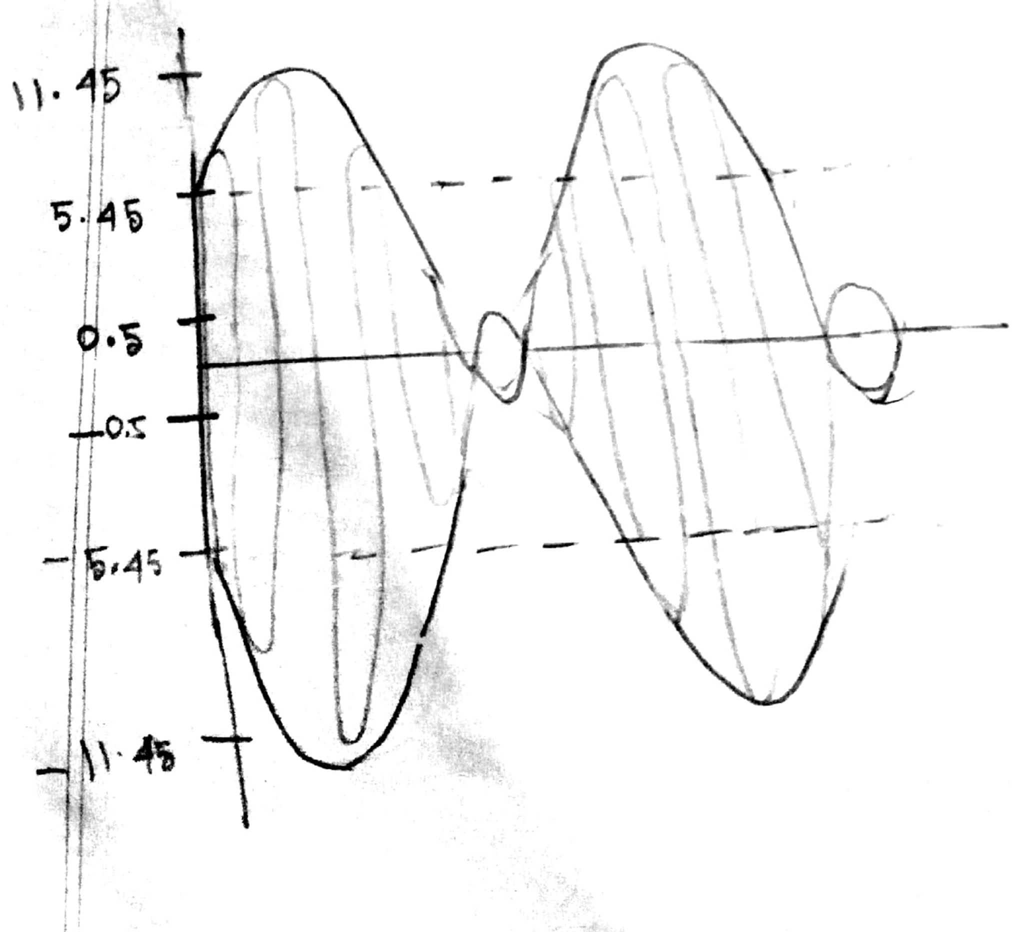
$\Rightarrow A_c = 5.45$





$5.45 - 6$
$= -0.5$

$-5.45 - (-6)$
$= 0.5$



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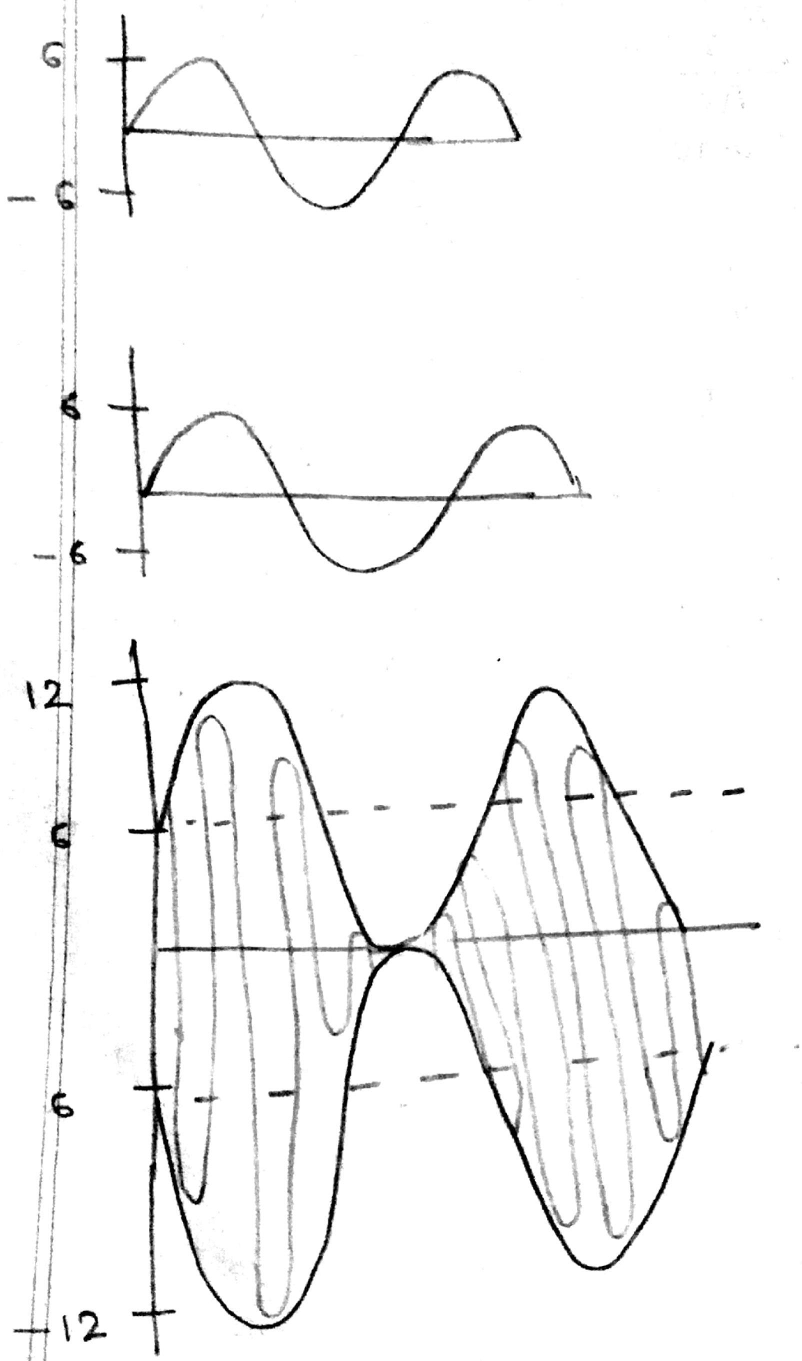
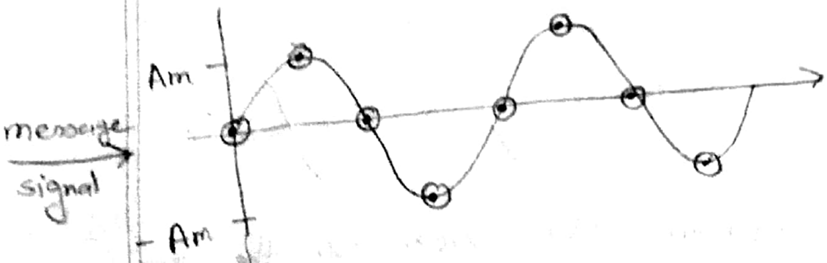
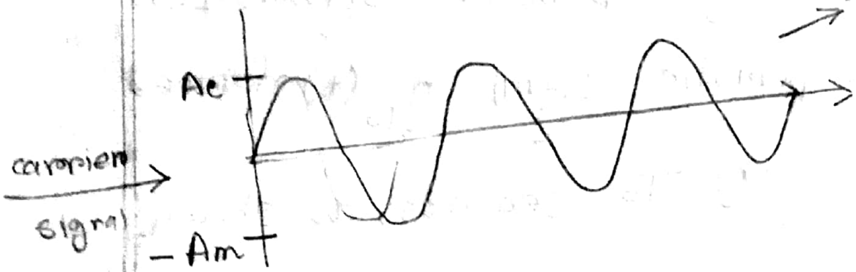

6
-6
6
-6
12
6
6
-12

Frequency modulation :





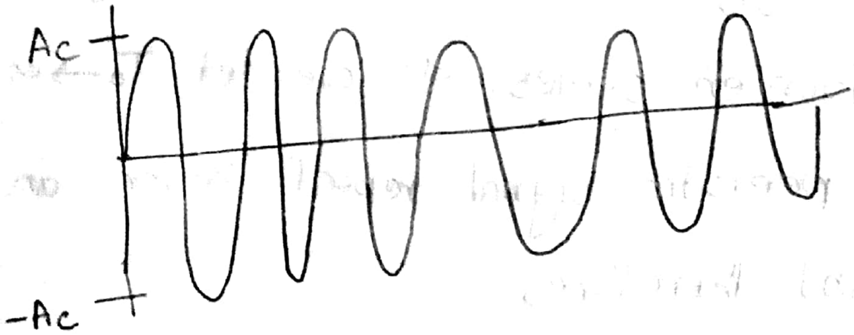
f_0 = Resting ~~freq~~

Δf = frequency deviation

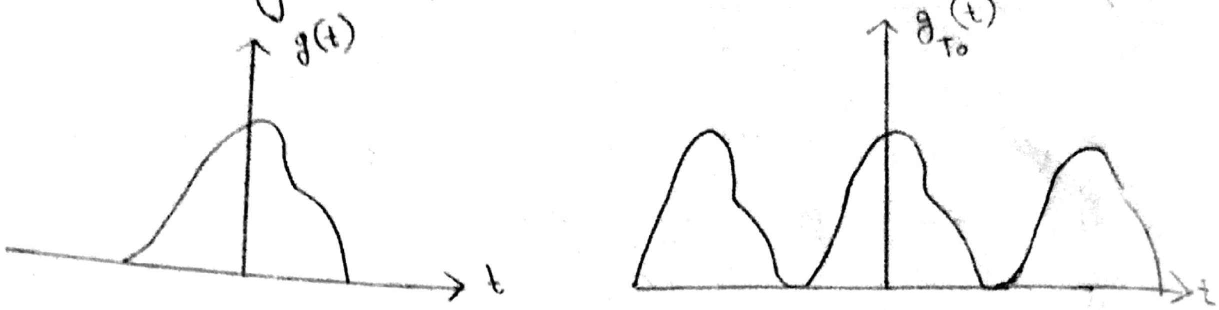
ground = same

top = compress

bottom = spread



Aperiodic signal represent by Fourier integral :



To represent an aperiodic signal $g(t)$ such as the one shown is fig. 1(a) by everlasting exponential signals. Let us construct a new periodic signal $g_{T_0}(t)$ formed by repeating signal $g(t)$ every T_0 seconds, as shown in figure 1(b)

The periodic signal $g_{T_0}(t)$ can be represented by an exponential Fourier series. If we let $T_0 \to \infty$ the pulses in the periodic signal repeat after an infinite interval, and therefore,

$$\lim_{T_0 \to \infty} g_{T_0}(t) = g(t) \quad \text{--- (1)}$$

The exponential Fourier series $g_{T_0}(t)$ is given by,

$$g_{T_0}(t) = \sum_{n=-\infty}^{\infty} D_n e^{jn\omega_0 t} \quad \text{--- (2)}$$

$$\therefore D_n = \frac{1}{T_0} \int_{-T_0/2}^{T_0/2} g_{T_0}(t)\, e^{-jn\omega_0 t}\, dt \quad \text{--- (3)}$$

We know, $\omega_0 = 2\pi / T_0$ — (1)

Integrating $g_{T_0}(t)$ over $(-T_0/2, T_0/2)$ is the same as integrating $g(t)$ over $(-\infty, \infty)$

Therefore we expressed eq. (3) as

$$D_n = \frac{1}{T_0} \int_{-\infty}^{\infty} g(t)\, e^{-jn\omega_0 t} \quad \text{— (5)}$$

Let us $G(\omega)$, a continuous function of

$$G(\omega) = \int_{-\infty}^{\infty} g(t)\, e^{-j\omega t}\, dt \quad \text{— (6)}$$

From eq. (6) $\quad D_n = \frac{1}{T_0} G(\omega_0 n)$ — (4)

This shows that the Fourier coefficients D_n are the samples of uniformly spaced at intervals of ω_0 rad/s. in Fig (2)(a) Therefore $(1/T_0)\, G(\omega)$ is the envelope for the coefficients D_n. We know let $T_0 \to \infty$ by doubling T_0 repeatedly. Doubling T_0 halves the fundamental frequency ω_0. so that there are now twice as many components in the spectrum. Howeverever, by doubling T_0 the envelope $(1/T_0)\, G(\omega)$ is halved. as fig (2)(b) If we continue this process of doubling T_0 repeatedly, the spectrum progressivly becomes densen ~~wh~~ while its magnitude becomes smaller.

substitution eq ⑥ in eq ③

$$g_{T_0}(t) = \sum_{n=-\infty}^{\infty} \frac{G(n\omega_0)}{T_0} e^{j\omega_0 n t} \quad \text{—— ⑦}$$

As $T_0 \to \infty$, $\omega_0 \to 0$. Because of this we shall replace ω_0 by a more appropriate notation $\Delta\omega$.

eq ④ $\Delta\omega = \frac{2\pi}{T_0}$ $\qquad \frac{1}{T_0} = \frac{\Delta\omega}{2\pi}$

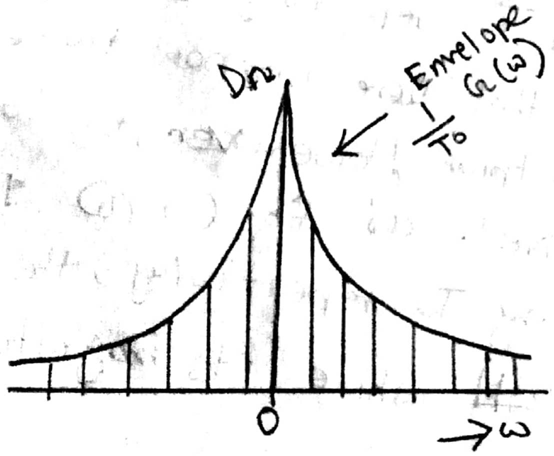
eq ⑦ is,

$$g_{T_0}(t) = \sum_{n=-\infty}^{\infty} \frac{G(n\Delta\omega)\Delta\omega}{2\pi} e^{(j\Delta\omega n)t}$$

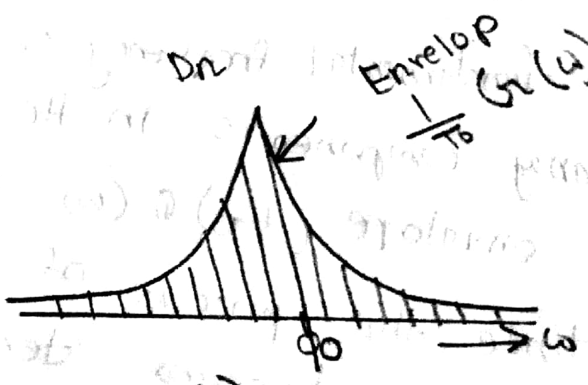
In the limit as $T_0 \to \infty$, $\Delta\omega \to 0$ and $g_{T_0}(t) \to g(t)$.

Therefore

$$g(t) = \lim_{T_0 \to \infty} g_{T_0}(t) = \lim_{\Delta\omega \to 0} \frac{1}{2\pi} \sum_{n=-\infty}^{\infty} G(n\Delta\omega) e^{(jn\Delta\omega)t} \Delta\omega$$



2(a)



2(b)

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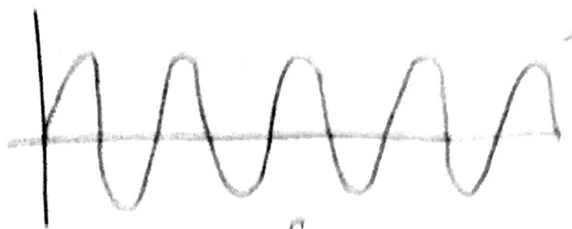
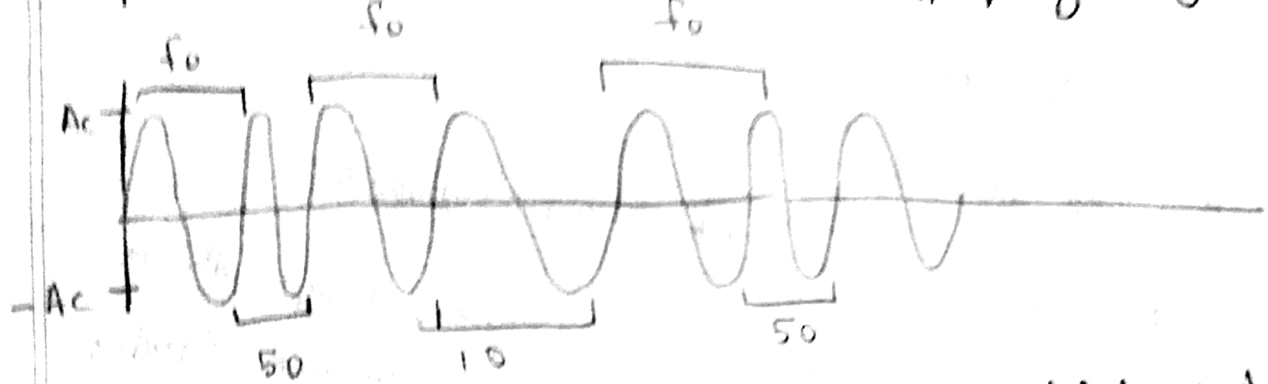
$f_c = 30KHz$ Top $= 30+20 = 50$

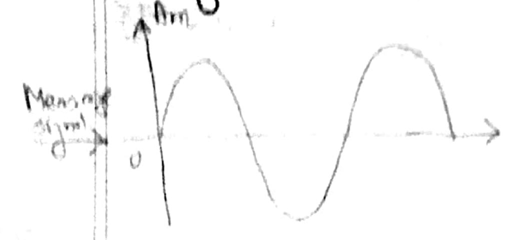
$\Delta f = 20KHz$ bottom $= 30-20 = 10$

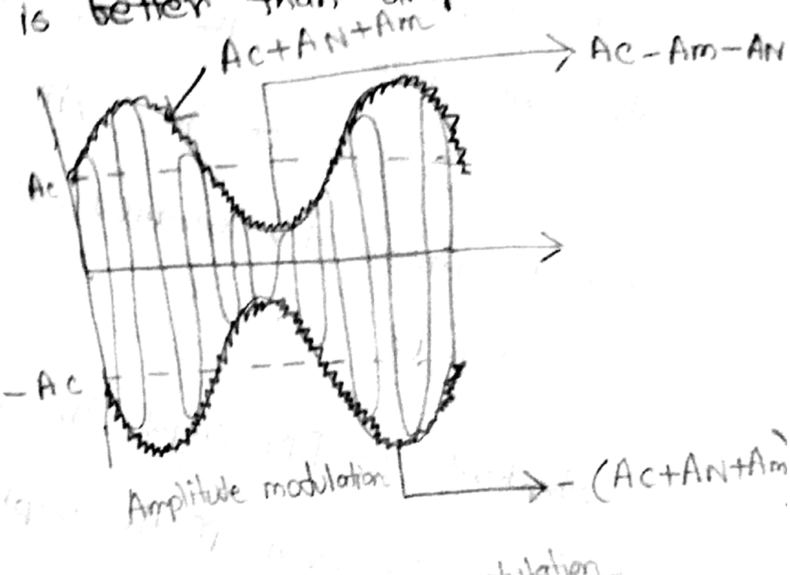


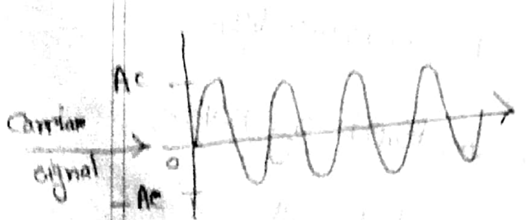
frequency swing $= 2\Delta f$

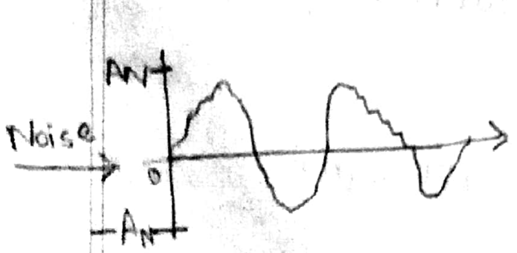


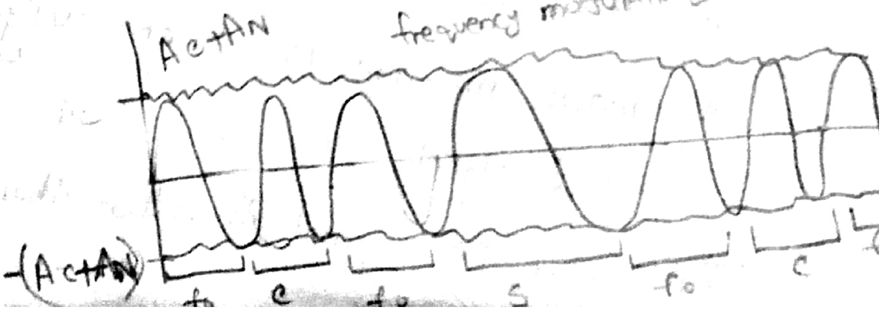
Why frequency modulation is better than amplitude modulation











Lets consiter two sinusoidal waves. One message signal A_m and one carrier signal A_c Now, in a noise free enviroment, we know that the motulated wave is,

$$C_m = (A_c + A_m \sin\omega_m t)\sin\omega_c t$$

However when a noise signal is present, and if the noise signal is

$$C_n = A_n \sin\omega_n t$$

then the motulated wave becomes,

$$C_m = (A_c + A_m \sin\omega_m t + A_N \sin\omega_N t)\sin\omega_c t$$

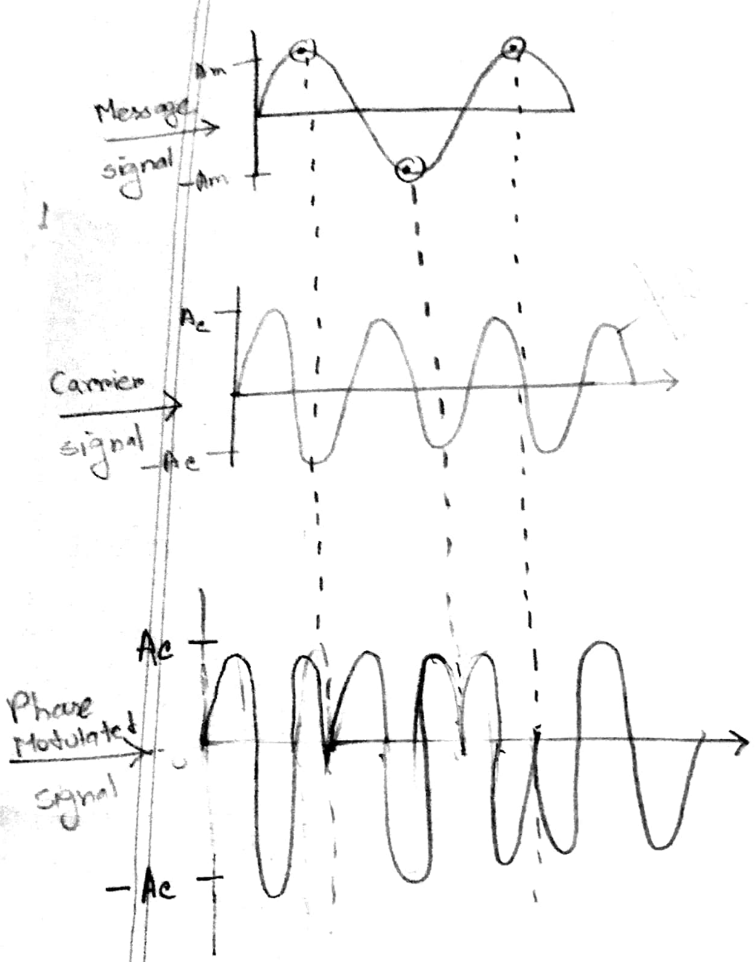
This happens because a noise signal always effects another signal. the amplitude of ~~the AM signal~~ ·

So, the amplitude of the AM signal is effected by noise and the information carried will not be the exact message we wanted to send.

On other hand, in FM signal, the message is carried by frequency. So, even if the amplitude is distored by noise, the main message is successfully carried by the motulated signal.

That's why FM signal is better than AM signal.

Phase modulation :



FINAL

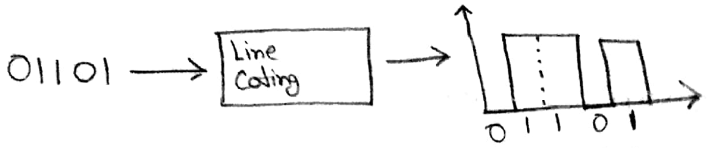
30.11.16

Line Coding

Line Coding : Binary data can be transmitted using a number of different types of pulses.

The choice of a particular pattern of pulses to represent the symbols 1 & 0 is called line coding (LC)

0 → horizontal
1 → value

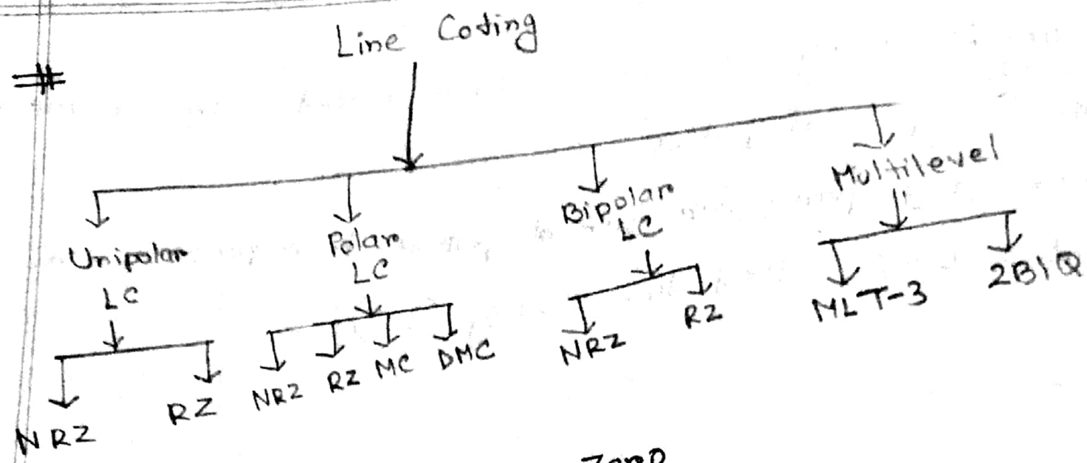


Why Line Coding is ~~not~~ needed :

→ Spectrum shaping & relocation without modulation.
→ Bit clock recovery can be elimienated.
→ DC component can be eliminated
→ Error detection capabilities.
→ B/W usage : Possibility of transmitting a higher bandwidth.

Properties of Line Coding :

→ Self synchronization
→ Low probability of bit error.
→ Spectrum of LC should suit the physical medium.
→ DC component should be ideally zero
→ Low power.



NRZ → Non-Return to Zero
RZ → Return to zero
MC → Manchester Coding
DMC → Differential Manchester Coding
MLT-3 → Multilevel transition-3
2B1Q → 2 Binary 1 Quartenary.

Selection of coding technique depends on :

1. To make the bit rate in a channel
2. To recover the sychronous information from recieved signal
3. Reduced power of transmission
4. Reducing the DC component.

Unipolar :

 # Advantages :

→ Simplicity in implementation.

→ Does not require a lot of B/W

 # Disadvantages :

→ Contains low frequency components

→ No error detection

→ No clocking for synchronization

→ RZ needs twice B/W than NRZ

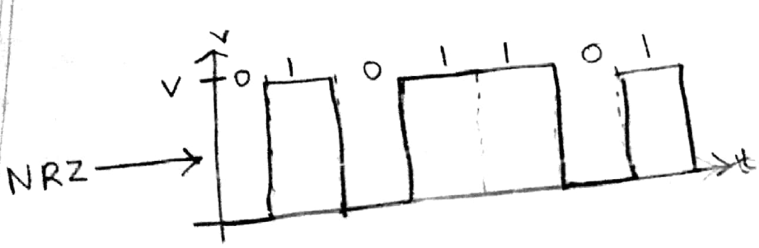
0 → NRZ & RZ same

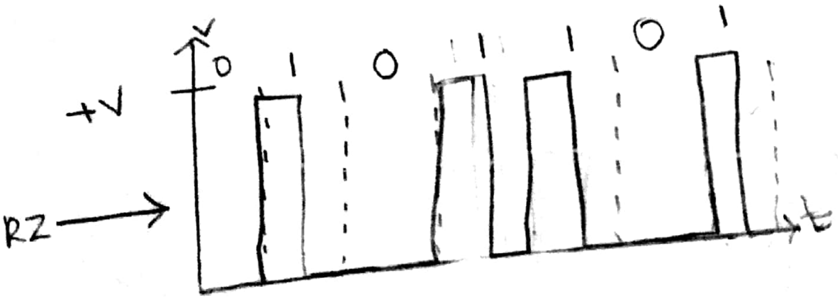
1 → NRZ = full slot

RZ first Half +V

Last " 0

that's why called zero





Polar :

Advantages :

→ Simplicity in implementation.

→ No DC component

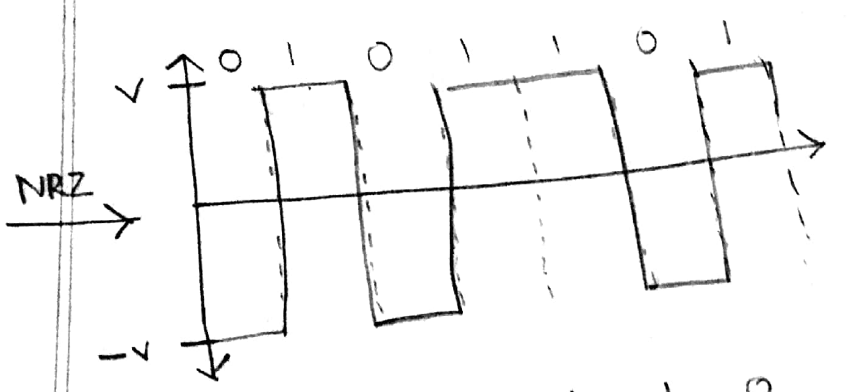
Disadvantages :

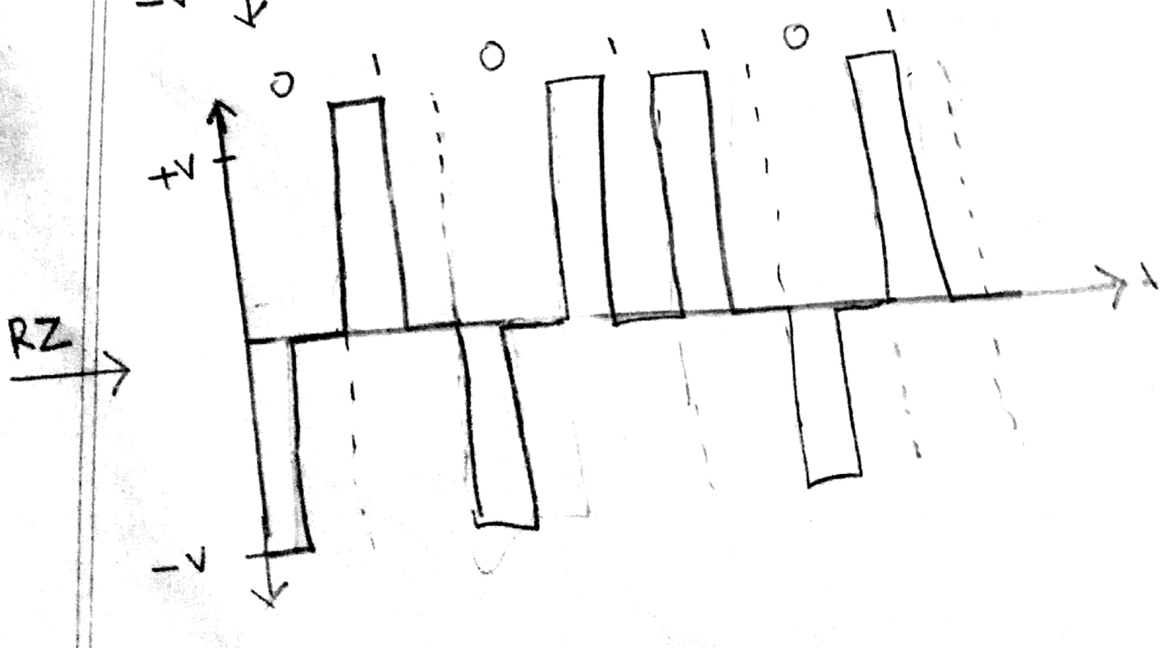
→ Continuous part is non-zero

→ No error detection

→ No clocking for synchonization

→ RZ needs twice B/W than NRZ





Bi Polar :

Advantages :

→ Less B/W than unipolar and polar

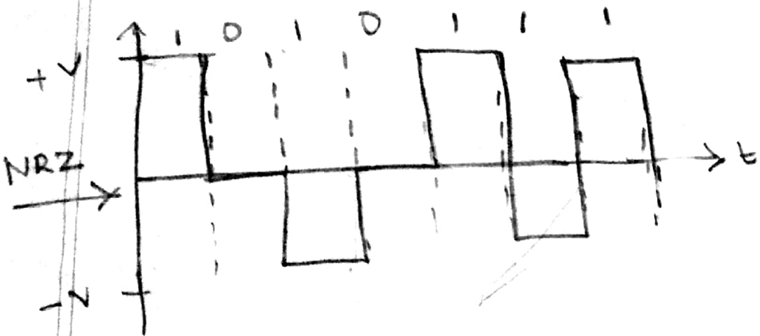
→ No DC component.

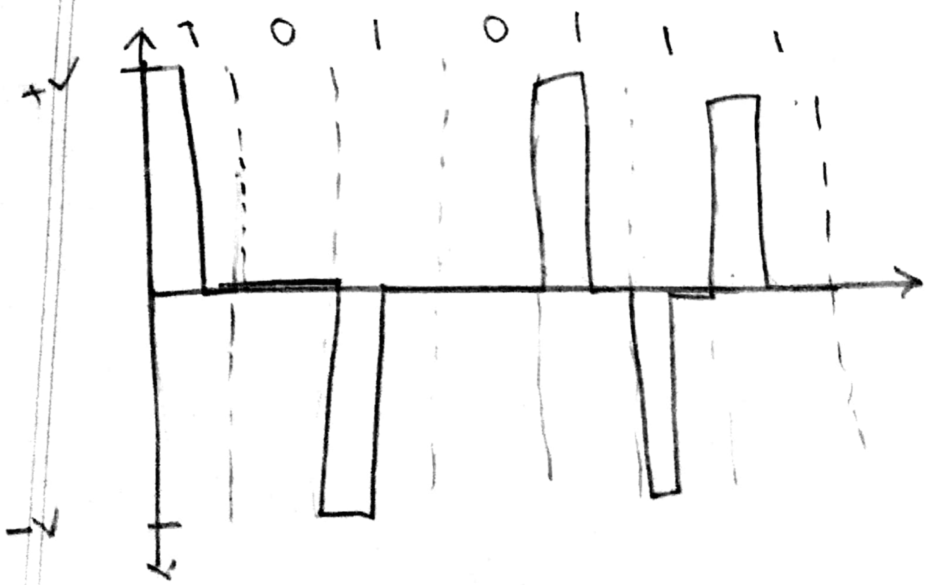
→ single bit error detection

→ No signal drop

Disadvantages :

→ No ~~clk~~ clocking for NRZ

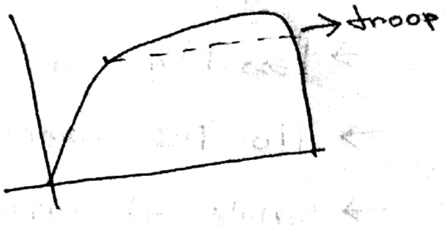




5.12.16

~~Next~~ Monday
CT

Manchester coding:



advantages:

→ No DC component

→ No signal trap

Disadvantages:

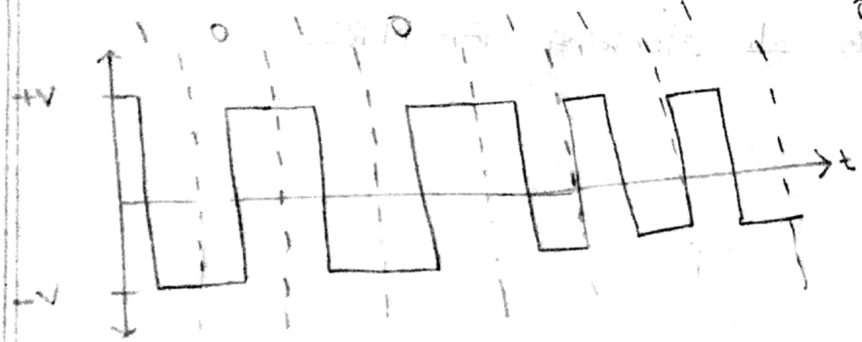
→ Requires large bandwidth

→ No error detection capabilities

→ Used in LAN

1 → 1st half +V
2nd " −V

0 → 1st half −V
2nd " +V

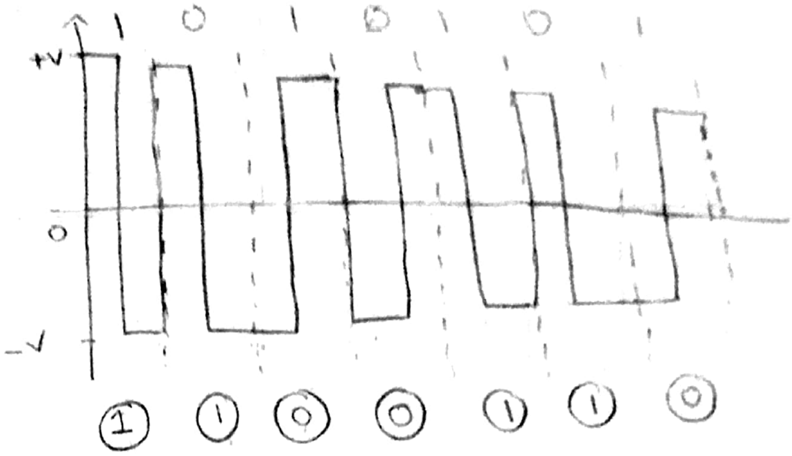


Differential Manchester Coding:

XOR

A	B	A ⊕ B
0	0	0
0	1	1
1	0	1
1	1	0

$d(k) = M(k) \oplus d(k-1)$



MLT-3 coding (Multi level transition):

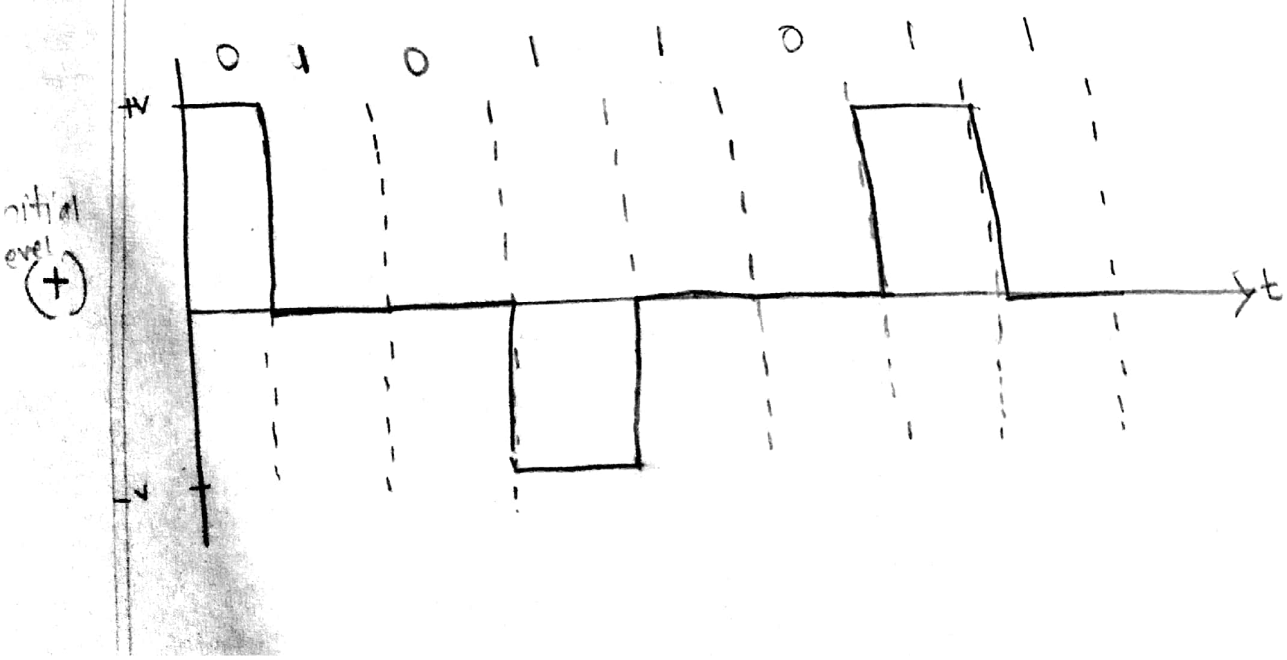
Rules:

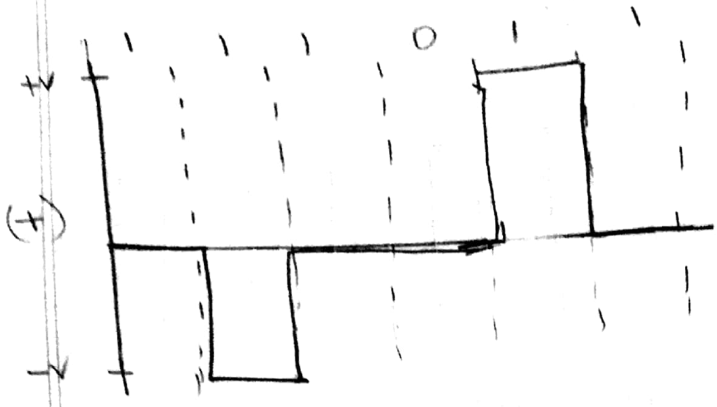
→ if next bit is zero, then no transition.

→ if next bit is One, current level is not zero, the next level is zero.

→ If next bit is one, current level is zero, then next level is opposite of the last non-zero level

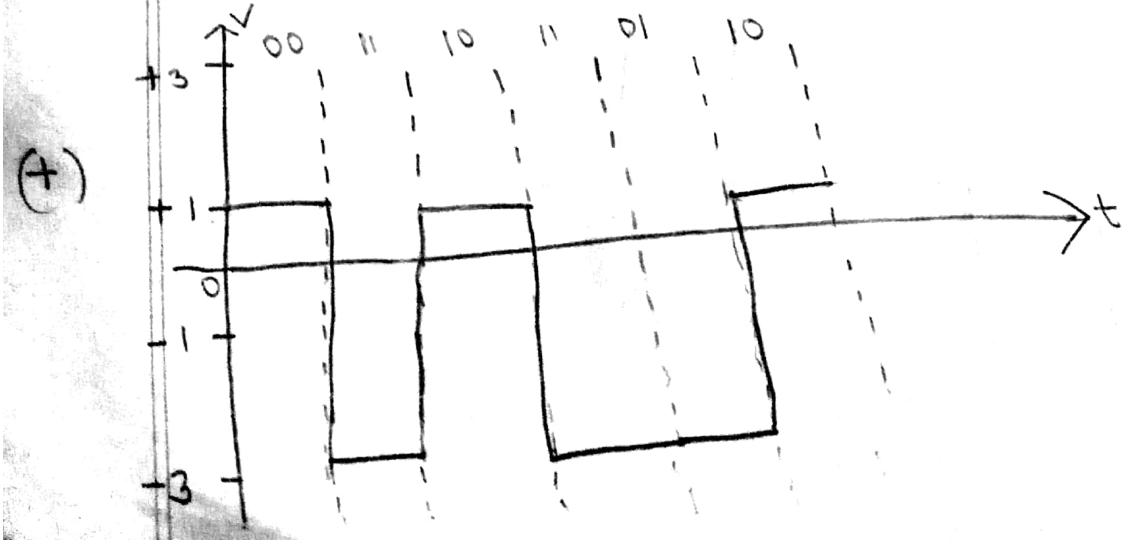
The levels are +V, 0, −V





2B1Q coding:

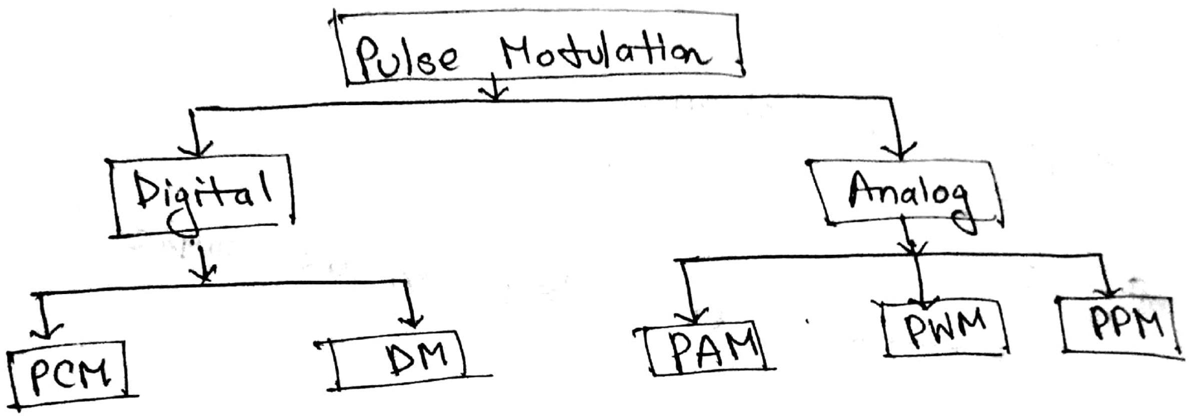
Next bit	~~Previous~~ current level (+) / Next level	~~Previous~~ current level (−) / Next level
0 0	+1	−1
0 1	+3	−3
1 0	−1	+1
1 1	−3	+3



Pulse Motulation

pulse Matulation :

The process of transmitting signals in the form of pulse. Some parameters of a pulse train is varied in accordance with the message signal



PCM → Pulse coted motulation

DM → Delta motulation.

PAM → Pulse Amplitude motulation

PWM → Pulse width motulation

PPM → pulse position motulation.

7.12.16

Features of pulse modulation:

→ Periodic pulse train is used as carrier.

→ Amplitude, Position & width is varied.

→ Message signal is discrete in time & amplitude

→ Transmission takes place as a sequence of coded pulses.

Pulse Amplitude modulation:

Advantages:

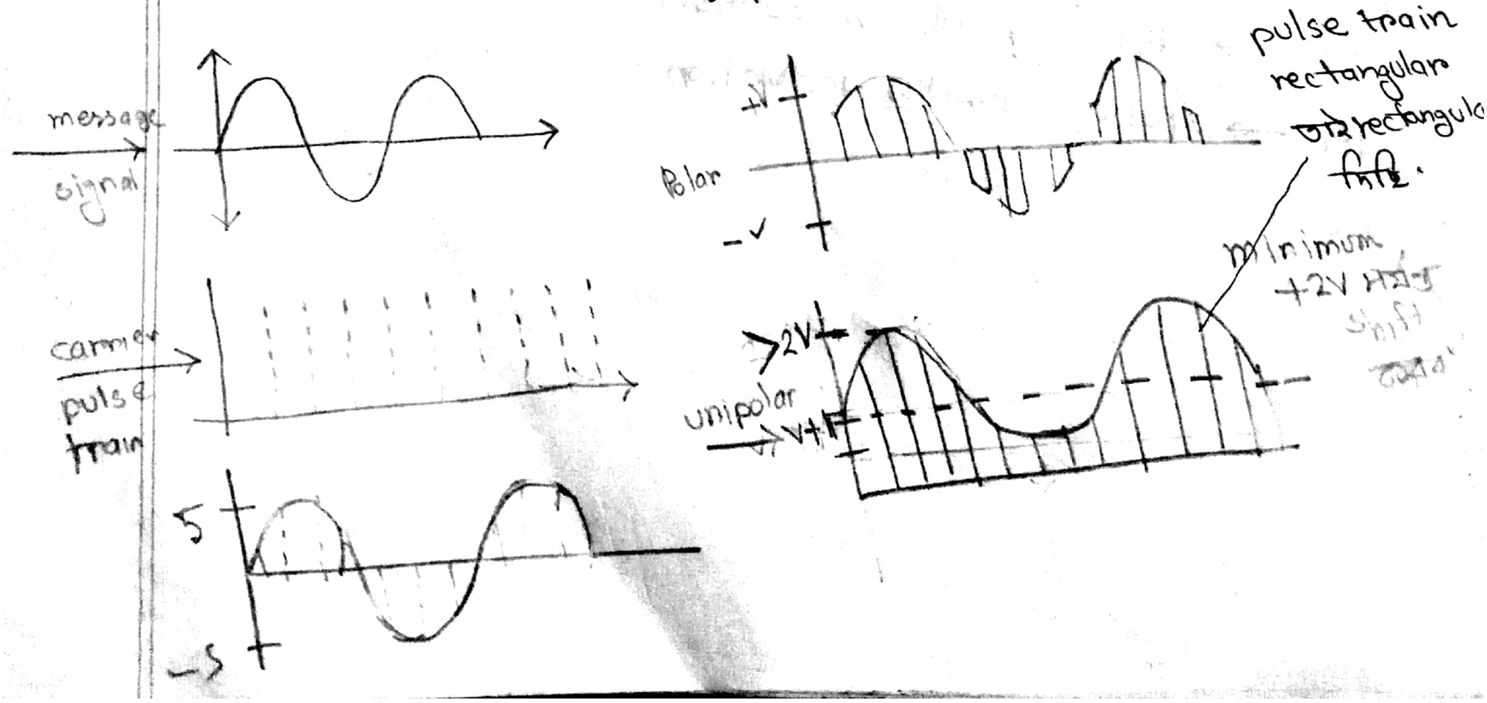
→ Generation & error detection are simple

Disadvantages:

→ Noise transformation is bad

→ Power depends on amplitude & width.

PAA PAM → Unipolar, Polar



PWM :

Advantages :

→ Noise is less effective compared to PAM

Disadvantages :

→ Since pulse width is different, so power will also be different for each individual slot.

PPM :

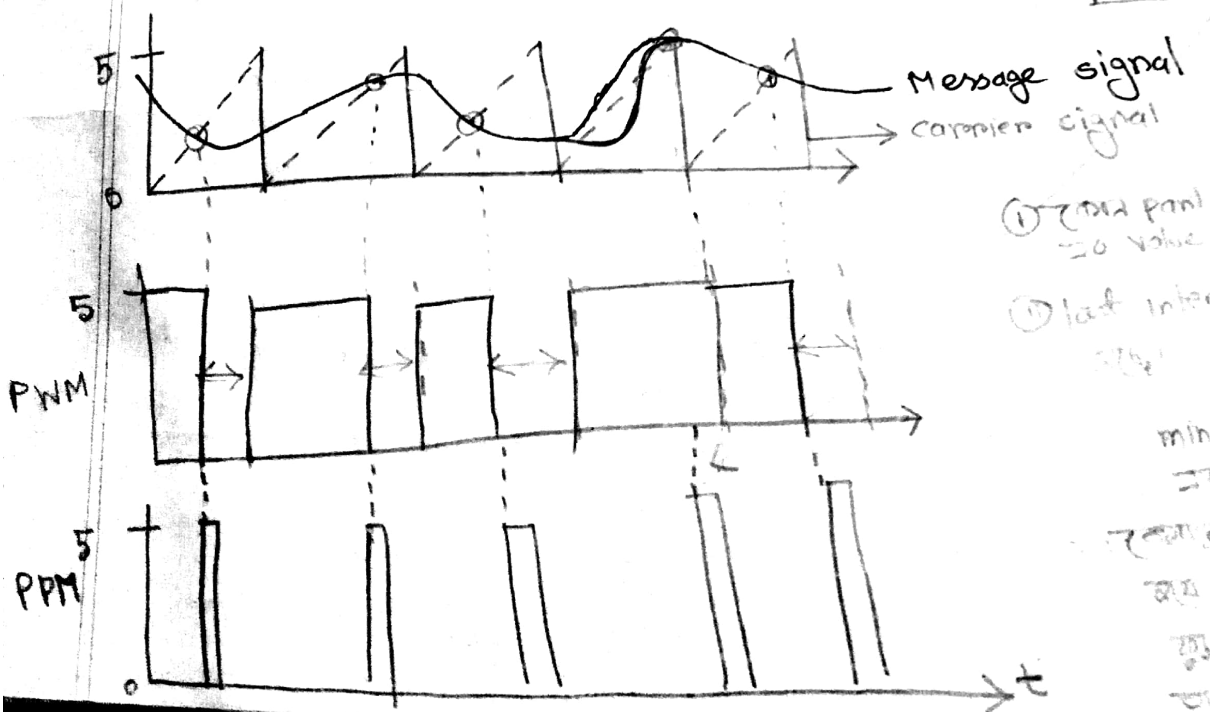
Advantages :

→ Amplitude is constant

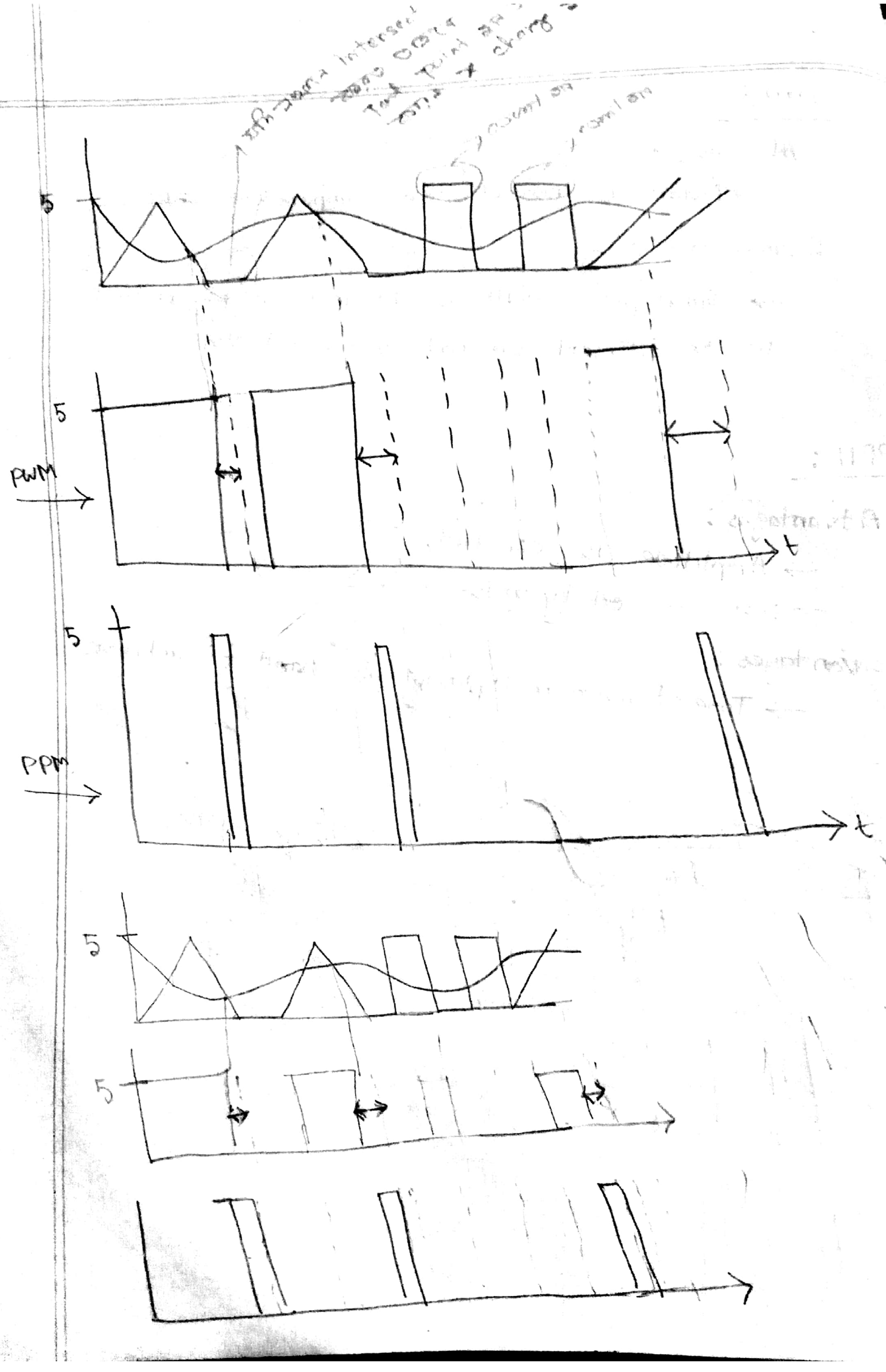
→ Less affected by noise

Disadvantages :

→ Time division multiplexing is hard to achieve



minimum width


5
PWM
t
5
PPM
t
5
5

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Digital:

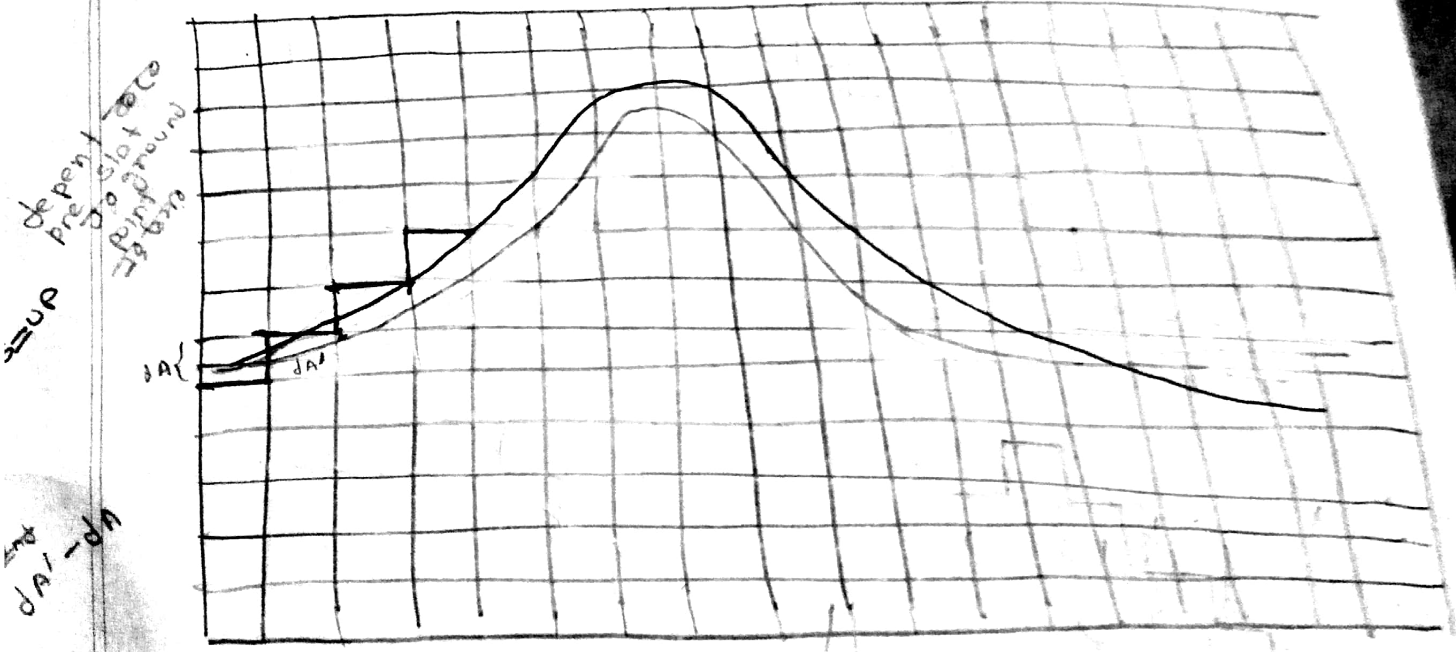
Delta modulation:

Features of Delta Modulation

→ A single bit transmitted per ~~seconds~~ sample

→ Requires higher sampling rate.

→ Works well for small changes in signal values ~~between~~ samples.



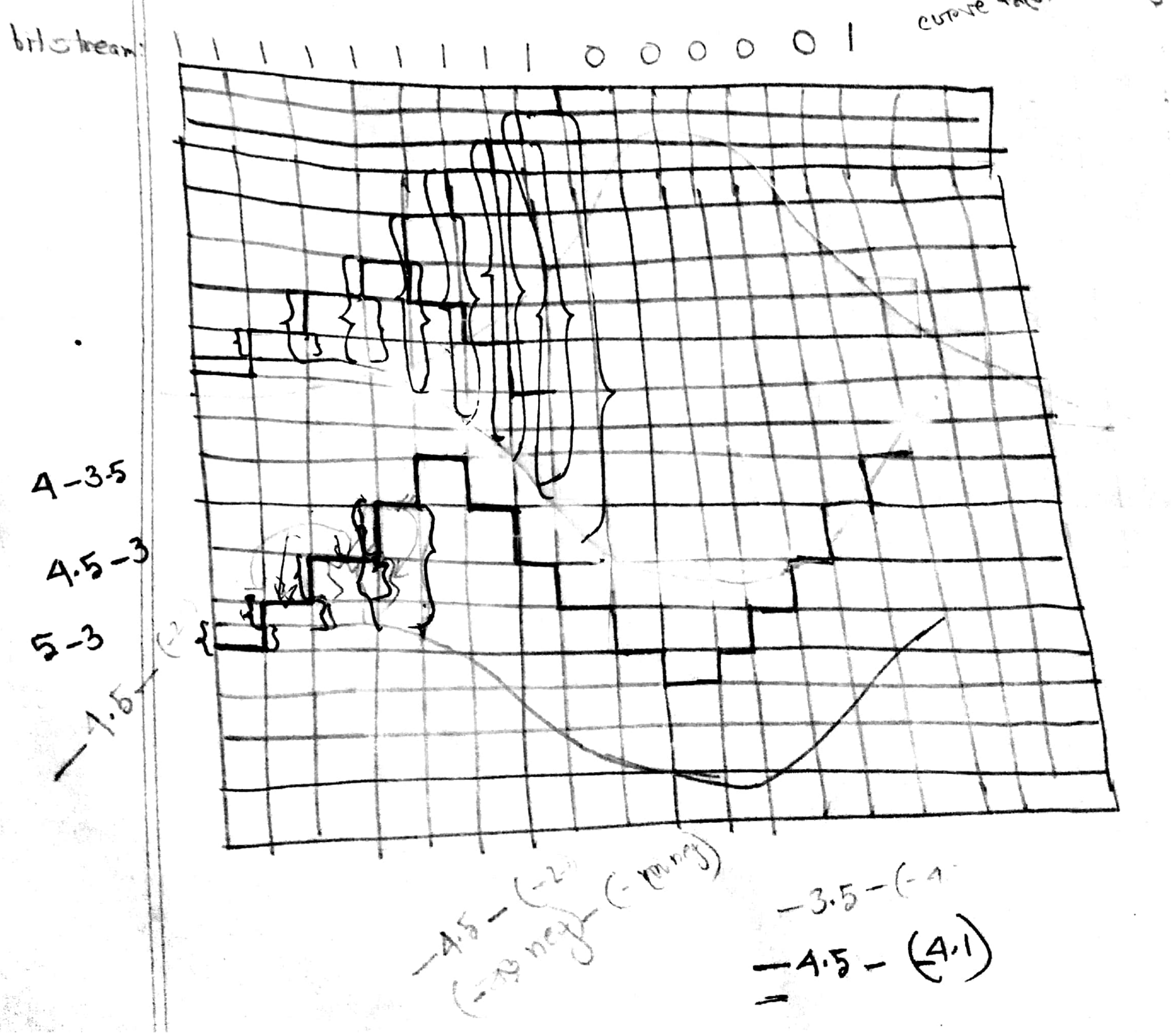
groom to mark

1. যে sqr থেকে start হবে তা ground mrk করব।
2. Upward যাবো। (cause কোনো কিছু নাই)
3. 2nd grid এ 1st grid এ ground থেকে
avg signal এর dis (dA' − dA) calculate করব।

≥ 0 up < 0 নিচে

যেকোনো নতুন sqr এ গেলে ground কে mark করব।

Upward transition দিলে 1
downward " " 0



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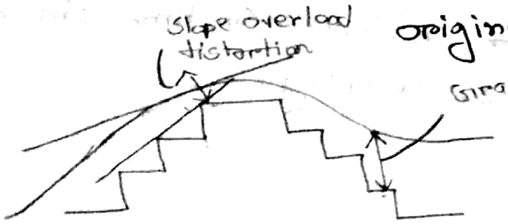
Errors of Delta modulation:

→ Slope overload distortion: Slope of signal is much higher than of ~~appor~~ approximated signal

→ Granular Noise: Difference between quantized & original signal.



msg তার ওই particular point এর difference Granular

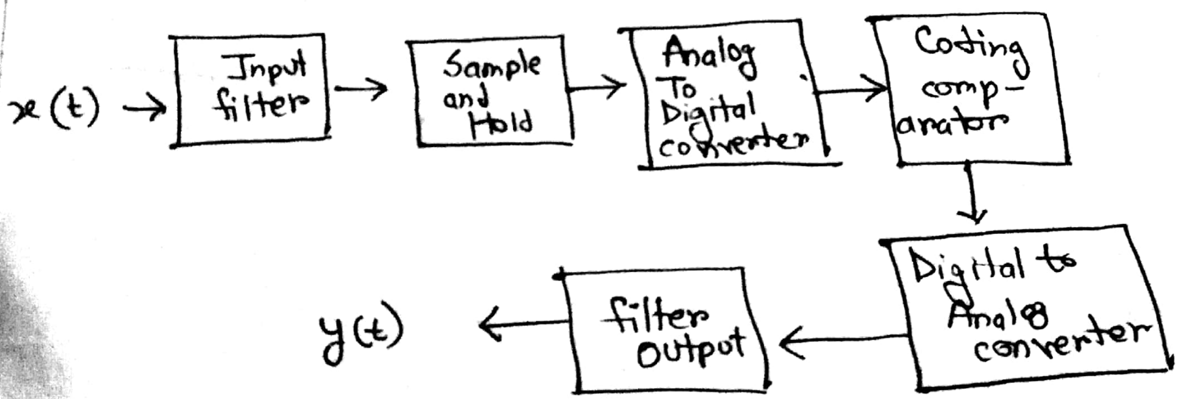
How to remove errors:

→ δ is varied according to the amplitude of analog signal

→ has wide dynamic range as δ is dynamic

→ better utilization of bandwidth.

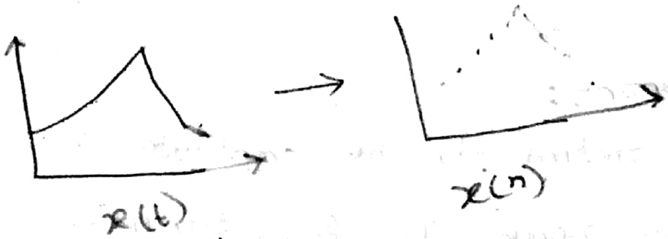
→ Improved sound to Noise ratio.



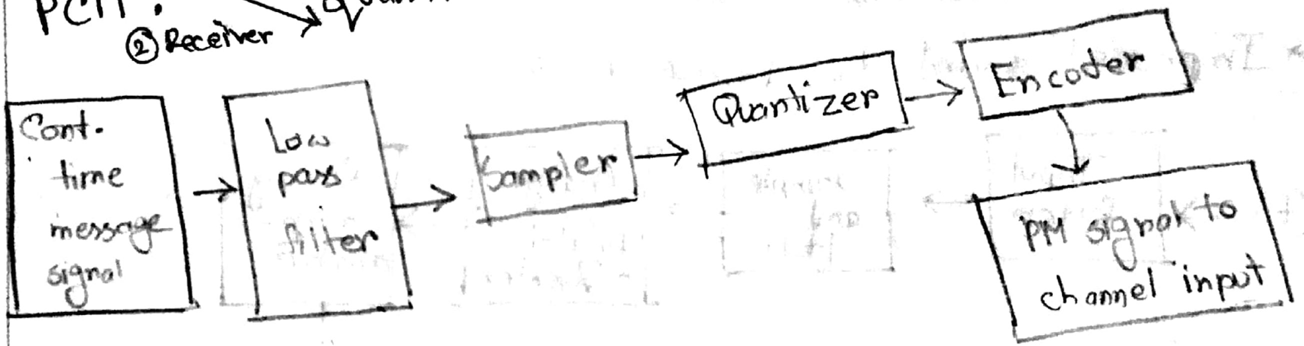
~~Blo~~ Block diagram of Digital Signal Processing

Sampling :

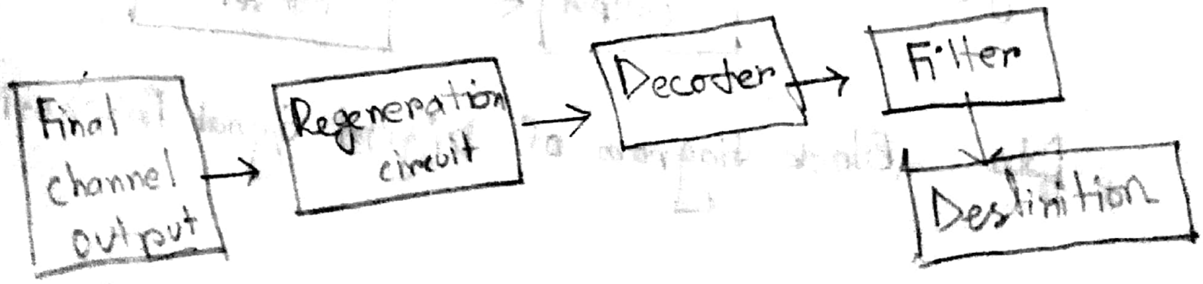
Sampling : Source generates analog signal but we want to transmit digital signal. We need to convert this signal where per second, there will be finite number of bits to represent the signal. Analog signal has infinite number of values in every time ~~ts~~ instance. So, time should be discritized. This is called Sampling.



PCM : ① sender → sampling, quantization
② Receiver

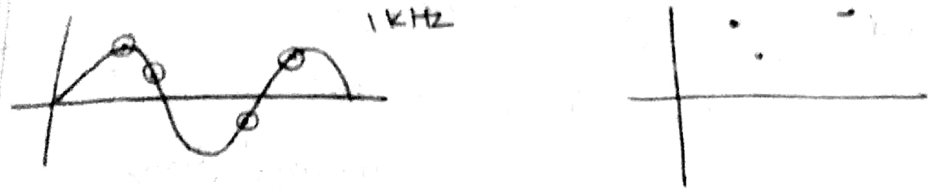


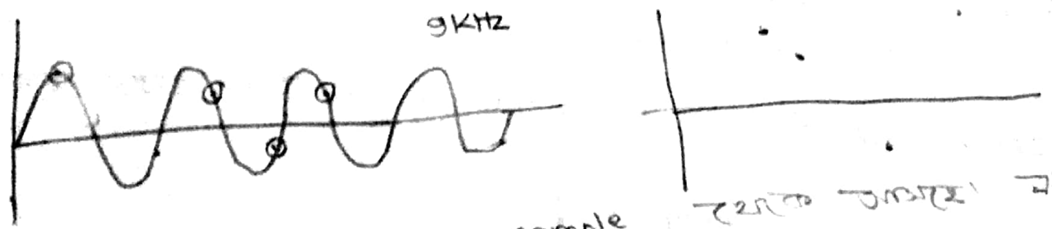
Senter



Receiver

sampling frequence : কতক্ষণ পর পর chose করব sampling point টা
sampling না করলে যে problem হয়.





হলেও আসলে সঠিকভাবে
বুঝতে পারা যায় না কোনটা sample

problem Aliasing

$(\pm f_0 \pm kf_s)$

given = 1KHz
sam = 8KHz

$f_0 = 1$ KHz , $f_s = 8$ KHz

$f_0 + kf_s$
$1 + 1.8$
$= 9$

K=-3	K=-2	K=-1	f_0	K=1	K=2	K=3
-23	-15	-7	1	9	17	25

Nyquist Sampling Theorem : (to remove aliasing)

The sampling rate must be at least twice the highest frequency component contained in the signal.

26.12.18

$f_0 = 1\,KHz$

$f_s = 8\,KHz$

↓

sampling freq মানে 1 হাজার বার সেকেন্ডে কোন কোন signal কে Sample করবে (aliasing frequency)

↓

given frequence এর

question : K = something এর জন্য aliasing freq বের করতে হবে।

অথবা f_0, f_s দেয়া থাকলে K বের করতে হবে।

Nyquist Sampling Theorem :

20, 30, 50

highest 50

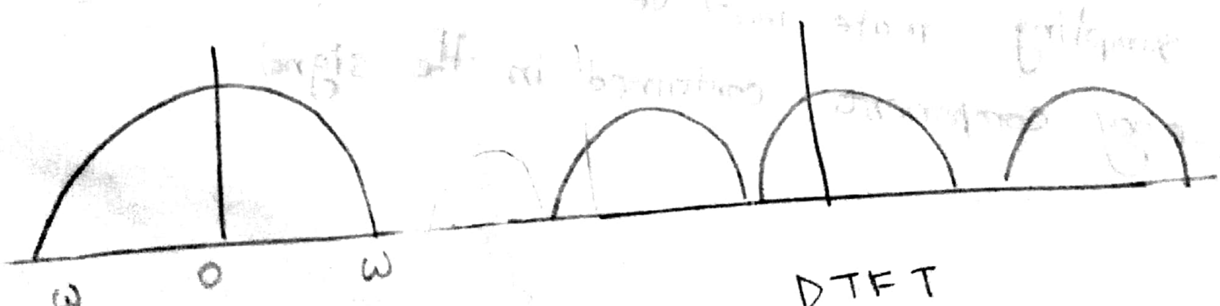
so double 50×2=100

(because twice)

20, 30 এর কম করে লাভ নাই কারন 20, 30 এর চেয়ে বেশী 50.

DTFT :

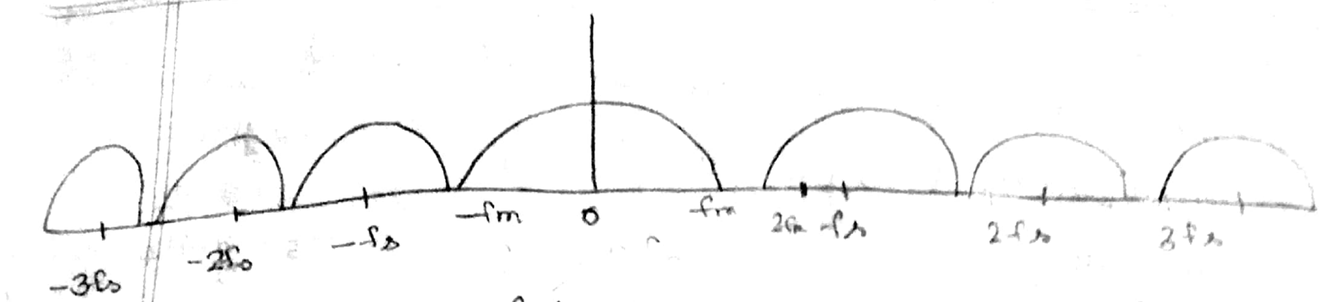
Discrete time Fourier Transform



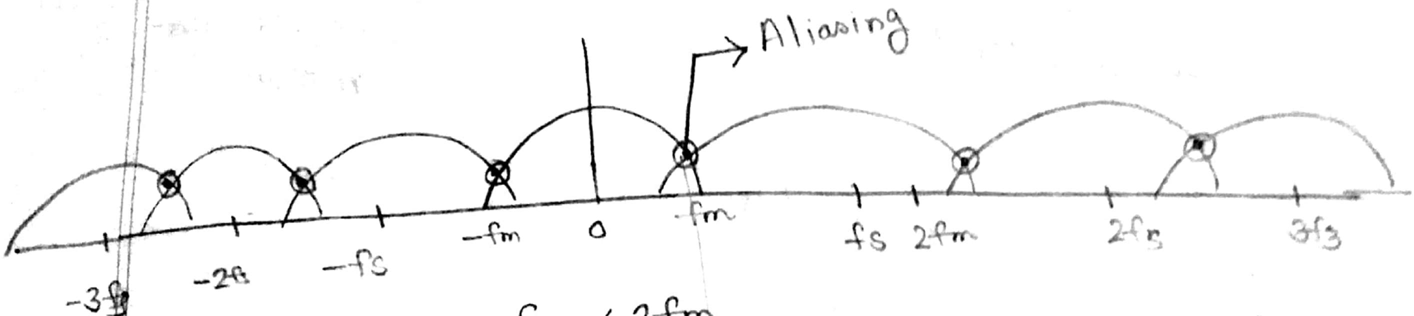
FS

FS এর অনেকগুলো copy DTFT

$fm - (-fm)$
$= 2fm$



$fs \geq 2fm$



$fs \leq 2fm$

fm = maximum frequency component

যদি fs 2fm এর চেয়ে ছোট হয়
তাহলে aliasing হবে।
(overlap হয়)
$fs \geq 2fm$ হলে aliasing হবে না।
overlap হয় না।

এই point টা কোন component থেকে আলাদা বোঝা যায় না।

fm নিচ্ছি কারণ $fm - (-fm) = 2fm$
maximum distance নিচ্ছি। তাহলে
ছোট/বড় যেকোনো কিছুর জন্যই
distance ঠিক হবে।

sampling alwayz x axis ধরি

$f_0 + K f_s$: $K=1$ → 6, $K=2$ → 11, $K=3$ → 16

$x(t) = 5\sin(2\pi f_0 t) + 75\sin(2\pi f_1 t) + \sin(2\pi f_2 t)$

$= 5\sin(2\pi f_0 n T_s) + 75\sin(2\pi f_1 n T_s) + \sin(2\pi f_2 n T_s)$

$= 5\sin(2\pi f_0/f_s\, n) + 75\sin(2\pi f_1/f_s\, n) + \sin(2\pi \frac{f_2}{f_s} n)$

$f_0 = 1KHz$, $f_1 = 3KHz$, $f_2 = 6KHz$, $f_s = 5KHz$

$= 5\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi \frac{3}{5} n) + \sin(2\pi \frac{6}{5} n)$

$\frac{1}{5} \to$ min, $\frac{6}{5} \to$ max

sample করতে হবে। result এ t থাকবে না তাই n হবে।

[সবচেয়ে ছোটটা f_0 নিবো]

max = 8
sample নিবো 8
$f_s = 5$ হবে।
$8 \times 2 = 16$
~~16~~ $5 < 16$
so aliasing হবে।

$= 5\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi \frac{3}{5} n) + \sin(2\pi [1 + \frac{1}{5}] n)$

$= 5\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi \frac{3}{5} n) + \sin(2\pi \times \frac{1}{5} n)$

$K=1$ → 6, $K=2$ → 11, $K=3$ → 16

aliasing না হওয়ার জন্য atleast 16 নিতে হবে।

f_0 ও f_2 aliasing

$= 6\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi \frac{3}{5} n)$

~~$= 6\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi [\frac{1}{5} + \frac{2}{5}] n)$~~

~~$= 6\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi \times \frac{1}{5} n + 2\pi \times \frac{2}{5} n)$~~

~~$= 6\sin(2\pi \frac{1}{5} n) + 75\sin(2\pi \times \frac{1}{5} n)$~~

~~$= 6\sin(2\pi \frac{1}{5} n)$~~

$\sin(2\pi n + \frac{2\pi}{5} n)$

$2\pi + 0$

এখানে aliasing হবে না কারণ,
$f_0 + K f_s$
$1 + 1 \times 5 = 6$
max 6 so 6 এর চেয়ে বেশি তাই এখানে aliasing হবে না।

$\sin(2\pi \frac{1}{5} n + ...$

$$2000\pi = 2\pi \times 1000\,Hz = 2\pi \times 1$$

$$x(t) = 6\cos(2000\pi n T_s) + 3\sin(4000\pi n T_s) + 4\cos(2000\pi n T_s)$$

$f_s = 2kHz$

$\cancel{f_o = 1kHz}$

$T_s =$

$$= 6\cos\left(2000\pi \frac{1}{f_s} n\right) + 3\sin\left(4000\pi \frac{1}{f_s} n\right) + 4\cos\left(2000\pi \frac{1}{f_s} n\right)$$

$$= 6\cos\left(2000\pi \frac{1}{2} n\right) + 3\sin\left(4000\pi \frac{1}{2} n\right) + 4\cos\left(2000\pi \frac{1}{2} n\right)$$

$$= 6\cos(2\pi f_s n T_s) + 3\sin(2\pi\, 2 n T_s) + 4\cos(2\pi\, 1 n T_s)$$

$\cancel{+ 4\cos(\tfrac{1}{2}}$

$$= 6\cos\left(\frac{1}{2}\right) + 3\sin(1) + 4\cos\left(\frac{1}{2}\right)$$

$f_o = \frac{1}{2}$ same = so aliasing

$\frac{1}{2}$, $\frac{1}{2}$ দিয়ে বোঝা যাচ্ছে।

তাই, $\frac{1}{2}$ ও 1 দিয়ে আমরা বলব aliasing.

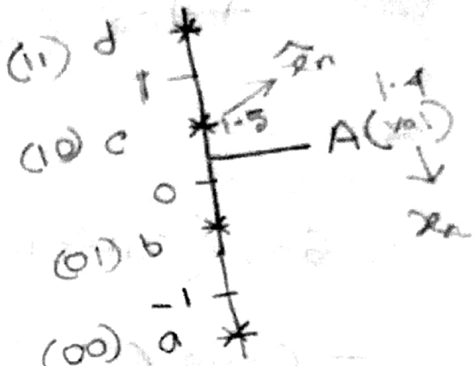
ভগ্নাংশ হতে পারবে না। alwayz পূর্ণ সংখ্যা

~~sampling always~~
quantization Y axis ~~ধরি~~.

27.12.16

Quantization

Quantization: After sampling, now we need to discritize the amplitude values by choosing a finite number of points in amplitude axis. In the fig, we are dividing the amplitude axis into ~~fovat~~ four levels (00, 01, 10, 11). If we have a point like 'A' we will simply assign it to ~~the~~ nearest level. This process is called quantization.



quantization error, $q_n = \hat{x}_n \sim x_n$

(বড় হলেও ছোট minus ~~করা~~ output always positive)

2^2 bit=2

$q_n = 1.5 - 1.4 = 0.1$

(i) uniform — (dis সবগুলো সমান হলে)

uniform এর R bit এ জন্য কতগুলো level?

2^R

(ii) non-uniform — (dis different)

problem of quantization:

→ cost of designing increases.

→ It takes huge time to process this large number of quantization steps.

Process :

→ Analog signal has amplitude between V_{min} & V_{max}.

→ Divide the range into L zones, each of height Δ.

$$\Delta = \frac{V_{max} - V_{min}}{L}$$

→ Assign quantization values of 0 to L−1 to the midpoint of each zone.

→ Approximate the sample amplitude value to the quantized values.

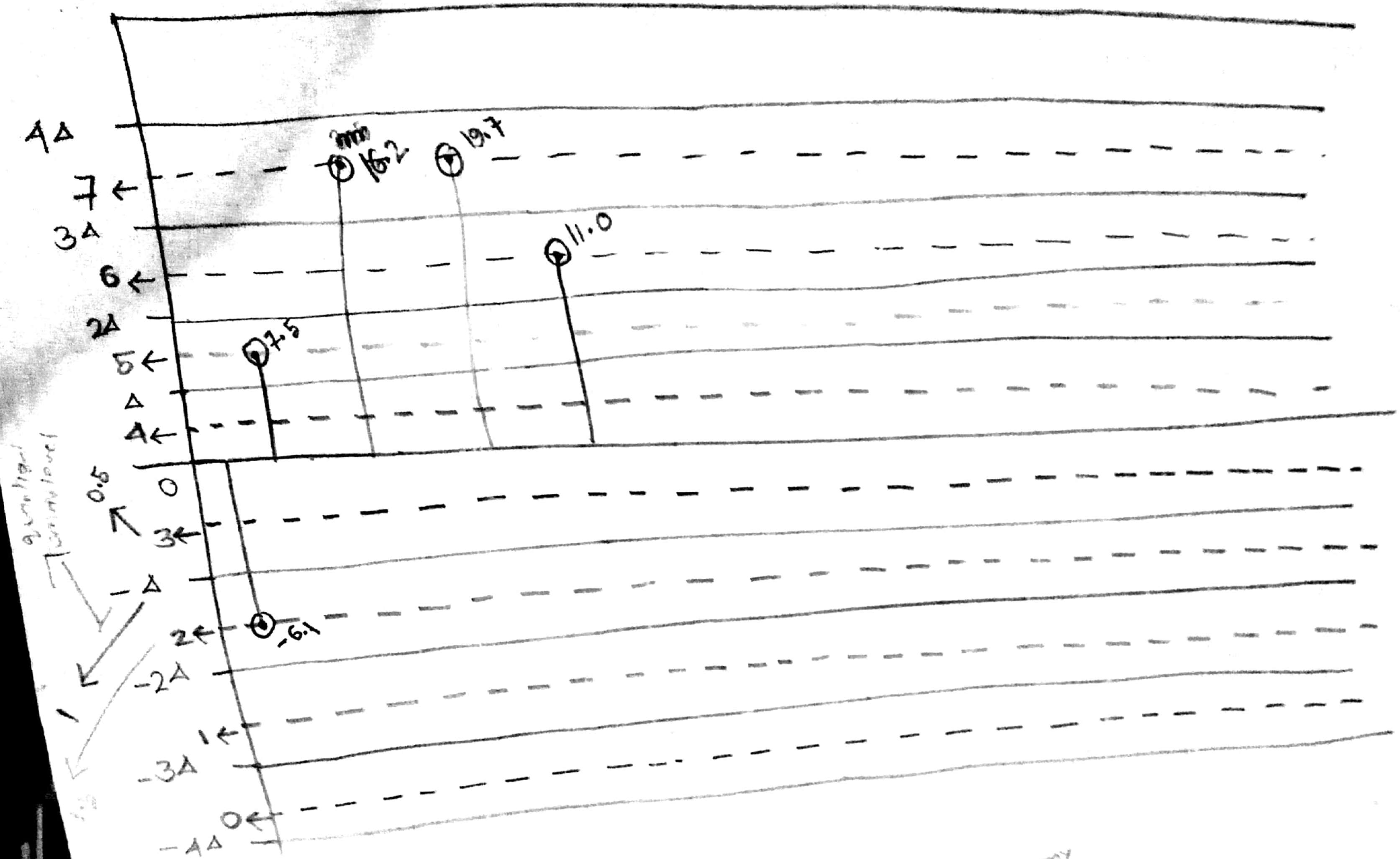
$\left(\frac{\text{Actual Amplitude}}{\Delta}\right)$

Normalized PAM Value	−1.22	1.5	3.24	3.94	2.20	−1.10	−2.26	−1.88	−1.20
Norm. Quantized value	−1.5	1.5	3.5	3.5	2.5	−1.5	−2.5	−1.5	−1.5
Norm. error	0.28	0	0.26	−.44	0.30	−0.4	−0.24	0.38	~~−3.~~ −0.30
Quantized Codes	2	5	7	7	6	2	1	2	2

$\{-6.1, 7.5, 16.2, 19.7, 11.0, -5.5, -11.3, -9.4, -6.0\}$

neg ও pos দুইটা আছে —19.7 হবে $V_{max} = 19$, $V_{min} = -19$

$V_{max} = 20$ (ধরি)
$V_{min} = -20$ (max ধরেছি)



$$\Delta = \frac{20-(-20)}{8} = \frac{40}{8} = 5$$

$$\frac{20}{5} = 4$$

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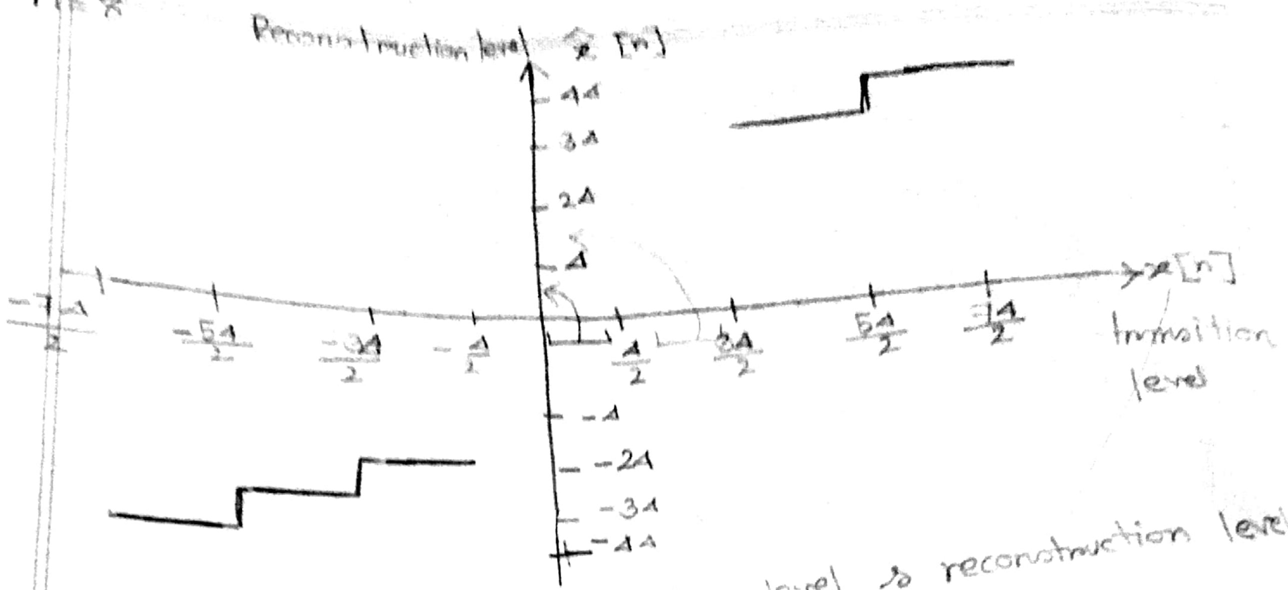


Relationship between transition level & reconstruction level

x axis এর quantized মান

Y " " মান

বলে দেয়া আছে Y axis কে কয়টা level এ ভাগ করবে।

যে value গুলো দেয়া আছে তার define করে দিতে হবে

$\{6.5, -10.5, 13.5, 14.0, -2.5, -7.5\}$

x axis generating point $\Rightarrow \left(\frac{n-1}{2}\right)\Delta = max$

$$\Rightarrow \left(\frac{8-1}{2}\right)\Delta = 14$$

$$\Rightarrow \Delta = \frac{28}{7} = 4$$

relationship always step function হবে।

Properties :

1. Memoryless : $\hat{x}[n]$ does not depend on $x[n]$
2. Time Invariant : Does not change with n.
3. Uniformity : ~~constrou~~ constant step size (Δ)

Companding

→ Process of compressing and then expanding.

→ High amp. analog signals are compressed prior to transmission & expanded in the receiver.

→ Tow types of companding : Analog, Digital.

$$V_{out} = \frac{V_{max} \ln\left(1 + \mu \frac{V_{in}}{V_{max}}\right)}{\ln(1+\mu)}$$

V_{max} = max uncompressed analog amp.

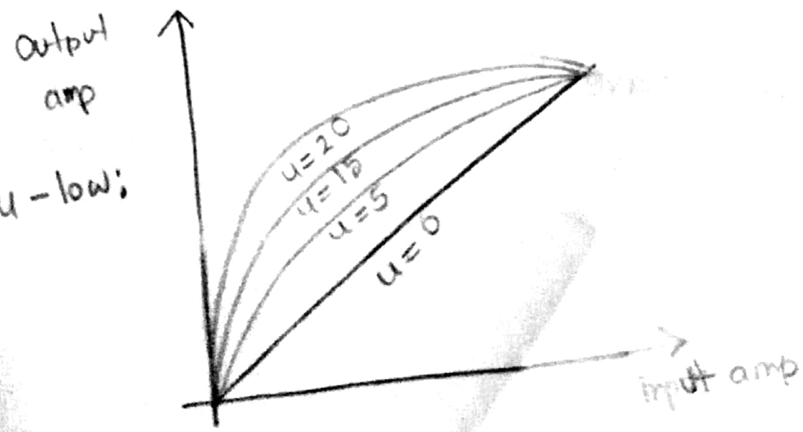
V_{in} = amp of input signal at a particular instance of ti

μ = Parameters used to define the amount of compression

V_{out} = Compressed output amplitude.

{2.5, −3.5, }

u-low;



~~[illegible]~~ 2000 × 1500

$\log_2$ $\frac{\ln 8}{\ln 2}$ $\log$ [illegible]

SNR

SNR_{Power} : $\dfrac{\text{Avg. signal power}}{\text{Avg. Noise power}}$

$SNR_{Voltage}$: $\dfrac{\text{RMS signal voltage}}{\text{RMS Noise voltage}}$

$SNR_{pow} = (SNR_{volt})^2$

$SNR_{dB} = 10\log_{10}(SNR_P)$

$= 20\log_{10}(SNR_V)$

→ $SNR_{dB} = 6.02n + 1.76$

Shanon capacity

$= B/W \cdot \log_2(1 + SNR_{dB})$

n = quantization process

এর level ~~[illegible]~~

ও level কে বাড়াতে হলে

কে কমে floor করা।

Antena

Defenition → ① ②

Types :

- Isotropic : equaly সব dis propagate করে।
- Dipole : # Half – wave
  # Quarter
- Parabolic :

Antena Gain:

- Power output

Effective area:

$$G = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi f^2 A_e}{c^2}$$

Propagation Modes:

- Ground
- sky
- line of sight

Ground wave propagation:

line of sight Equations:

$$d = 3.57\sqrt{h}$$

$$d = 3.57\sqrt{Kh} \qquad K = 4/3$$

Maximum dis between two antena for LOS:

LOS Wireless Transmission Impairments:

(just point)

Types of Fading:

(just point)