

Lec-21

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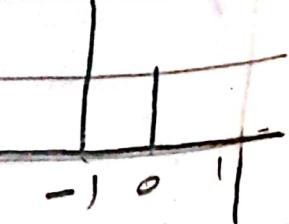
$$\text{Time Reversal} \rightarrow z(t)_s = \sum_{k=-\infty}^{+\infty} a_k e^{jkw_0 t}$$

$$z(-t)_s = \sum_{k=-\infty}^{+\infty} a_k e^{-jkw_0 t}$$

Let  $m = -K \rightarrow z(-t) = \sum_{k=-\infty}^{+\infty} a_{-m} e^{-jkw_0 t}$

$$z(t) \xrightarrow{\text{FS}} Q_K \xrightarrow{\text{FT}} \sum_{k=-\infty}^{+\infty} a_k e^{jkw_0 t}$$

$$z(-t) \xrightarrow{\text{FS}} a_{-1c} \quad k = -\infty \quad -1 \quad 0 \quad 1$$



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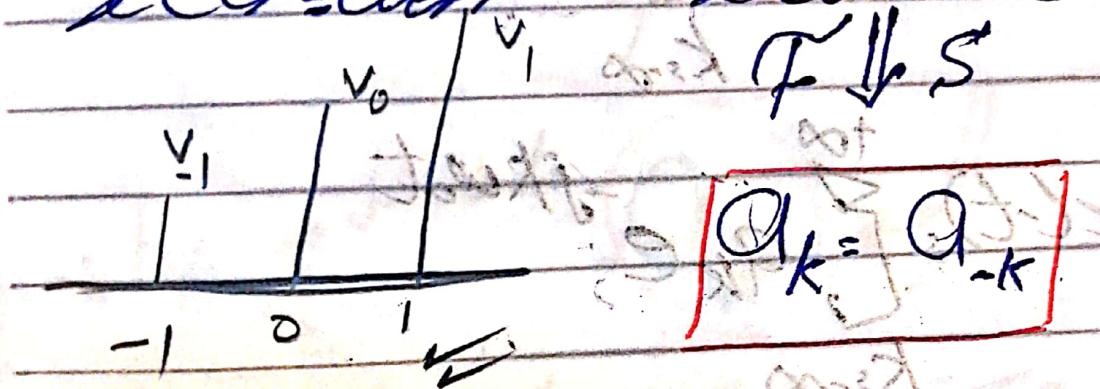
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$$x(-t) \xrightarrow{F.S} a_{-k}$$

$$x(t) \xrightarrow{F.S} a_k$$

$$x(t) = \text{even} \quad x(t) = x(-t)$$



$$x(t) = \text{odd} \quad x(t) = -x(-t)$$

$$F.S$$

$$a_k = -a_{-k}$$

$$a_{-k} = -a_k$$

Time  $x(t) = \sum q_k e^{jkw_0 t}$

Scaling  $x(gt) = \sum q_k e^{jk(gw_0)t}$

$x(gt) = \sum q_k e^{jk(gw_0)t}$

$x(t) \xrightarrow{F} Q_k$

$x(gt) \xrightarrow{Q_k}$

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## Multiplication

$$x(t) \xrightarrow{FS} a_k; \quad y(t) \xrightarrow{FS} b_k$$

$$w(t) = x(t) \cdot y(t) \xrightarrow{FS} c_k$$

$$\left\{ \sum_k a_k e^{jk\omega t} \right\} \cdot \left\{ \sum_k b_k e^{jk\omega t} \right\}$$

$$c_k = \frac{1}{T} \int_0^T x(t) \cdot y(t) e^{-jk\omega t} dt$$

$$= \frac{1}{T} \int_0^T \left( \sum_k a_k e^{jk\omega t} \right) \cdot \left( \sum_l b_l e^{jl\omega t} \right) e^{-jk\omega t} dt$$

$$= \frac{1}{T} \int_0^T \left( \sum_k a_k e^{jk\omega t} \right) \cdot \left( \sum_l b_l e^{jl\omega t} \right) e^{-jk\omega t} dt$$

$$= \frac{1}{T} \sum_m a_m \sum_l b_l \left\{ \int_0^T e^{j(m+l-k)\omega_0 t} dt \right\}$$

$$d \rightarrow (t) e^{j\theta} = \cos\theta + j \sin\theta$$

$$= C_k = \frac{1}{T} \left[ q_m \right]_{\text{f.s.}} b f \left[ T \right]_{\text{f.s.}} k = l_{tm} \cdot l_{skm} \cdot Q_w$$

$$c_k = \sum_m a_m \cdot b_{k-m}$$

$$\beta = \sum a(m) b(k-m)$$

$$C_{k+1} = \left[ \begin{array}{c|c} a_m & b_{k-m} \\ \hline m & \end{array} \right] \cdot P_S \cdot \left( \begin{array}{c|c} & c \\ \hline & \end{array} \right)$$

$$\stackrel{?}{=} \sum_n [A(k), a(n)] - b(k-n)$$

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## Conjugation:

$$x(t) \xrightarrow{F^S} a_k$$

$$x(t) \xrightarrow{F^S} b_k$$

$$b_k = \int_T x^*(t) e^{-jkw_0 t} dt$$

$$x(t) = \sum_k a_k e^{jkw_0 t}$$

$$x^*(t) = \left\{ \sum_k a_k e^{jkw_0 t} \right\}^*$$

$$\{z_1, z_2\}^* = z_1^* + z_2^*$$

$$x^*(t) = \sum_k \{a_k e^{jkw_0 t}\}^*$$

$$\{z_1, z_2\}^* = \left[ \sum_k a_k^* e^{-jkw_0 t} \right]$$

Let  $m = -k$

$$\sum Q^* e^{j\omega t}$$

$$m$$

$$x(t) \xleftarrow{FS} q_k$$

$$x^*(t) \xleftarrow{FS} q_{-k}$$

$$[x \text{ real}] \rightarrow x(t) = x^*(t)$$

$$q_k = q_{-k}^*$$

$$q_{-k} = q_k^*$$

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x real even  $\Rightarrow$

$$q_k = q_{-k} = q_k^*$$

$$q_k$$

$$q_k^*$$

$$q_k = q_{-k}^* \quad q_{-k} = q_k^*$$

x real odd

$$x(t) = -x(-t)$$

$$q_k = -q_{-k}$$

$$q_k = -q_{-k} \quad q_{-k} = -q_k$$

$$q_k^* = -q_k$$

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Total Power

~~average~~  $\{$

~~average~~  $\{$

$$\frac{1}{T} \int_T |x(t)|^2 dt \quad \begin{cases} \text{Total} \\ \text{Average} \end{cases}$$

$$= \sum_k |a_k|^2 \quad \begin{cases} \text{Power} \end{cases}$$

$$K$$

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الجامعة

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$j\omega t$

$e$

$j\omega n$

$e$

$w \uparrow \downarrow$

زيادة

$$\omega = \omega + 2\pi$$

$$j(\omega + 2\pi)n$$

$$= e^{j\omega n} \cdot e^{j2\pi n}$$

$$= 1$$

$j(\omega + 2\pi)n$

$j\omega n$

$$\omega_0 = \frac{2\pi}{T}$$

$$x(t)_s \left[ \sum_{k=-\infty}^{+\infty} q_k e^{jk\omega_0 t} \right]$$

$$\omega_0 = \frac{2\pi}{N}$$

$$k = -\infty$$

$$\omega = k\omega_0$$

$$\phi(t) = e^{jk\omega_0 t}$$

$$\phi_k[n] = e^{jk\omega_0 n}$$

$$\phi[n] = e^{j(k+N)w_n}$$

~~$k+N$~~

$$e^{j\omega n}$$

$\downarrow$

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

Always

Periodic

$\underline{N}$

$$e^{j(k+N)\frac{2\pi}{N}n} = e^{jk(\frac{2\pi}{N})n}$$

$$\phi_{K+N}[n], \phi_K[n]$$

~~$$x[n] = \sum_{k=0}^{\infty} a_k e^{jkwn}$$~~

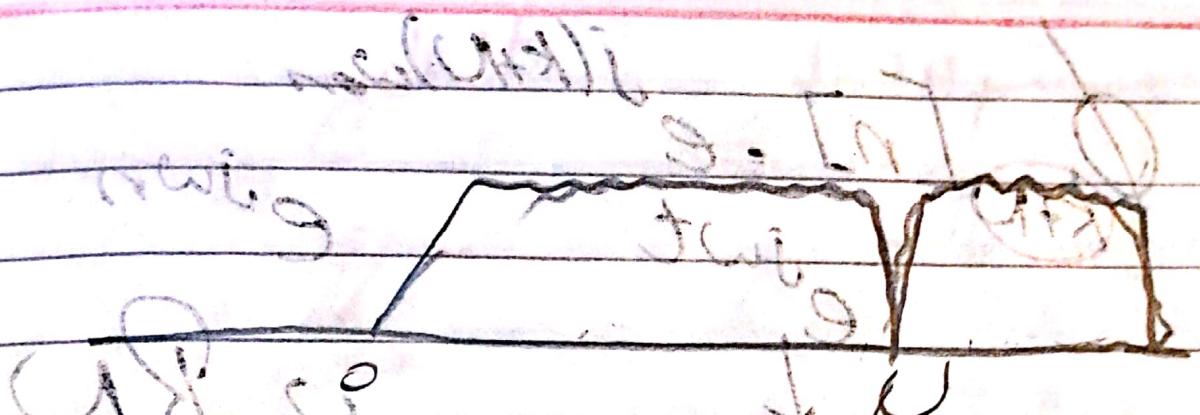
$k \geq 0$

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$$x[n] = \sum_{k=-\infty}^{\infty} q_k e^{jk\left(\frac{2\pi}{T}\right)n}$$

Claim  $q_0 = q_1 = q_2 = \dots$

Fourier

and  
the Fourier transform  
is plotted