

# Gate 2023 EC 58

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## PROBLEM STATEMENT

Let  $x_1(t) = u(t + 1.5) - u(t - 1.5)$  and  $x_2(t)$  is shown in the figure below. For  $y(t) = x_1(t) * x_2(t)$ , the  $\int_{-\infty}^{\infty} y(t) dt$  is \_\_\_\_\_.

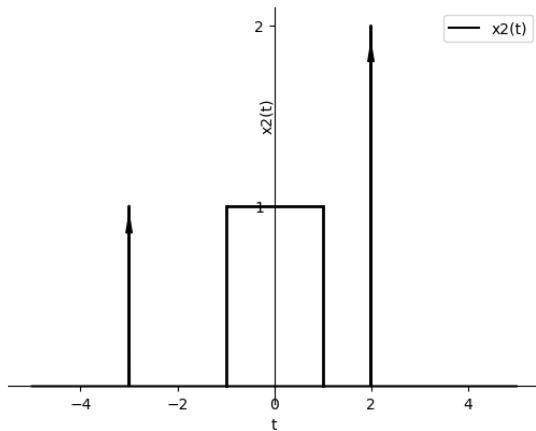


Fig. 1. Figure

$$x_1(t) = u(t + 1.5) - u(t - 1.5)$$

$$x_1(t) = \text{rect}\left(\frac{t}{3}\right)$$

$$x_1(t) = \text{rect}\left(\frac{t}{3}\right) \quad \text{Fourier transform} = 3\text{sinc}(\omega)$$

$$x_2(t) = \delta(t + 3) + \text{rect}\left(\frac{t}{2}\right) + 2\delta(t - 2)$$

Taking Fourier transform:

$$X_2(\omega) = e^{3j\omega} + 2\text{sinc}(\omega) + 2e^{-2j\omega}$$

$$y(t) = x_1(t) * x_2(t)$$

$$Y(\omega) = X_1(\omega) \cdot X_2(\omega)$$

We know:

$$Y(\omega) = \int_{-\infty}^{\infty} y(t)e^{-j\omega t} dt$$

$$\int_{-\infty}^{\infty} y(t) dt = Y(0)$$

$$Y(0) = X_1(0) \cdot X_2(0)$$

$$= 3(1 + 2 + 2)$$

$$= 15$$

## SOLUTION

### INPUT PARAMETERS

| Input Parameters |  |  |
|------------------|--|--|
| Function         | Expression   | Description  |
| $x_1(t)$         | $u(t + 1.5) - u(t - 1.5)$  | Step function with delay and width parameters.             |
| $x_2(t)$         | $\delta(t + 3) + \text{rect}\left(\frac{t}{2}\right) + 2\delta(t - 2)$ | Impulse function followed by a rectangle and two impulses. |