Laplace Transform Part 3

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1. Properties of Laplace Transform :-

→ TIME SHIFTING :-

If,

Time domain; frequency domain or Laplace domain

$$f(t) \rightleftharpoons F(s)$$

then,

$$f(t-t_0) \rightleftharpoons F(s) \cdot e^{-st_0}$$ → Right hand shift

$$f(t+t_0) \rightleftharpoons F(s) \cdot e^{st_0}$$ → Left hand shift

Example: Find the L.T. of $u(t-2)$

Solution: Let $f(t) = u(t)$

then we know,

$$F(s) = L[f(t)]$$

$$= L[u(t)]$$

$$= \frac{1}{s}$$

Applying right shift time scaling property:

$$L[f(t-2)] = F(s) \cdot e^{-s(2)}$$

$$= F(s) \cdot e^{-2s}$$

$$= \frac{1}{s} \cdot e^{-2s}$$

→ Frequency Shifting :-

If,

$$f(t) \rightleftharpoons F(s)$$

then,

$$e^{s_0 t} f(t) \rightleftharpoons F(s-s_0)$$ ← right shift in frequency domain

$$e^{-s_0 t} f(t) \rightleftharpoons F(s+s_0)$$

focus, signs are opposite

↑ left shift in frequency domain

Example: Find the LT of function: $e^{-at}\cos(\omega t)$

Solution: Let $f(t) = \cos(\omega t)$

We know,

$$F(s) = L[f(t)] = \frac{s}{s^2+\omega^2}$$

Apply the frequency shifting property:

$$L[e^{-at} f(t)] = F(s+a)$$

$$\boxed{L[e^{-at} f(t)] = \frac{s+a}{(s+a)^2+\omega^2}}$$

2. References:

1. Neso Academy

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