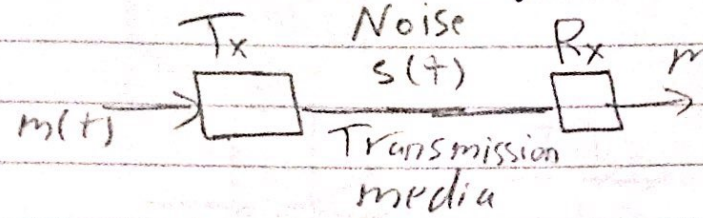
1st lecture

# Data Communication

Text book: Communication systems
Simon Haykin 4th edition

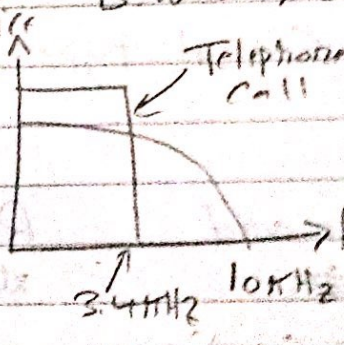



Human Voice
Talk up to 10 KHz
Hear up to 20 KHz

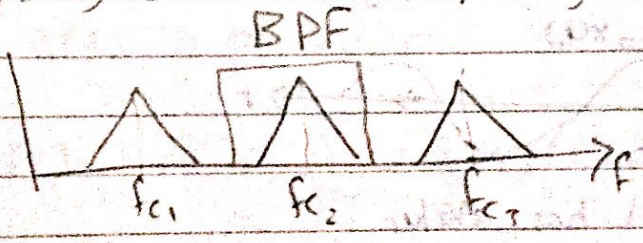
base band signal : band of All freq. in the orignal signal (no modulation)

base band transmission signal ال

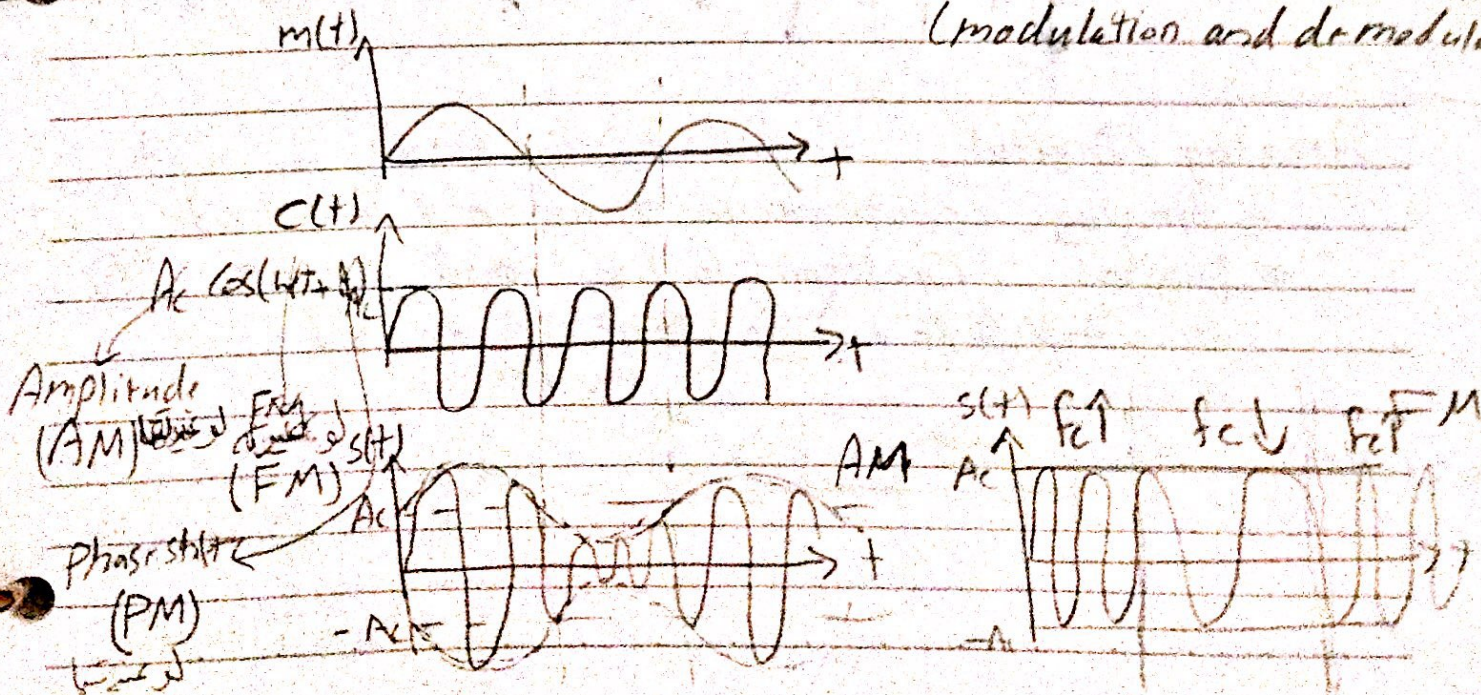
telephone system
B.W => 3.4 KHz

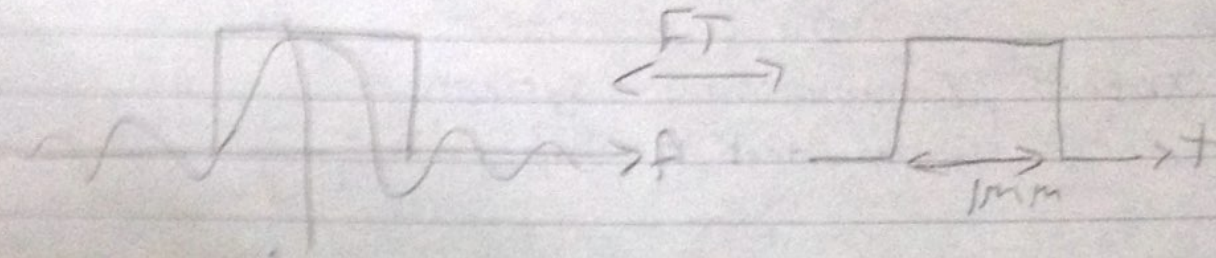


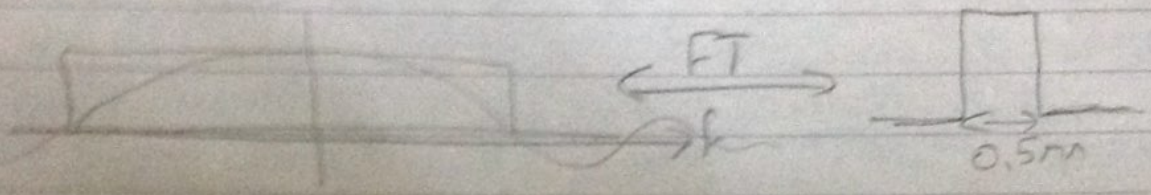

Frequency Division Multiplexing




Digital band modulation => ADSL (Modem)
Two way Communication
(modulation and demodulation)






Important.

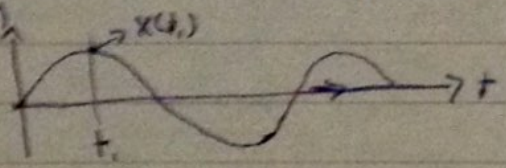
1- Signal types ( 2- F.S ( 3- F.T

Ons, bi  Cn  Complex form

Continous and Discrete:

Review on Signals

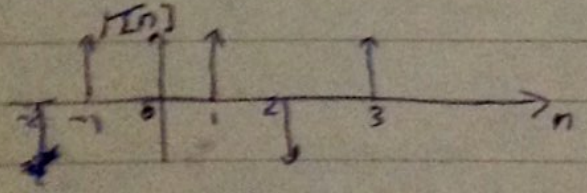
* Continous




For any time signal has a value

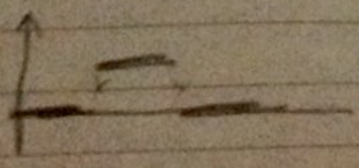
ex: at $t_1 \Rightarrow x(t_1)$

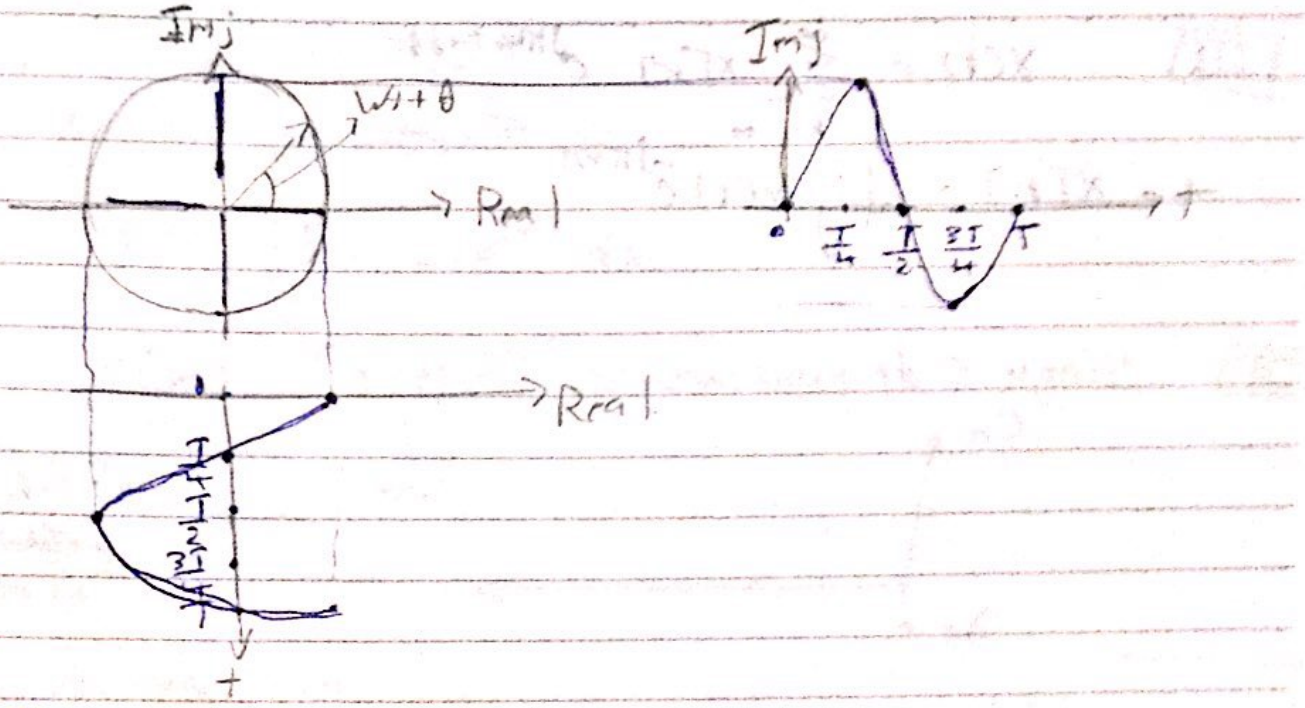
* Discrete




Analog / Digital:

* Analog: Continous in time and Amplitude
* Digital: Continous in time and discrete in Amplitude (take certain levels)






## 2. Fourier Series

**I** $x(t)$ is periodic

$$x(t) = A_0 + \sum_{K=1}^{\infty} [A_K \cos(K\omega_0 t) + B_K \sin(K\omega_0 t)]$$

$$A_0 = \frac{1}{T}\int_0^T x(t)\,dt$$

$$A_K = \frac{2}{T}\int_0^T x(t)\cos(K\omega_0 t)\,dt$$

$$B_K = \frac{2}{T}\int_0^T x(t)\sin(K\omega_0 t)\,dt$$

$x(t) = a_0 + a_1 x + a_2 x^2 + \cdots$

$x(0) = a_0$

$\dot{x}(0) = a_1$ & $\ddot{x} = 2a_2$

**II** Complex form

$$x(t) = C_0 + \sum_{K=1}^{\infty} C_K \cos(K\omega_0 t + \theta_K)$$

$$\sum_{K=1}^{\infty} C_K [\cos(\theta_K)\cos(K\omega_0 t) - \sin\theta_K \sin(K\omega_0 t)]$$

$\therefore A_K = C_K \cos(\theta_K)$

$B_K = -C_K \sin(\theta_K)$

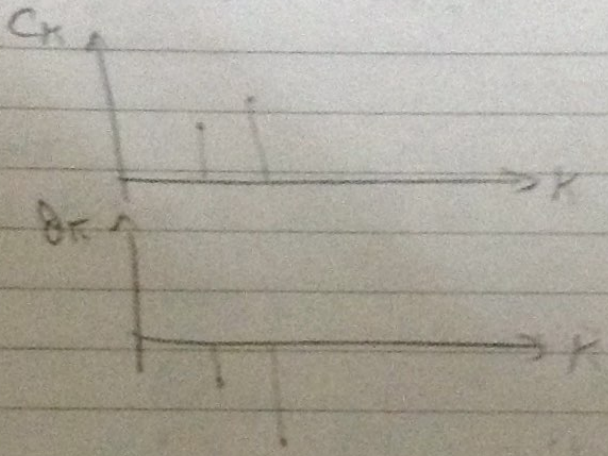
$C_K = \sqrt{A_K^2 + B_K^2}$

III $x(t) = \sum_{k=-\infty}^{\infty} x[k]\, e^{j k \omega_0 t}$

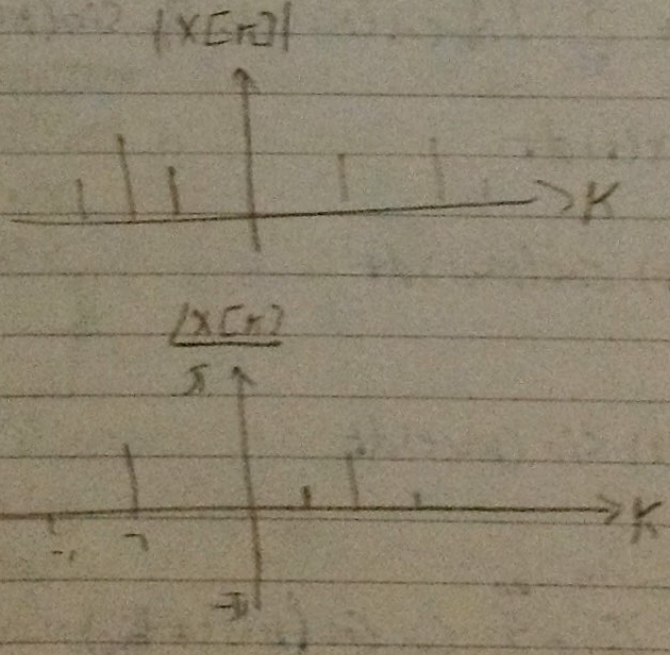
$x[k] = \frac{1}{T}\int_{T} x(t)\, e^{-j k \omega_0 t}$

$\cos t = \frac{1}{2}(e^{jt} + e^{-jt})$

II Single side representation




III Double side representation



3- Fourier Transform:

x(t) is Non-periodic

$$x(t) = \frac{1}{2\pi}\int_{w} X(jw)\, e^{jwt}\, dw$$

$$X(jw) = \int_{t} x(t)\, e^{-jwt}\, dt$$

Volt/Hz (Probability density) ; Volt

4- Average Power:

$$P(t) = \frac{V^2(t)}{R}, \quad R = 1 \text{ (Normalized)}$$

1) Time-domain: $\frac{1}{T}\int x^2(t)\, dt$

2) FS (single side): $c_0^2 + \sum_{k=1}^{\infty} C_k^2/2$

3) Fs (Double side): $\sum_{k=-\infty}^{\infty} X^2[k]$

$$A\cos\theta = \frac{A}{2}\left(e^{j\theta} + e^{-j\theta}\right)$$

P ↑

$\frac{A^2}{2}$

$$\left(\frac{A}{2}\right)^2 + \left(\frac{A}{2}\right)^2 = \frac{A^2}{2}$$