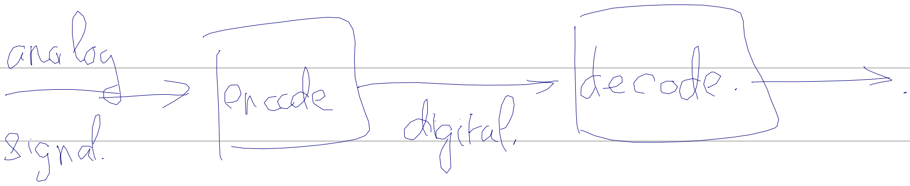
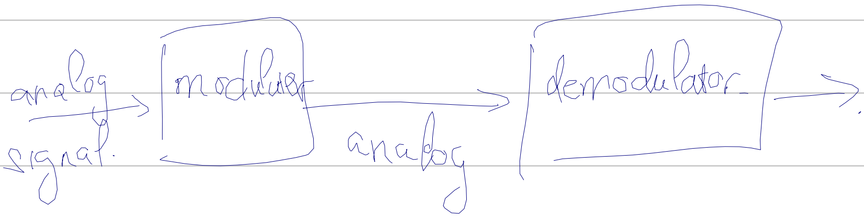
CS440 — Jul 12th

Encoding & Modulation Techniques.



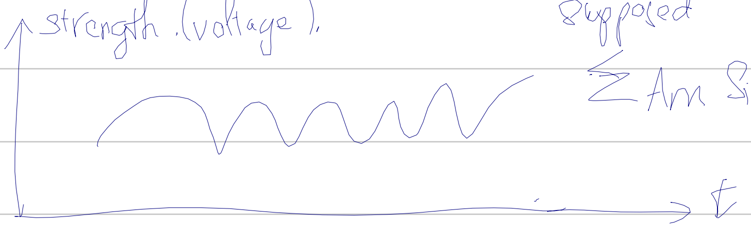


Example:

Analog signal: radio station, (modulator), reciver(demod)

Mod: shifting of signal.

Voice Info



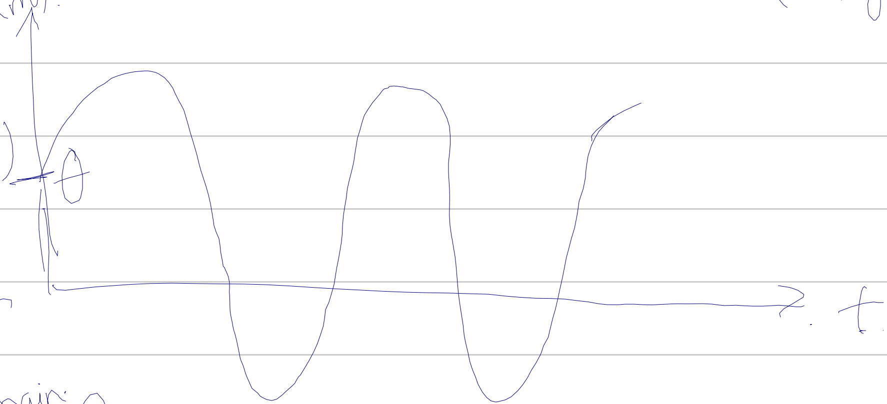
suppose

$\sum A_m \sin(w_m t + \theta)$

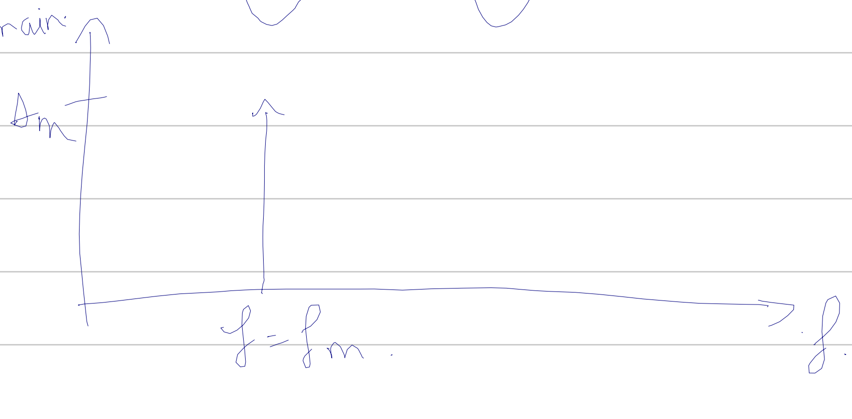
$\sum A_m \sin(2\pi f_m t + \theta)$

Analyse v(m).

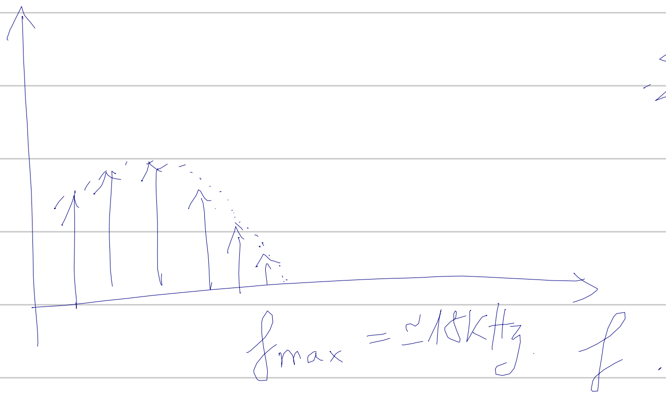
$v(m) = A_m \sin(2\pi f_m t + \theta)$



if we plot in freq domain



$$\sum A_m \sin(2\pi f_m t + \theta)$$

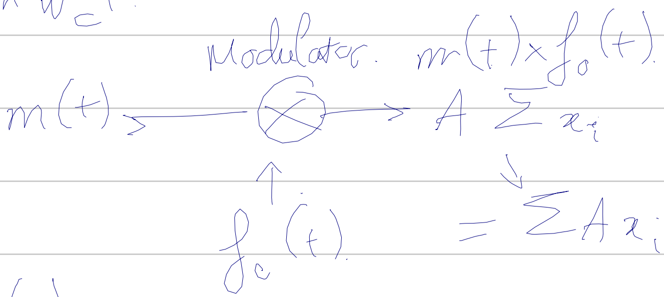


Band of freqs = Bandwidth of the signal

<u>Modulator:</u>

Voice signal $m(t) = \sum A_m \sin w_m t$

$f_c(t) = A_c \sin w_c t$



$m(t) \times f_c(t)$

$$= \sum A_m A_c \sin w_c t \ \sin w_m t$$

$$= \sum \frac{A_m A_c}{2} \, 2 \sin w_c t \sin w_m t$$

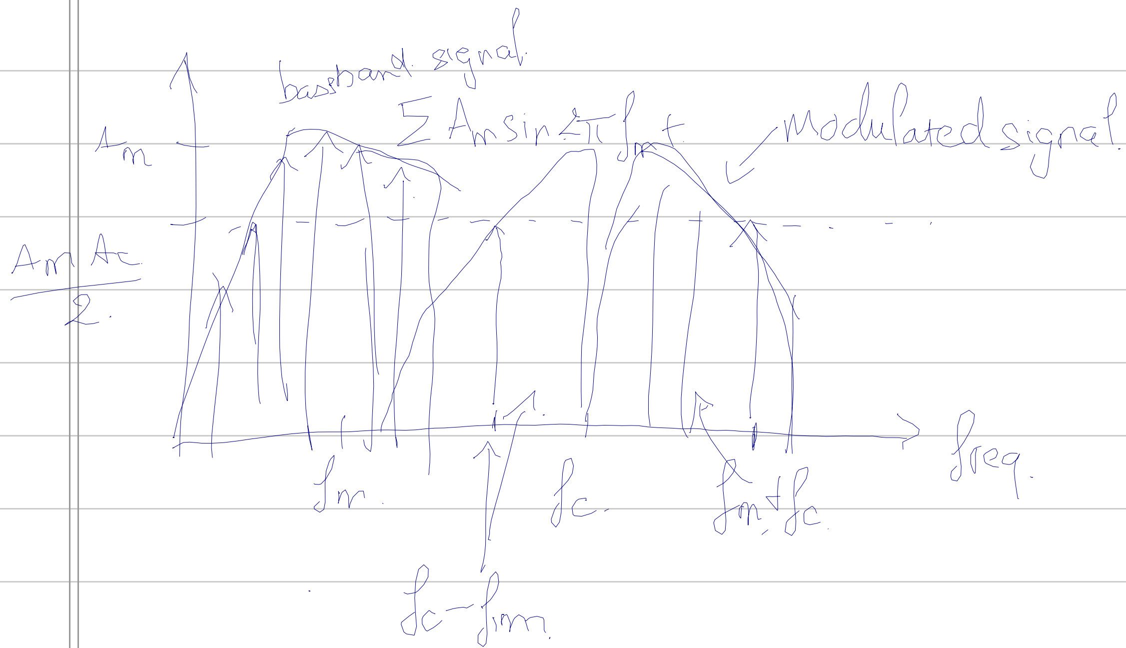
$$= \sum \frac{A_m A_c}{2} \left[\sin \left(\frac{w_c + w_m}{2}\right) t + \sin \frac{w_c - w_m}{2} t \right]$$

$w = 2\pi f$

$$= \sum \frac{A_m A_c}{2} \left[\underbrace{\sin \pi (f_c + f_m) t}_{1.001 \text{ MHz}} + \underbrace{\sin \pi (f_c - f_m) t}_{0.999 \text{ MHz}} \right]$$

$= 1001.000$ Hz + 999000 Hz

$= 2000$ Hz



→ The modulated signal has same shape as baseband signal

On the receiving end, multiply $A_c \sin w_c t$

we get 2 components

$f_c - f_m + f_c = 2f_c - f_m = - f_m$

$f_c + f_m + f_c = \underbrace{2f_c}_{2\pi} + f_m = f_m$

After that pass it to low pass filter → get f_m

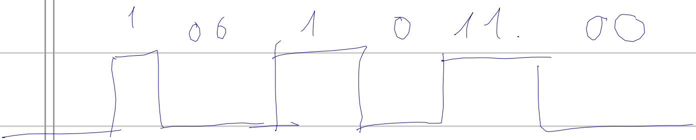
$\boxed{c = f\lambda}$ baseband f is small → λ is high
→ antenna must be big.

modulated f is big → λ is small
→ antenna is normal size.

⇒ cannot transmit at base band freq.
(also noise, & absorption of medium)

Terminology: Mark & Space
1 0

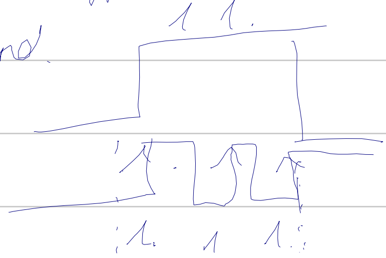
Interpreting signals.   4 probs.



1st prob) depend on the clock, interpretation of 1 or 0 is different.

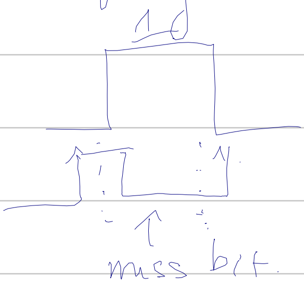
2nd prob) where to sampling makes a difference

3rd prob) oversampling. supposed send



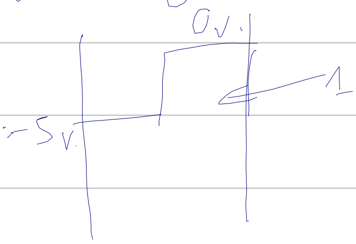
but sampling

4th prob) undersampling.



Def of Digital signal encoding format

NRZ-L:



NRZI: 0 → 1. , 1 → 1; there is a transition when going to 1.

Bipolar AMI: 0: no change

1: either positive or negative, alternatively.

Pseudoternary: 3 levels: 1 is represented by 0. level.

0 is represented by positive (1) or negative (-1) alternatively.

Manchester: : 0 → 1, 1 → 0 : transmission in the middle
0 : lower
1 : raiser

Differential Manchester: Manchester + the alternatie of previous 1 or 0.

(midterm question, give the bits → plot & define the name)

Encoding Schemes

Signal spectrum: focus energy on the middle to not intefere with other signals

FM : not susceptible to noise, better than AM

Spectral Density of Various signal encoding scheme:

?, don't understand

	Strength	Weakness
NRZ-L	- simple to implement	- average DC voltage - difficult for consecutive 1 or 0s
NRZ-I		
Bipola-AMI (avg = 0)	- much better detection on R_x end if the gap of 2 level is big (next page) -	- need wider spectrum - consume more energy/power if gap is big (?)
Manchester:	- transition in each bit → easy to clock → best synch of clock rate	- freq is double than other

Midterm:
2 hours.
Qn from LAN
- { different between repeator, switch, hub, router.
  similarity.

Transmission Media.
Why certain devices use for certain Bandwidth
fibre: how info flow, v/s coxial cable.

Compare encoding scheme.

Bipolar AMI:
advantage:

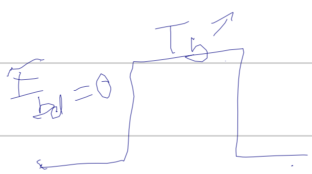
attenuation lower voltage down.
logic 1 — can be 5V, 100V, 2.5V etc.
logic 0 — 0V
noise bring 0V up.

5 V : comprision threshold is 2.5 V.
100 V ———————— 5 V.
=> much better detection.

$$\text{Power} = \frac{\text{Voltage}}{\text{current}} = \frac{V^2}{R}.$$

logic 1 - V.
logic 0 - 0 V

$$E = PT_b = \frac{V^2 T_b}{R}.$$



$$\text{logic } 1 \Rightarrow \frac{V}{2}(0.25) \Rightarrow E = PT = \frac{\left(\frac{V}{2}\right)^2 T}{R} = \frac{V^2}{4RT}$$

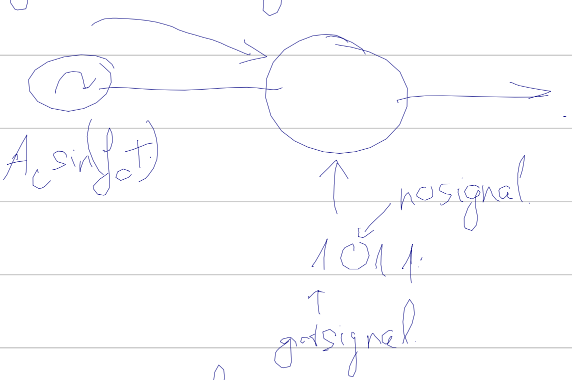
$$\text{logic} \Rightarrow -\frac{V}{2}(-0.25) \Rightarrow E = PT = \frac{\left(-\frac{V}{2}\right)^2 T}{R} = \frac{V^2}{4R} T.$$

$$\Rightarrow \sum E = \frac{V^2}{2R} T \Rightarrow \text{less energy}$$

Scrambling: to avoid codes 1:1111 or 0000 are sent consecutively.

Mod of Analog & Digital Data: (ASK, BFSK, BPSK)

Key: "allow" signal or not.

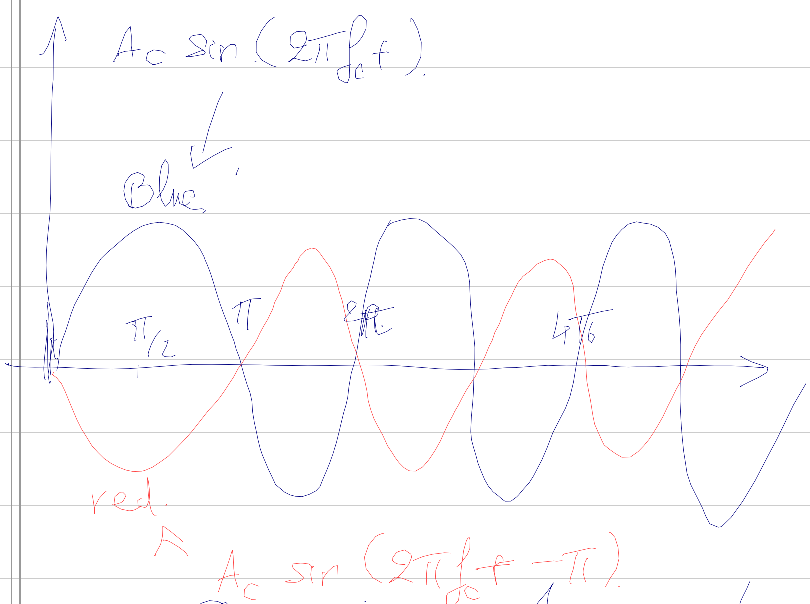


ASK: Amplitude = 0 or = X.

0 1

BFSK: Frequency change between 0 and 1.

BPSK: Phase change between 0 & 1.



MFSK 1 frequency for different values (insted of only 0-1 in BFSK)

$M = 4 \rightarrow$ transfer in half time shorter than BPSK on the same data.

QPSK: change phase every 45°

Practice 5.11 GPSK & QQ PSK at home

⊗ multiplier

QAM: not much really we

Midterm Until slide 39 / signal encoding