



Fourier Transform Pair:

The Fourier transform of $f(x)$ is given by

$$F(s) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{isx} dx \rightarrow (1)$$

Then the function $f(x)$ is the Inverse Fourier transform of $F(s)$ is given by,

$$f(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} F(s) e^{-isx} ds \rightarrow (2)$$

The above eqns. (1) and (2) are jointly called Fourier transform pair.

Self Reciprocal function:

If the Fourier transform of $f(x)$ is equal to $F(s)$, then $f(x)$ is said to be reciprocal function under Fourier transform.

$$\text{i.e., } F[f(x)] = F(s)$$

$$\text{Eg: } F[e^{-x^2/2}] = e^{-s^2/2}$$

Parseval's Identity or Rayleigh's Theorem:

If $F(s)$ is the Fourier transform of $f(x)$

then

$$\int_{-\infty}^{\infty} |f(x)|^2 dx = \int_{-\infty}^{\infty} |F(s)|^2 ds$$

Results:

$$\text{i). } \cos x = \frac{e^{ix} + e^{-ix}}{2}$$

$$\text{ii). } \sin x = \frac{e^{ix} - e^{-ix}}{2i}$$



Problems :

1]. Find the FT of $f(x) = \begin{cases} 1 & \text{if } |x| < a \\ 0 & \text{if } |x| > a \end{cases}$

Soln :

$$f(x) = \begin{cases} 1, & -a < x < a \\ 0, & -\infty < x < -a \text{ \& } a < x < \infty \end{cases}$$



$$\begin{aligned} F(s) = F[f(x)] &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{isx} dx \\ &= \frac{1}{\sqrt{2\pi}} \int_{-a}^a (\cos sx + i \sin sx) dx \end{aligned}$$

$$e^{i\theta} = \cos \theta + i \sin \theta$$

$$= \frac{1}{\sqrt{2\pi}} \left[2 \int_0^a \cos sx dx + i \cdot 0 \right]$$

$$= \frac{2}{\sqrt{2\pi}} \left[\frac{\sin sx}{s} \right]_0^a$$

$$= \frac{2}{\sqrt{2\pi}} \frac{\sin sa}{s}$$

2]. Find the FT of $f(x) = \begin{cases} x & \text{if } |x| \leq a \\ 0 & \text{if } |x| > a \end{cases}$

Soln :

$$f(x) = \begin{cases} x & \text{if } -a \leq x \leq a \\ 0 & \text{if } -\infty < x < -a \text{ \& } a < x < \infty \end{cases}$$

$$F(s) = F[f(x)] = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{isx} dx$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-a}^a x (\cos sx + i \sin sx) dx$$

$$= \frac{1}{\sqrt{2\pi}} \left[\int_{-a}^a x \cos sx dx + i \int_{-a}^a x \sin sx dx \right]$$



$x \cos sx \rightarrow \text{odd}$

$x \sin sx \rightarrow \text{even}$

$$\begin{aligned}
 &= \frac{1}{\sqrt{2\pi}} \left[0 + 2i \int_0^a x \sin sx \, dx \right] \\
 &= \frac{1}{\sqrt{2\pi}} \left\{ 2i \left[x \left(-\frac{\cos sx}{s} \right) - 1 \left(-\frac{\sin sx}{s^2} \right) + 0 \right] \right\}_0^a \\
 &= \frac{1}{\sqrt{2\pi}} 2i \left[\frac{a \cos sa}{s} + \frac{\sin sa}{s^2} - 0 \right] \\
 &= \frac{2i}{\sqrt{\pi}} \left[\frac{\sin sa - sa \cos sa}{s^2} \right]
 \end{aligned}$$

Q3]. Show that fourier transform of

$$f(x) = \begin{cases} a^2 - x^2, & |x| < a \\ 0, & |x| > a > 0 \end{cases} \text{ and hence find that}$$

$$2\sqrt{\frac{2}{\pi}} \left[\frac{\sin as - as \cos as}{s^3} \right]. \text{ Hence deduce that}$$

$$\int_0^\infty \left(\frac{\sin t - t \cos t}{t^3} \right) dt = \pi/4. \text{ Using P.I. Show that}$$

$$\int_0^\infty \left(\frac{\sin t - t \cos t}{t^3} \right)^2 dt = \pi/15$$

Soln.:

$$f(x) = \begin{cases} a^2 - x^2, & -a < x < a \\ 0, & -\infty < x < -a \text{ \& } a < x < \infty \end{cases}$$

$$F(s) = \frac{1}{\sqrt{2\pi}} \int_{-a}^a (a^2 - x^2) (\cos sx + i \sin sx) \, dx$$

$$= \frac{1}{\sqrt{2\pi}} \left[\int_{-a}^a (a^2 - x^2) \cos sx \, dx + i \int_{-a}^a (a^2 - x^2) \sin sx \, dx \right]$$

EVEN EVEN EVEN ODD



$$\begin{aligned}
 &= \frac{1}{\sqrt{2\pi}} \left[\int_0^a (a^2 - x^2) \frac{\cos sx}{s} dx + i(0) \right] \\
 &= \frac{1}{\sqrt{2\pi}} \left[(a^2 - x^2) \frac{\sin sx}{s} - (-2x) \left(-\frac{\cos sx}{s^2} \right) + (-2) \left(\frac{\sin sx}{s^3} \right) \right]_0^a \\
 &= \frac{1}{\sqrt{2\pi}} \left[-2x \frac{\cos sx}{s^2} + (a^2 - x^2) \frac{\sin sx}{s} + 2 \frac{\sin sa}{s^3} \right]_0^a \\
 &= \frac{1}{\sqrt{2\pi}} \left[-2a \frac{\cos sa}{s^2} + \frac{2 \sin sa}{s^3} \right] \\
 &= 2 \frac{1}{\sqrt{2\pi}} \left[\frac{\sin sa - sa \cos sa}{s^3} \right] \\
 \text{put } a=1, \quad F(s) &= 2 \frac{1}{\sqrt{2\pi}} \left[\frac{\sin s - s \cos s}{s^3} \right]
 \end{aligned}$$

i). USING Inverse Fourier Transform,

$$\begin{aligned}
 \textcircled{2} f(x) &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} F(s) e^{-isx} ds \\
 &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} 2 \frac{1}{\sqrt{2\pi}} \left[\frac{\sin s - s \cos s}{s^3} \right] [\cos sx - i \sin sx] ds
 \end{aligned}$$

$$= \frac{2}{\pi} \int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) \cos sx \, ds$$

$$\text{Put } x=0, \quad f(0) = \frac{4}{\pi} \int_0^{\infty} \frac{\sin s - s \cos s}{s^3} \, ds$$

$$\int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) ds = \frac{\pi}{4} \quad f(0) = \frac{\pi}{4} (1-0) = \frac{\pi}{4}$$

$$\Rightarrow \int_0^{\infty} \left(\frac{\sin t - t \cos t}{t^3} \right) dt = \frac{\pi}{4}$$



ii). Using Parseval's Identity,

$$\textcircled{2} \int_{-\infty}^{\infty} |f(x)|^2 dx = \int_{-\infty}^{\infty} |F(s)|^2 ds$$

$$\int_{-1}^1 (1-x^2)^2 dx = \int_{-\infty}^{\infty} \left\{ \frac{2}{\pi} \left(\frac{\sin s - s \cos s}{s^3} \right) \right\}^2 ds$$

$$2 \int_0^1 (1+x^2-2x^3) dx = \frac{8 \times 2}{\pi} \int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right)^2 ds$$

$$\frac{16}{\pi} \int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right)^2 ds = 2 \left[x + \frac{x^5}{5} - 2 \frac{x^3}{3} \right]_0^1$$

$$= 2 \left[1 + \frac{1}{5} - \frac{2}{3} \right]$$

$$= 2 \left[\frac{15+3-10}{15} \right]$$

$$= \frac{16}{15}$$

$$\int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right)^2 ds = \frac{16}{15} \left(\frac{\pi}{16} \right)$$

$$\int_0^{\infty} \left(\frac{\sin t - t \cos t}{t^3} \right)^2 dt = \frac{\pi}{15}$$

And the FT of $f(x) = \begin{cases} a-|x|, & |x| < a \\ 0, & |x| > a > 0 \end{cases}$

and deduce that $\int_0^{\infty} \left(\frac{\sin t}{t} \right)^2 dt$ and $\int_0^{\infty} \left(\frac{\sin t}{t} \right)^4 dt$



Soln.:

$$f(x) = \begin{cases} a-|x|, & -a < x < a \\ 0, & -\infty < x < -a \text{ \& } a < x < \infty \end{cases}$$

$$F(s) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{isx} dx$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-a}^a (a-|x|) [\cos sx + i \sin sx] dx$$

$$= \frac{2}{\sqrt{2\pi}} \int_0^a (a-x) \cos sx dx + 0$$

$$= \sqrt{\frac{2}{\pi}} \left[(a-x) \frac{\sin sx}{s} - (-1) \left(-\frac{\cos sx}{s^2} \right) \right]_0^a$$

$$= \sqrt{\frac{2}{\pi}} \left[-\frac{\cos sa}{s^2} \right]_0^a$$

$$= -\sqrt{\frac{2}{\pi}} \left[\frac{\cos sa}{s^2} - \frac{1}{s^2} \right] = \sqrt{\frac{2}{\pi}} \left[\frac{1 - \cos sa}{s^2} \right]$$

$$= \sqrt{\frac{2}{\pi}} \frac{2 \sin^2 \frac{sa}{2}}{s^2}$$

$$\cos 2\theta = 1 - 2 \sin^2 \theta$$

$$\cos \theta = 1 - 2 \sin^2 \frac{\theta}{2}$$

i). using IFT

$$f(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} F(s) e^{-isx} ds$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \frac{2}{s^2} \sqrt{\frac{2}{\pi}} \sin^2 \frac{sa}{2} e^{-isx} ds$$

$$= \frac{2}{\pi} \int_{-\infty}^{\infty} \frac{1}{s^2} \sin^2 \frac{sa}{2} [\cos sx - i \sin sx] ds$$

$$f(x) = \frac{4}{\pi} \int_0^{\infty} \frac{1}{s^2} \sin^2 \frac{sa}{2} \cos sx ds$$



Put $x=0$, $a=2$

$$f(0) = \frac{4}{\pi} \int_0^{\infty} \frac{\sin^2 s}{s^2} ds$$

$$\int_0^{\infty} \left(\frac{\sin s}{s} \right)^2 ds = \frac{\pi}{4} f(0) = \frac{\pi}{4} (2-10)$$

$$\int_0^{\infty} \left(\frac{\sin t}{t} \right)^2 dt = \frac{\pi}{2} \quad 's' \text{ is dummy variable.}$$

ii). Parseval's Identity:

$$\int_{-\infty}^{\infty} |f(x)|^2 dx = \int_{-\infty}^{\infty} |F(s)|^2 ds$$

$$\int_{-2}^2 [2-x]^2 dx = \int_{-\infty}^{\infty} 4 \frac{\pi}{\pi} \frac{\sin^4 \frac{sa}{2}}{s^4} ds$$

$$2 \int_0^2 (2-x)^2 dx = \frac{8}{\pi} 2 \int_0^{\infty} \left[\frac{\sin \frac{sa}{2}}{s} \right]^4 ds$$

$$2 \left[\frac{(2-x)^3}{-3} \right]_0^2 = \frac{16}{\pi} \int_0^{\infty} \left[\frac{\sin \frac{sa}{2}}{s} \right]^4 ds$$

$$-\frac{2}{3} [0-8] = \frac{16}{\pi} \int_0^{\infty} \left[\frac{\sin s}{s} \right]^4 ds \quad \because a=2$$

$$\frac{16}{3} \frac{\pi}{16} = \int_0^{\infty} \left[\frac{\sin t}{t} \right]^4 dt \quad (\because s \text{ is dummy var})$$

$$\int_0^{\infty} \left[\frac{\sin t}{t} \right]^4 dt = \frac{\pi}{3}$$



3] Find the Fourier transform of $f(x) = \begin{cases} 1-x, & |x| < 1 \\ 0, & |x| > 1 \end{cases}$

and deduce that $\int_0^{\infty} \left(\frac{\sin t}{t}\right)^2 dt$ and $\int_0^{\infty} \left(\frac{\sin t}{t}\right)^4 dt$

Soln.:

$$f(x) = \begin{cases} 1-x, & -1 < x < 1 \\ 0, & -\infty < x < -1 \text{ and } 1 < x < \infty \end{cases}$$

$$F(s) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{isx} dx$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-1}^1 (1-x) (\cos sx + i \sin sx) dx$$

$$= \frac{1}{\sqrt{2\pi}} \left[\int_{-1}^1 (1-x) \cos sx dx + i \int_{-1}^1 (1-x) \sin sx dx \right]$$

even even -1 even odd

$$= \frac{1}{\sqrt{2\pi}} \left[2 \int_0^1 (1-x) \cos sx dx + 0 \right]$$

$$= \sqrt{\frac{2}{\pi}} \left[(1-x) \frac{\sin sx}{s} - (-1) \left(-\frac{\cos sx}{s^2} \right) \right]_0^1$$

$$= \sqrt{\frac{2}{\pi}} \left[-\frac{\cos s}{s^2} + \frac{1}{s^2} \right]$$

$$F(s) = \sqrt{\frac{2}{\pi}} \left[\frac{1 - \cos s}{s^2} \right]$$

IFT

$$f(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} F(s) e^{-isx} ds$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \sqrt{\frac{2}{\pi}} \left[\frac{1 - \cos s}{s^2} \right] [\cos sx - i \sin sx] ds$$

$$= \frac{1 - \cos(-s)}{(-s)^2}$$

$$= 1 - \cos s$$



$$\begin{aligned}
 &= \frac{1}{\pi} \left[\int_{-\infty}^{\infty} \left[\frac{1 - \cos s}{s^2} \right] \cos sx \, ds - \int_{-\infty}^{\infty} \left[\frac{1 - \cos s}{s^2} \right] \sin sx \, ds \right] \\
 &= \frac{1}{\pi} \left[2 \int_0^{\infty} \left(\frac{1 - \cos s}{s^2} \right) \cos sx \, ds - i(0) \right] \\
 &\quad \left(\frac{1 - \cos s}{s^2} \right) \cos sx \rightarrow \text{even} \\
 &\quad \left(\frac{1 - \cos s}{s^2} \right) \sin sx \rightarrow \text{odd} \\
 f(x) &= \frac{2}{\pi} \int_0^{\infty} \left(\frac{2 \sin^2 s/2}{s^2} \right) \cos sx \, ds
 \end{aligned}$$

Put $x=0$,

$$f(0) = \frac{4}{\pi} \int_0^{\infty} \left(\frac{\sin^2 s/2}{s} \right) ds$$

$$\int_0^{\infty} \left(\frac{\sin^2 s/2}{s} \right) ds = \frac{\pi}{4} f(0) = \pi/4$$

$$\therefore f(0) = \frac{1-0}{1} = 1$$

Put $z = s/2$

$$dz = \frac{ds}{2} \Rightarrow ds = 2 \, dz$$

$$\begin{aligned}
 &\text{when } s=0 \Rightarrow z=0 \\
 &s \rightarrow \infty \Rightarrow z \rightarrow \infty
 \end{aligned}$$

$$\int_0^{\infty} \left(\frac{\sin^2 z}{2z} \right) 2 \, dz = \pi/4$$

$$\Rightarrow \int_0^{\infty} \left(\frac{\sin^2 z}{z} \right) dz = \frac{\pi}{2}$$



Using Parseval's Identity

$$\int_{-\infty}^{\infty} |f(x)|^2 dx = \int_{-\infty}^{\infty} |F(s)|^2 ds$$

$$\int_{-1}^1 (1-x)^2 dx = \frac{2}{\pi} \int_{-\infty}^{\infty} \left(\frac{1-\cos s}{s^2} \right)^2 ds$$

$$2 \int_0^1 (1-x)^2 dx = \frac{2}{\pi} \int_{-\infty}^{\infty} \left(\frac{2 \sin^2 s/2}{s^2} \right)^2 ds$$

$$= \frac{8}{\pi} \int_{-\infty}^{\infty} \frac{\sin^4 s/2}{s^4} ds$$

$$2 \left[\frac{(1-x)^3}{-3} \right]_0^1 = \frac{16}{\pi} \int_0^{\infty} \frac{\sin^4 s/2}{s^4} ds$$

$$-\frac{2}{3} [0-1] = \frac{1}{\pi} \int_0^{\infty} \frac{\sin^4 s/2}{(s/2)^4} ds$$

$$\frac{2}{3} = \frac{1}{\pi} \int_0^{\infty} \left(\frac{\sin s/2}{s/2} \right)^4 ds$$

$$\int_0^{\infty} \left(\frac{\sin t}{t} \right)^4 dt = \frac{2\pi}{3}$$

$$\int_0^{\infty} \left(\frac{\sin t}{t} \right)^4 dt = \frac{2\pi}{6}$$

$$\int_0^{\infty} \left(\frac{\sin t}{t} \right)^4 dt = \frac{\pi}{3}$$

Take $t = s/2$

$$dt = ds/2 \Rightarrow ds = 2dt$$

when

$$s=0 \Rightarrow t=0$$

$$s=\infty \Rightarrow t=\infty$$



UNIT-IV FOURIER SERIES AND FOURIER TRANSFORM

FOURIER TRANSFORM

problems on FT: transform of $f(x)$
A7. Find the Fourier transform of $f(x)$ if
 $f(x) = \begin{cases} 1, & |x| < a \\ 0, & |x| > a > 0 \end{cases}$ Deduce that i) $\int_0^{\infty} \frac{\sin t}{t} dt = \frac{\pi}{2}$
ii) $\int_0^{\infty} \left(\frac{\sin t}{t}\right)^2 dt = \frac{\pi}{2}$

Soln.:
we already find $F(s) = \sqrt{\frac{2}{\pi}} \left(\frac{\sin as}{s} \right)$

IFT

$$f(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} F(s) e^{-isx} ds$$



$$= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \frac{2}{\pi} \left(\frac{\sin as}{s} \right) [\cos sx - i \sin sx] ds$$

$$= \frac{1}{\pi} \left[\int_{-\infty}^{\infty} \left(\frac{\sin as}{s} \right) \cos sx ds - i \int_{-\infty}^{\infty} \left(\frac{\sin as}{s} \right) \sin sx ds \right]$$

$$f(x) = \frac{2}{\pi} \int_0^{\infty} \left(\frac{\sin as}{s} \right) \cos sx ds - i(0)$$

$$\int_0^{\infty} \left(\frac{\sin as}{s} \right) \cos sx ds = \frac{\pi}{2} f(x)$$

put $x=0, a=1$

$$\int_0^{\infty} \left(\frac{\sin as}{s} \right) ds = \frac{\pi}{2} f(0)$$

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

$$f(0) = 1$$

$$\therefore \int_0^{\infty} \left(\frac{\sin t}{t} \right) dt = \frac{\pi}{2} \quad (\because t \text{ is dummy variable})$$

ii). PI

$$\int_{-\infty}^{\infty} |f(x)|^2 dx = \int_{-\infty}^{\infty} |F(s)|^2 ds$$

$$\int_{-a}^a dx = \int_{-\infty}^{\infty} \left(\sqrt{\frac{2}{\pi}} \frac{\sin as}{s} \right)^2 ds$$

$$(x)_{-a}^a = \frac{2}{\pi} \int_{-\infty}^{\infty} \left(\frac{\sin as}{s} \right)^2 ds$$



$$2a \frac{\pi}{2} = 2 \int_0^{\infty} \left(\frac{\sin as}{s} \right)^2 ds$$

$$\int_0^{\infty} \left(\frac{\sin as}{s} \right)^2 ds = \frac{\pi}{2} a$$

$$\int_0^{\infty} \left(\frac{\sin s}{s} \right)^2 ds = \frac{\pi}{2} \quad (\because a=1)$$

$$\Rightarrow \int_0^{\infty} \left(\frac{\sin x}{x} \right)^2 dx = \frac{\pi}{2}$$



Transforms of simple functions:

II. Find the fourier transform of

$$f(x) = \begin{cases} 1-x^2, & |x| < 1 \\ 0, & |x| \geq 1 \end{cases} \quad \text{and hence prove that}$$

$$\int_0^{\infty} \frac{\sin s - s \cos s}{s^3} \cos \frac{s}{2} ds = \frac{3\pi}{16}$$

Soln :

$$\text{Given } f(x) = \begin{cases} 1-x^2, & -1 < x < 1 \\ 0, & \text{otherwise} \end{cases}$$

$$F[f(x)] = \frac{1}{\sqrt{2\pi}} \int_{-1}^1 (1-x^2) e^{isx} dx$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-1}^1 (1-x^2) (\cos sx + i \sin sx) dx$$

$$= \frac{1}{\sqrt{2\pi}} \left[2 \int_0^1 (1-x^2) \cos sx dx + i(0) \right]$$

$$= \sqrt{\frac{2}{\pi}} \left[(1-x^2) \frac{\sin sx}{s} - (-2x) \left(-\frac{\cos sx}{s^2} \right) + (-2) \left(-\frac{\sin sx}{s^3} \right) \right]_0^1$$

$$= \sqrt{\frac{2}{\pi}} \left[(1-x^2) \frac{\sin sx}{s} - \frac{2x \cos sx}{s^2} + \frac{2 \sin sx}{s^3} \right]_0^1$$

$$= \sqrt{\frac{2}{\pi}} \left[\left(\frac{2 \cos s}{s^2} + \frac{2 \sin s}{s^3} \right) - 0 \right] 2 \sin$$

$$= 2 \sqrt{\frac{2}{\pi}} \left[\frac{\sin s - s \cos s}{s^3} \right]$$



by using IFT,

$$f(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} F(s) e^{-isx} ds$$

$$= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} 2\sqrt{\frac{2}{\pi}} \left[\frac{\sin s - s \cos s}{s^3} \right] (\cos sx - i \sin sx) ds$$

$$= \frac{2}{\pi} \left[\int_{-\infty}^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) \cos sx ds - i \int_{-\infty}^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) \sin sx ds \right]$$

$$= \frac{4}{\pi} \left[\int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) \cos sx ds - i(0) \right]$$

$$\Rightarrow \int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) \cos sx ds = \frac{\pi}{4} f(x)$$

$$\int_0^{\infty} \left(\frac{\sin s - s \cos s}{s^3} \right) \cos s/2 ds = \frac{3\pi}{16}$$

$$\begin{aligned} \therefore f(x) &= 1 - x^2 \\ f(1/2) &= 1 - 1/4 \\ &= 3/4 \end{aligned}$$