# 3.7 Properties of DT Fourier Series

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* Linearity
* Timeshift
* Parseval's relation

## Examples of Questions

A signal $x(t)$ is such that - find the signal $x(t)$

1. $x(t)$ is real
2. $x(t)$ is periodic with period $T=4$
3. $a_k = 0$ for $|k|>1$
4. The signal with Fourier Coefficients $b_k = a_k e^{-jk\frac{\pi}{2}}$ is odd
5. $\frac{1}{4}\int_0^4 |x(t)|^2 dt = \frac{1}{2}$

<u>solution</u>

from 2 and 3 we know

$$x(t) = a_0 + a_1 e^{j\frac{2\pi}{4}t} + a_{-1} e^{-j\frac{2\pi}{4}t}$$

$$= a_0 + a_1 e^{j\frac{\pi}{2}t} + a_{-1} e^{-j\frac{\pi}{2}t}$$

real signal $\Rightarrow$ $a_k = a_{-k}^*$

so $a_0 = a_{-0}^* = a_0^*$ conjugated

$a_1 = a_{-1}^*$

$a_1^* = a_{-1}$

$$x(t) = a_0 + a_1 e^{j\frac{\pi}{2}t} + a_1^* e^{-j\frac{\pi}{2}t} = a_0 + 2\,\mathrm{Re}\left(a_1 e^{j\frac{\pi}{2}t}\right)$$

To use 4, use 3.5.3 and 3.5.2

$x(-t)$ has Fourier coeff. $a_{-k}$

$x(t-t_0)$ has Fourier coeff $a_k e^{jk\frac{\pi}{2}t_0}$

Let $y(t) = x(-t)$

Let $z(t) = y(t-1)$

F.C. of $y(t) = C_k = a_{-k}$

F.C. of $z(t) = b_k = C_k e^{-jk\frac{\pi}{2}} = a_{-k} e^{-jk\frac{\pi}{2}}$

$\therefore$ the signal with coeff $b_k$ is obtained with transforming $x(t)$ into $x(at+t_0)$