EX: Find the Laplace transforms of the following waveform:

$$(t^2 - 1)u(t - 1)$$

SOL'N: To create a form that allows us to apply the time delay identity, we replace t with $(t - 1 + 1)$ in the part preceding the step function:

$$([(t-1)+1]^2 - 1)u(t-1)$$

Now we apply the delay identity:

$$\mathcal{L}\{f(t-a)u(t-a)\} = e^{-as}\mathcal{L}\{f(t)\}$$

This means we replace $t - 1$ with t before taking the Laplace transform:

$$\mathcal{L}\{([(t-1)+1]^2 - 1)u(t-a)\} = e^{-s}\mathcal{L}\{[t+1]^2 - 1\}$$

Expanding the quadratic term yields the following result:

$$e^{-s}\mathcal{L}\{[t+1]^2 - 1\} = e^{-s}\mathcal{L}\{t^2 + 2t\} = e^{-s}\left(\frac{2}{s^3} + \frac{2}{s^2}\right) = 2e^{-s}\left(\frac{s+1}{s^3}\right)$$