Subject : 12 / 2 / 2019 .

Communication System :-

المرسل		المستقبل
Transmiter	channel	Reciver
↓		↓
Sendor		destination

* Communication channel :-

medium between a transmitter and its destination.

1) Wireline channel :-

Cables are normally used to Connect a transmitter and a destination.

Ex :- * Coaxial Cable.
* fiber optic is normally used since it has a huge Bandwidth .

2) Wireless channel :-

antennas are used for transmission and reception.

Application :-

on Wireline channel :-

* Bredband internal Service.
* Fixed Phone Service.

on Wireless channel :-

* Radio Communications (AM and FM) .

* mobile Communication.
* Satelite Communication.
* Wireless network (WiFi , wiMAX).

antennas used for transmission and reseption ⇐ Wireless *

$$X(t) = A \cos \omega t .$$

* in Communications frequency domain is always used.

time domain signal $g(t)$ → $\boxed{\text{Fourier transform}}$ → frequency domain signal $G(f)$

* let we have a time domain signal $g(t)$, and I need to convert this time domain into frequency domain signal, so I need to use fourier transform :-

$$G(F) = \int_{-\infty}^{\infty} g(t)\, e^{-j2\pi f t}\, dt .$$

* let I have a frequency domain signal and I need to change this signal into time domain then I need to used inverse fourier transform :-

$$g(t) = \int_{-\infty}^{\infty} G(F) e^{j2\pi f t}\, df .$$

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$$G(f) = \int_{-\infty}^{\infty} g(t)\, e^{-j2\pi ft}\, dt$$

time domain description $g(t)$ $\xrightarrow{\text{Fourier transform}}$ Frequency domain description $G(F)$

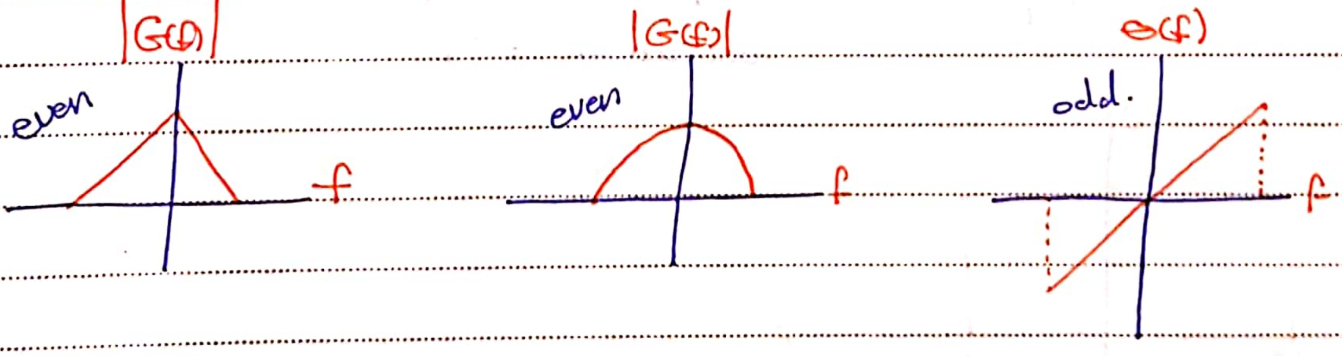
Frequency domain description $G(F)$ $\xrightarrow{\text{inverse fourier transform}}$ time domain description $g(t)$

$$g(t) = \int_{-\infty}^{\infty} G(f)\, e^{j2\pi ft}\, df.$$

$$\therefore\ G(F) = \underbrace{|G(f)|}_{\text{amplitude}}\ \underbrace{e^{j\theta(f)}}_{\text{phase}}$$

* amplitude :- amplitude Spectrum of signal is an even function of frequency.
* Phase :- the phase spectrum of signal is an odd function of the frequency.

* even يعني متماثل حول y axis ويمثل المقدار.
* odd يعني متماثل حول x axis ويمثل الزاوية.



chapter 2 :- Fourier transform :-

time domain signal → $\boxed{\text{Fourier transform}}$ → Frequency domain signal.

* Fourier transform is used to change the signal's representation from time domain into frequency domain.

$$G(f) = \int_{-\infty}^{\infty} g(t)\, e^{-j2\pi f t}\, dt.$$

$$g(t) = \int_{-\infty}^{\infty} G(f)\, e^{j2\pi f t}\, df.$$

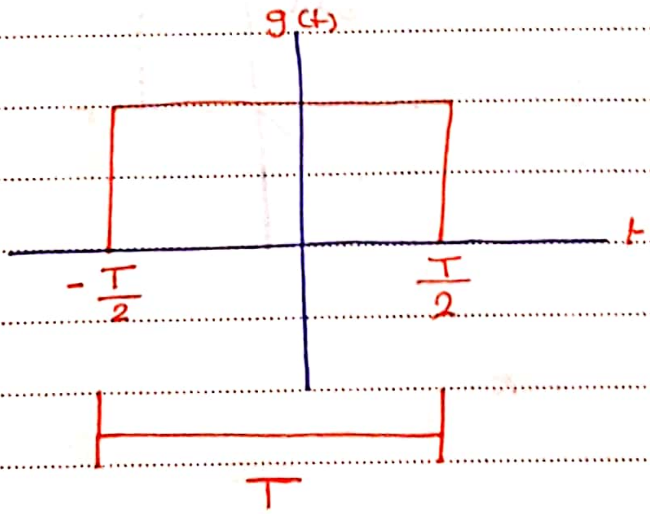
} Fourier transform pair.

* Example :-

Find the fourier transform of the signal $g(t) = A\, \text{rect}\left(\frac{t}{T}\right)$.

Solution :-

$g(t) = A\, \text{rect}\left(\frac{t}{T}\right)$ → amplitude $= A$
duration $= T$



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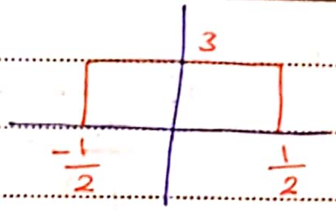
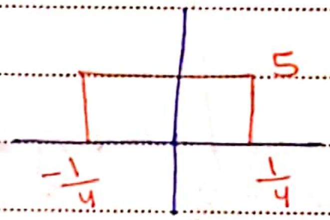
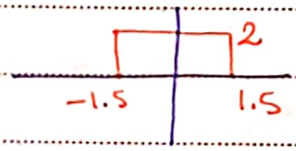
* $g(t) = 3\ \text{rect}(t) \rightarrow$



* $g(t) = 5\ \text{rect}(2t) \rightarrow$



* $g(t) = 2\ \text{rect}\left(\frac{t}{3}\right) \rightarrow$



* تذكر حل المثال :-

$$\therefore\ G(f) = \int_{-\infty}^{\infty} g(t)\, e^{-j2\pi f t}\, dt$$

$$= \int_{-\frac{T}{2}}^{\frac{T}{2}} A\, e^{-j2\pi f t}\, dt$$

$$= A \int_{-\frac{T}{2}}^{\frac{T}{2}} e^{-j2\pi f t}\, dt$$

$$= A \cdot \left. \frac{e^{-j2\pi f t}}{-j2\pi f} \right|_{t=-\frac{T}{2}}^{\frac{T}{2}}$$

$$= \frac{A}{-j2\pi f}\left(e^{-j\pi f T} - e^{j\pi f T}\right) \rightarrow \sin \pi f t = \frac{1}{2j}\left(e^{j\pi f t} - e^{-j\pi f t}\right).$$

$$= \frac{A}{\pi f} \cdot \frac{1}{j2}\left(e^{j\pi f T} - e^{-j\pi f T}\right).$$

$$= \frac{A}{\pi f} \sin(\pi f T) = A\, \frac{\sin(\pi f T)}{\pi f} \rightarrow \text{sinc}\, x = \frac{\sin x}{x}$$

$$= AT\ \text{sinc}(\pi f T)$$

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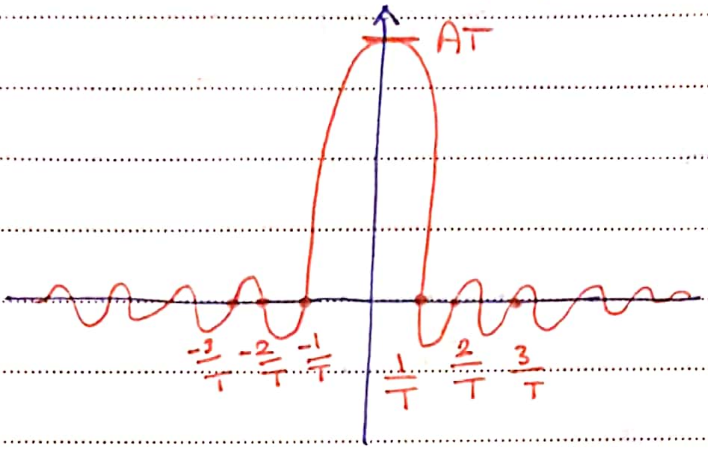
$\mathcal{F}\left\{A \, rect\left(\frac{t}{T}\right)\right\}$ $AT \, sinc(\pi f T)$.



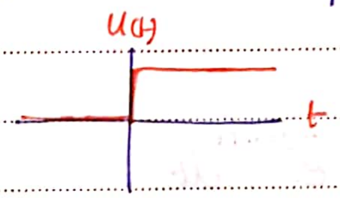
اذا طلب المقدار

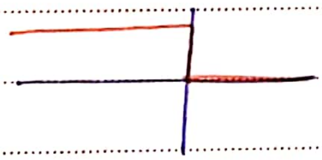
تكون الاشارة كلها بالموجب ←

* Example :- Find the fourier transform of the signal :-

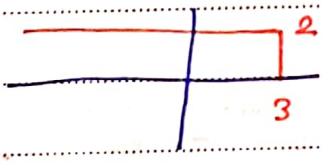
$g(t) = e^{-at} \, u(t)$ → $u(t)$ = unit step function.

$$u(t) = \begin{cases} 1 , & t \geq 0 \\ 0 , & t < 0 \end{cases}$$

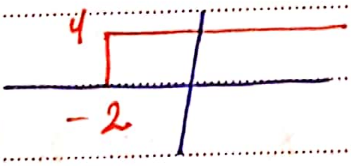




→ $u(-t)$



→ $2u(3-t)$



→ $4u(t+2)$

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$\therefore \; g(t) = e^{-at} \, u(t)$

$$= \begin{cases} e^{-at} & , t \geq 0 \\ 0 & , t < 0 \end{cases}$$

$\{ e^{-\infty} = \text{Zero} \}$

$$\therefore G(f) = \int_0^\infty e^{-at} \cdot e^{-j2\pi f t} \, dt$$

$$= \int_0^\infty e^{-(a+j2\pi f)t} \, dt$$

$$= \left. \frac{e^{-(a+j2\pi f)t}}{-(a+j2\pi f)} \right|_0^\infty$$

$$= \frac{1}{-(a+j2\pi f)} \left(\cancel{e^{-\infty}} - \cancel{e^{0}} \right)$$

zero 1

$$= \frac{-1}{-(a+j2\pi f)} = \frac{1}{a+j2\pi f}$$

if

$|G(f)| = ?$

$$|G(f)|^2 = G(f) \cdot G^*(f)$$

$$= \frac{1}{a+j2\pi f} \cdot \frac{1}{a-j2\pi f}$$

$$= \frac{1}{a^2 + (2\pi f)^2}$$

$$|G(f)| = \frac{1}{\sqrt{a^2 + (2\pi f)^2}}$$

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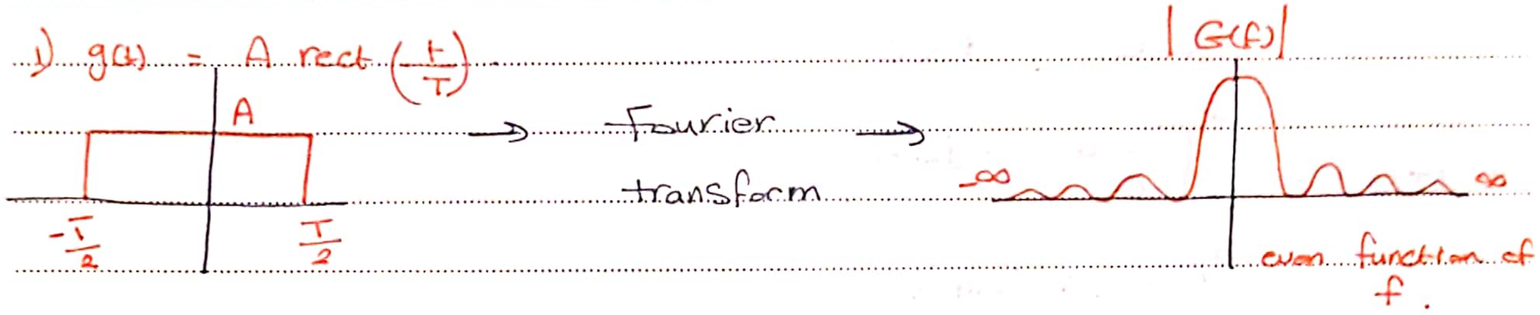
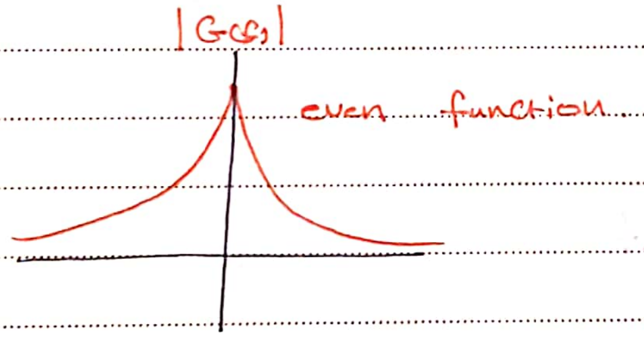
* $G(f) = \int_{-\infty}^{\infty} g(t)\, e^{-j2\pi f t}\, dt$

1) $g(t) = A\, rect\left(\frac{t}{T}\right)$



2) $g(t) = e^{-at}\, u(t)$

$e^{-at}\, u(t) \rightarrow$ Fourier transform $\rightarrow |G(f)| = \frac{1}{\sqrt{a^2 + (2\pi f)^2}}$



Properites of fourier transform :-

1) Linearity (Superposition) :-

let $F\{g_1(t)\} = G_1(f)$

and $F\{g_2(t)\} = G_2(f)$

$\therefore F\{a g_1(t) + b g_2(t)\} = a\, G_1(f) + b\, G_2(f)$

a , b are Constant.

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* Example :-

Compute the fourier transform of $g(t) = e^{-a|t|}$.

$$|t| = \begin{cases} t & t \geq 0 \\ -t & t < 0 \end{cases}$$

$$\therefore g(t) = e^{-at}\,u(t) + e^{at}\,u(-t)$$

اوجدناه في المثال السابقة

$$\therefore F\{e^{at}\,u(-t)\} = \int_{-\infty}^{0} e^{at} \cdot e^{-j2\pi f t}\,dt = \frac{1}{a - j2\pi f} = \frac{1}{a - j2\pi f}$$

$$\therefore = \frac{1}{a + j2\pi f} + \frac{1}{a - j2\pi f}$$

$$= \frac{2a}{a^2 + (2\pi f)^2}$$

∴ بالتعويض :-

$$F\{e^{-a|t|}\} = F\{e^{-at}\,u(t) + e^{at}\,u(-t)\}$$

$$= \frac{2a}{a^2 + (2\pi f)^2}$$

(2) Dilation :-

let $F\{g(t)\} = G(f)$.

what $F\{g(at)\} = ?$

$$F\{g(at)\} = \int_{-\infty}^{\infty} g(at)\, e^{-j2\pi f t}\,dt$$

Let $u = at$, $du = a\,dt \rightarrow \therefore dt = \frac{du}{a}$

$$\therefore F\{g(u)\} = \int_{-\infty}^{\infty} g(u) \cdot e^{-j2\pi f \frac{u}{a}} \frac{du}{a}.$$

$$= \frac{1}{a}\int_{-\infty}^{\infty} g(u)\, e^{-j2\pi \frac{f}{a} u}\, du.$$

$$= \frac{1}{|a|}\, G\left(\frac{f}{a}\right)$$

$$\therefore F\{g(at)\} = \frac{1}{|a|}\, G\left(\frac{f}{a}\right).$$

* Example :-

Find Fourier transform $\rightarrow \underbrace{F\{e^{-2at}\, u(t)\}}_{g\,(2t)}.$

Solution :-

$$F\{e^{-at} u(t)\} = \frac{1}{a + j2\pi f} \longrightarrow g(t)$$

$$\therefore F\{g(2t)\} = \frac{1}{2}\, G\left(\frac{f}{2}\right) = \frac{1}{2}\left(\frac{1}{a + j2\pi \frac{f}{2}}\right).$$

Problem (1) :- Find :-

1) $F\{e^{-\frac{1}{2}at}\, u(t)\}.$

2) $F\{e^{\frac{1}{5}at}\, u(t)\}.$

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* Example :-

Find $F\left\{3 \operatorname{rect} \frac{t}{2T}\right\}$.

Solution :-

$$\underset{g(t)}{F\left\{3 \operatorname{rect}\left(\frac{t}{T}\right)\right\}} = 3T \operatorname{sinc}(\pi f T).$$

$$\therefore F\left\{3 \operatorname{rect}\left(\frac{t}{2T}\right)\right\} = g\left(\frac{1}{2}t\right)$$

$$\therefore F\left\{g\left(\frac{1}{2}t\right)\right\} = \frac{1}{1/2} G\left(\frac{f}{1/2}\right) = 2\,G(2f).$$

$$\therefore F\left\{3 \operatorname{rect}\left(\frac{t}{2T}\right)\right\} = 6T \operatorname{sinc}(2\pi f T)$$

* * *

Problems :- (2)

1) $F\left\{4 \operatorname{rect}\left(\frac{t}{5T}\right)\right\}$.

2) $F\left\{2 \operatorname{rect}\left(\frac{3t}{T}\right)\right\}$.

3) $F\left\{\operatorname{rect}\left(\frac{2t}{3T}\right)\right\}$.

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Problem (1) :-

1) $\mathcal{F}\{e^{-\frac{1}{2}at} u(t)\}$

$$g(t) = e^{-at} u(t) \rightarrow \mathcal{F}(g(t)) = \frac{1}{a+j2\pi f}$$

$$\therefore \mathcal{F}\{e^{-\frac{1}{2}at} u(t)\} = \mathcal{F}\{g(\tfrac{-1}{2}t)\}$$

$$= \frac{1}{\left|\frac{1}{2}\right|} G\left(\frac{f}{\frac{1}{2}}\right) = 2\, G(2f) = 2\left(\frac{-1}{a-j4\pi f}\right).$$

2) $\mathcal{F}\{e^{\frac{1}{5}at} u(t)\}$

$$g(t) = e^{at} u(t) \rightarrow \mathcal{F}(g(t)) = \frac{1}{a-j2\pi f}.$$

$$\therefore \mathcal{F}\{e^{\frac{1}{5}at} u(t)\} = \mathcal{F}\{g(\tfrac{1}{5}t)\}$$

$$= \frac{1}{\left|\frac{1}{5}\right|} G\left(\frac{F}{\frac{1}{5}}\right) = 5\, G(5F) = 5\left(\frac{1}{a+j2\pi(5F)}\right).$$

Problem (2) :-

1) $\mathcal{F}\left(4\,\mathrm{rect}\,\frac{t}{5T}\right)$

$$\mathcal{F}\left(4\,\mathrm{rect}\,\frac{t}{T}\right) = 4T\,\mathrm{sinc}(\pi f T). \rightarrow g(t)$$

$$\mathcal{F}\left(4\,\mathrm{rect}\,\frac{t}{5T}\right) = g\left(\frac{1}{5}t\right) = \frac{1}{|1/5|} G\left(\frac{F}{1/5}\right)$$

$$= 5\, G(5F) = 20T\,\mathrm{sinc}(5\pi f T).$$

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2) $\mathcal{F}\left(2\,\text{rect}\,\frac{3t}{T}\right)$

$$\mathcal{F}\left(2\,\text{rect}\,\frac{t}{T}\right) = 2T\,\text{sinc}\,(\pi f T) \rightarrow g(t).$$

$$\mathcal{F}\left(2\,\text{rect}\,3\frac{t}{T}\right) = g(3t) = \frac{1}{|3|}\,G\left(\frac{F}{3}\right)$$

$$= \frac{2}{3}T\,\text{sinc}\left(\pi\frac{F}{3}T\right).$$

3) $\mathcal{F}\left(\text{rect}\,\frac{2t}{3T}\right)$

$$\mathcal{F}\left(\text{rect}\,\frac{t}{T}\right) = T\,\text{sinc}\,(\pi f T) \rightarrow g(t).$$

$$\therefore \mathcal{F}\left(\text{rect}\,\frac{2}{3}\frac{t}{T}\right) = g\left(\frac{2}{3}t\right) = \frac{1}{|2/3|}\,G\left(\frac{F}{2/3}\right)$$

$$= \frac{3}{2}T\,\text{rect}\left(\pi\,\frac{3}{2}F T\right).$$

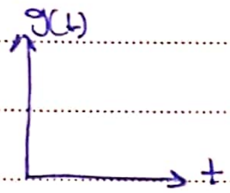
* * * *

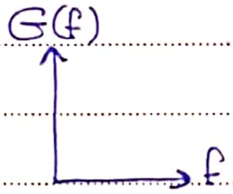
* Fourier transform :-

$$g(t) \rightarrow \boxed{\text{Fourier transform}} \rightarrow G(f)$$

$g(t)$: time domain Signal

$G(f)$: frequency domain Signal.





proparities of fourier transform :-

1) linearity (superposition)
2) Dilation.
3) Time shifting :-

shifting a signal in time domain → result in frequency domain

$g(t) \rightarrow G(f)$.

$g(t-t_0) \rightarrow ?$

$$G(f) = \int_{-\infty}^{\infty} g(t-t_0)\, e^{-j2\pi f t}\, dt$$

let $u = t - t_0 \rightarrow du = dt \rightarrow t = u + t_0$

$$\therefore G(f) = \int_{-\infty}^{\infty} g(u)\, e^{-j2\pi f (u+t_0)}\, du$$

$$= \int_{-\infty}^{\infty} g(u)\, e^{-j2\pi f u} \cdot \underbrace{e^{-j2\pi f t_0}}_{\text{Constant}}\, du$$

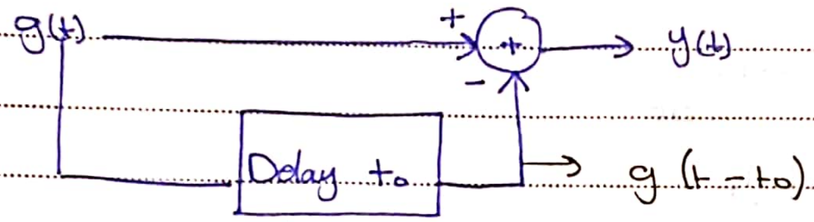
$$\therefore \mathcal{F} = e^{-j2\pi f t_0} \int_{-\infty}^{\infty} g(u)\, e^{-j2\pi f u}\, du$$

$$= e^{-j2\pi f t_0} \cdot G(f)$$

$$\therefore g(t - t_0) \Rightarrow e^{-j2\pi f t_0}\, G(f).$$

Example :-

for the block diagram shown below find the transfer function?



$$T(f) = \frac{Y(f)}{G(f)}$$

$$\mathcal{F}\{g(t)\} = G(f)$$
$$\mathcal{F}\{Y(t)\} = Y(f)$$

$$\mathcal{F}\{g(t - t_0)\} = e^{-j2\pi f t_0} \cdot G(f).$$

$$y(t) = g(t) - g(t - t_0).$$
$$Y(f) = G(f) - G(f)\, e^{-j2\pi f t_0}.$$
$$Y(f) = G(f)\left[1 - e^{-j2\pi f t_0}\right].$$

$$\therefore T(f) = \frac{Y(f)}{G(f)} = 1 - e^{-j2\pi f t_0}$$

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4) Frequency Shifting :-

$g(t) \rightarrow G(f)$

$\underbrace{e^{+j2\pi f_c t} \; g(t)}_{X(t)} \rightarrow ?? \quad X(f)$

$\therefore X(f) = \int_{-\infty}^{\infty} x(t)\, e^{-j2\pi f t}\, dt$

$= \int_{-\infty}^{\infty} g(t)\, e^{j2\pi f_c t} \cdot e^{-j2\pi f t}\, dt.$

$= \int_{-\infty}^{\infty} g(t)\, e^{-j2\pi (f - f_c) t}\, dt$

$= G(f - f_c).$

$\therefore e^{j2\pi f_c t} g(t) \Longrightarrow G(f - f_c).$

* Example :-

Find the fourier transform of $x(t) = 2\cos 2\pi f_c t \; g(t)$

* $2\cos 2\pi f_c t = e^{j2\pi f_c t} + e^{-j2\pi f_c t}$

$\therefore X(t) = e^{j2\pi f_c t} g(t) + e^{-j2\pi f_c t} g(t)$

$\therefore F(x(t)) = F\{e^{j2\pi f_c t} g(t)\} + F\{e^{-j2\pi f_c t} g(t)\}.$

$= G(f - f_c) + G(f + f_c)$

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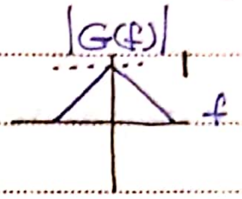
Example :-

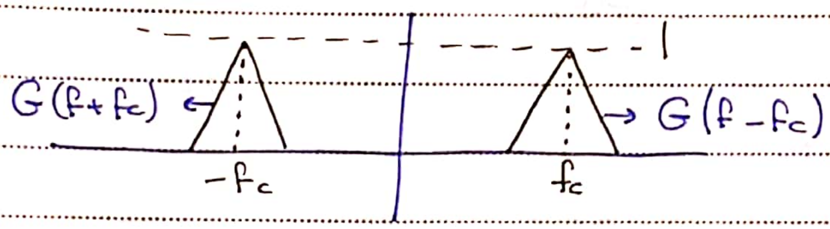
let the signal $g(t)$ has a fourier transform as in the figure how the fourier transform of

$x(t) = 2\cos 2\pi f_c t \, g(t)$ looks like

يعني (draw the fourier transform of $x(t)$).



نستخدم خاصية frequency shift :-



5) Differentiation in time domain :-

$g(t) \rightarrow G(f)$

$\frac{d\, g(t)}{dt} \rightarrow j2\pi f \, G(f)$

$\frac{d^n g(t)}{dt} \rightarrow (j2\pi f)^n \, G(f)$

* Example :- Find fourer transform of $g(t) = t$

$G(f) = \int_{-\infty}^{\infty} t \, e^{-j2\pi f t} \, dt$

$g(t) = t \rightarrow \acute{g}(t) = 1 \longrightarrow F\{1\} =$

$\therefore F(g(t)) = F\{1\}(j2\pi f)$

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$g(t) = t^2$

$F\{g(t)\} = (j2\pi f)^2 \; F\{2\}$

* proparites of fourier Transform :-

1) Time shifting :-

$F(g(t-t_0)) \Rightarrow e^{-j2\pi f t_0} \; G(f).$

2) Frequency shifting :-

$g(t)\, e^{j2\pi f_0 t} \longrightarrow G(f-f_0).$

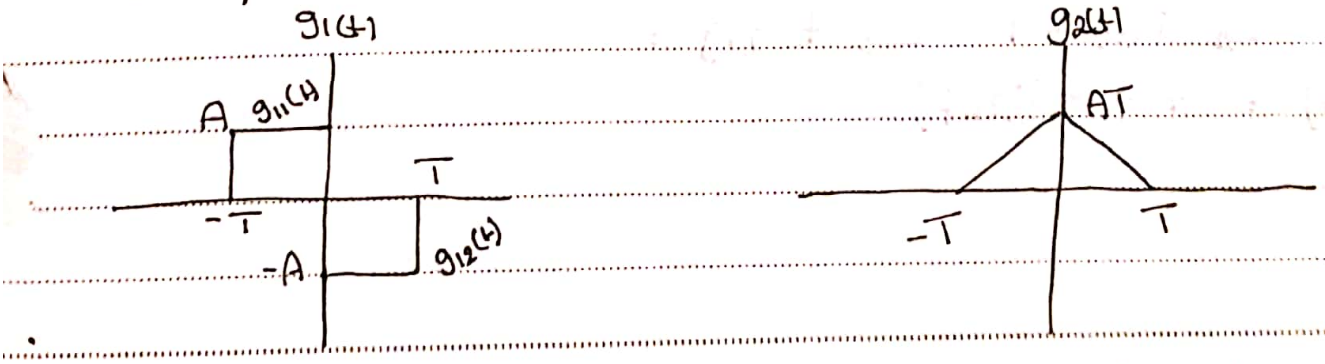
3) Differentiation in time domain :-

$\dot{g}(t) \rightarrow (j2\pi f)\; G(f).$

4) integration in time domain :-

$\int_{-\infty}^{t} g(\tau)\, d\tau \rightleftharpoons \frac{1}{j2\pi f} \cdot G(f)$

* Example :-



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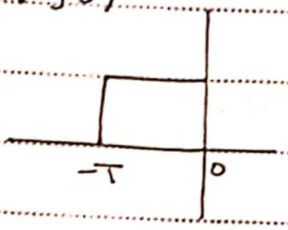
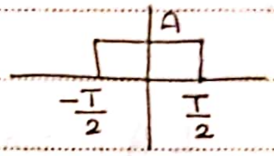
* العلاقة بين g_2 و g_1 ← مشتقة g_2 تساوي g_1 ، تكامل g_1
يساوي g_2 .

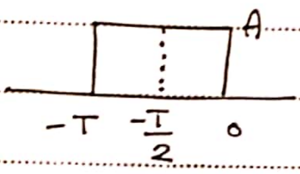
$(-T, 0)$



→ in general :



$$F\left(A \operatorname{rect} \frac{t}{T}\right) = AT \operatorname{sinc}(\pi f T).$$



→ $A \operatorname{rect}\left(\frac{t + T/2}{T}\right)$ shift in time domain.

$$F\left\{A \operatorname{rect}\left(\frac{t + T/2}{T}\right)\right\}$$

$$= AT \operatorname{sinc}(\pi f T)\, e^{j2\pi f \frac{T}{2}}$$

$$= AT \operatorname{sinc}(\pi f T)\, e^{j\pi f T}.$$

$g_1(t)$ $(0, T)$:-

$$g(t) = -A \operatorname{rect}\left(\frac{t - T/2}{T}\right)$$

$$F(g_{12}(t)) = -AT \operatorname{sinc}(\pi f T)\, e^{-j\pi f T}.$$

$$F(g_2(t)) = \frac{1}{j2\pi f} F(g_1(t)) = \frac{1}{j2\pi f} F(g_{11}(t) + g_{12}(t)).$$

$$= \frac{1}{j2\pi f}\left(F(g_{11}(t)) + F(g_{12}(t))\right)$$

$$= \frac{1}{j2\pi f}\left(AT \operatorname{sinc}(\pi f T)\, e^{j\pi f T} - AT \operatorname{sinc}(\pi f T)\, e^{-j\pi f T}\right).$$

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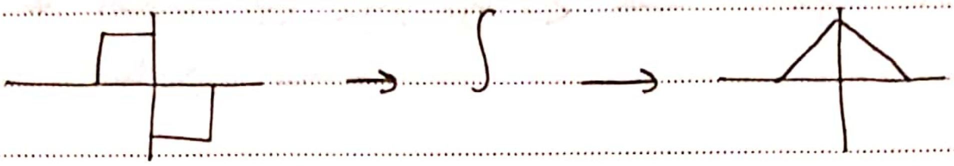
Saja

Subject : 20/2/2017.



$$\therefore = \frac{1}{j2\pi f}\left[AT\ \text{sinc}(\pi f T)\, e^{j\pi f T} - AT\ \text{sinc}(\pi f T)\, e^{-j\pi f T}\right]$$

$$= \frac{AT\ \text{sinc}(\pi f T)}{j2\pi f}\left[e^{j\pi f T} - e^{-j\pi f T}\right].$$

Note :- $\sin \pi f T = \frac{1}{2j}\left[e^{j\pi f T} - e^{-j\pi f T}\right].$

$$= AT\ \text{sinc}(\pi f T) \cdot \frac{\cancel{2j}\ \sin(\pi f T)}{\cancel{j2}\ \pi f} \rightarrow * \frac{T}{T}$$

$$= AT\ \text{Sinc}(\pi f T) \cdot T \cdot \frac{\sin(\pi f T)}{\pi f T}$$

$$= AT^2\ \text{sinc}^2(\pi f T).$$

$$g_1(t) \longrightarrow \boxed{\int} \longrightarrow g_2(t)$$

$$F\{g_2(t)\} = \frac{1}{j2\pi f} F(g_1(t)).$$

Subject : .... 21 / 2 /2014

*properties of fourier transform :-

Modulation property :-

let $g_1(t) \rightarrow G_1(f)$

$g_2(t) \rightarrow G_2(f)$

Then what is the fourier transform of $F\{g_1(t)\, g_2(t)\}$.

$$F\{g_1(t)\, g_2(t)\} = G_1(f) \underbrace{*}_{\text{Convolution}} G_2(f)$$

Convolution Theory :-

$$F\{g_1(t) \underbrace{*}_{\text{Convolution}} g_2(t)\} = G_1(f)\, G_2(f)$$

Duality :-

let $g_1(t) \rightleftharpoons G_1(f)$

$$G(t) \rightleftharpoons g(-f)$$

$$F\left\{A\, \text{rect}\left(\frac{t}{T}\right)\right\} = AT\, \text{sinc}(TfT)$$

Find $F\{A\, \text{sinc}(2Wt)\}$ → الحل اما عن طريق التكامل او خاصية duality

الحل $\underline{=*}$ $F\left(A\, \text{sinc}(2Wt)\right) = A\, \frac{1}{2W}\, \text{rect}\left(f \cdot \frac{1}{2W}\right)$

$T = \frac{t}{\frac{1}{2W}}$

$$= \frac{A}{2W}\, \text{rect}\left(\frac{f}{2W}\right)$$

or :- $A \operatorname{Sinc}(2wt) = A \cdot \frac{\sin 2wt}{2wt}$ → ونحل تكامل

Rayleigh energy theorem :-

let we have the fourier transform pair

$g(t) \rightleftharpoons G(f)$.

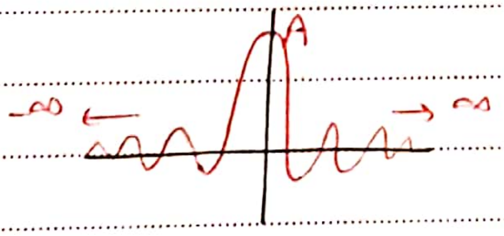
Then $\underbrace{\int_{-\infty}^{\infty} |g(t)|^2 dt}_{\text{energy Contained in the signal } g(t)} = \int_{-\infty}^{\infty} |G(f)|^2 df$.

$\therefore \underset{\text{energy}}{E} = \int_{-\infty}^{\infty} |g(t)|^2 dt = \int_{-\infty}^{\infty} |G(f)|^2 df$

* Example :-

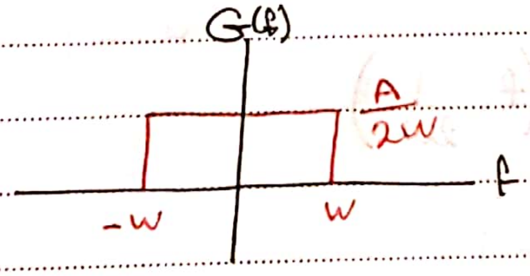
Compute the energy of the signal $g(t) = A \operatorname{sinc}(2wt)$

$E = \int_{-\infty}^{\infty} |g(t)|^2 dt = \int_{-\infty}^{\infty} |G(f)|^2 df$.



$\operatorname{Sinc}(2wt) = \frac{\sin 2wt}{2wt}$ وتكامل

or :- $F\{A \sin(2wt)\} = \frac{A}{2w} \operatorname{rect}\left(\frac{f}{2w}\right)$.



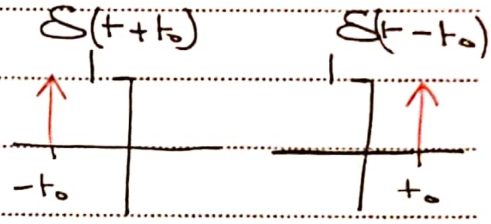
$$= \int_{-\infty}^{\infty} |G(f)|^2 \, df$$

$$= \int_{-w}^{w} \left(\frac{A}{2w}\right)^2 df = \left(\frac{A}{2w}\right)^2 \int_{-w}^{w} df = \left(\frac{A}{2w}\right)^2 f \Big|_{-w}^{w}$$

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

Section (2.4) :- delta function :-

$$\delta(t-t_0) = \begin{cases} 1 , & t = t_0 \\ 0 , & \text{otherwise} \end{cases}$$

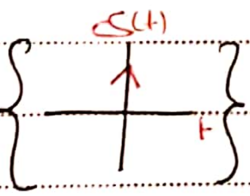
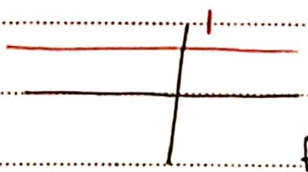


$$* \int_{-\infty}^{\infty} g(t)\, \delta(t-t_0)\, dt = g(t_0)$$

$$* \; g(t) \overset{\text{Convolution}}{*} \delta(t) = g(t)$$

$$F\{\delta(t)\} = \int_{-\infty}^{\infty} \delta(t)\, e^{-j2\pi f t}\, dt = e^{-j2\pi f t_0} \Big|_{t_0=0} = 1$$

$$\therefore F(\delta(t)) = 1$$

F  $=$ 

it has a Constant value for the whole frequency band.

$$g(t) = \int_{-\infty}^{\infty} G(f)\, e^{j2\pi f t}\, df$$

$$= \int_{-\infty}^{\infty} \delta(f)\, e^{j2\pi f t}\, df = e^{j2\pi f t} \Big|_{f=0} = 1$$