

# NCERT-discrete : 10.5.3 - 2

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## I. QUESTION

The laplace transform of  $x_1(t) = e^{-t}u(t)$  is  $X_1(s)$ , where  $u(t)$  is the unit step function. The laplace transform of  $x_2(t) = e^t u(-t)$  is  $X_2(s)$ . Which one of the following statements is TRUE?

- 1) The region of convergence of  $X_1(s)$  is  $Re(s) \geq 0$
- 2) The region of convergence of  $X_2(s)$  is confined to the left half-plane of  $s$ .
- 3) The region of convergence of  $X_1(s)$  is confined to the right half-plane of  $s$ .
- 4) the imaginary axis in the  $s$ -plane is included in both the region of convergence of  $X_1(s)$  and the region of convergence of  $X_2(s)$ .

**Solutions :**

Symbols	Description
$X_1(s)$	Laplace transform of $x_1(t)$
$X_2(s)$	Laplace transform of $x_2(t)$
$u(t)$	Unit step function

TABLE I

PARAMETERS, DESCRIPTIONS

Laplace transform of  $x_1(t)$  is given by :

$$X_1(s) = \int_{-\infty}^{\infty} e^{-t} e^{-st} u(t) dt \quad (1)$$

$$= \left[ \frac{-e^{-t(s+1)}}{s+1} \right]_0^{\infty} \quad (2)$$

$$= \frac{1}{s+1}, \quad (3)$$

$$\text{ROC of } X_1(s) : Re(s) > -1 \quad (4)$$

Laplace transform of  $x_2(t)$  is given by :

$$X_2(s) = \int_{-\infty}^{\infty} e^t e^{-st} u(-t) dt \quad (5)$$

$$= \left[ \frac{e^{t(1-s)}}{1-s} \right]_{-\infty}^0, (\because u(t) = 0, \forall t < 0) \quad (6)$$

$$= \frac{1}{1-s}, \quad (7)$$

$$\text{ROC of } X_2(s) : Re(s) < 1 \quad (8)$$

Based on the regions of convergence of  $X_1(s)$  and  $X_2(s)$ , we can conclude that option 4) is correct .

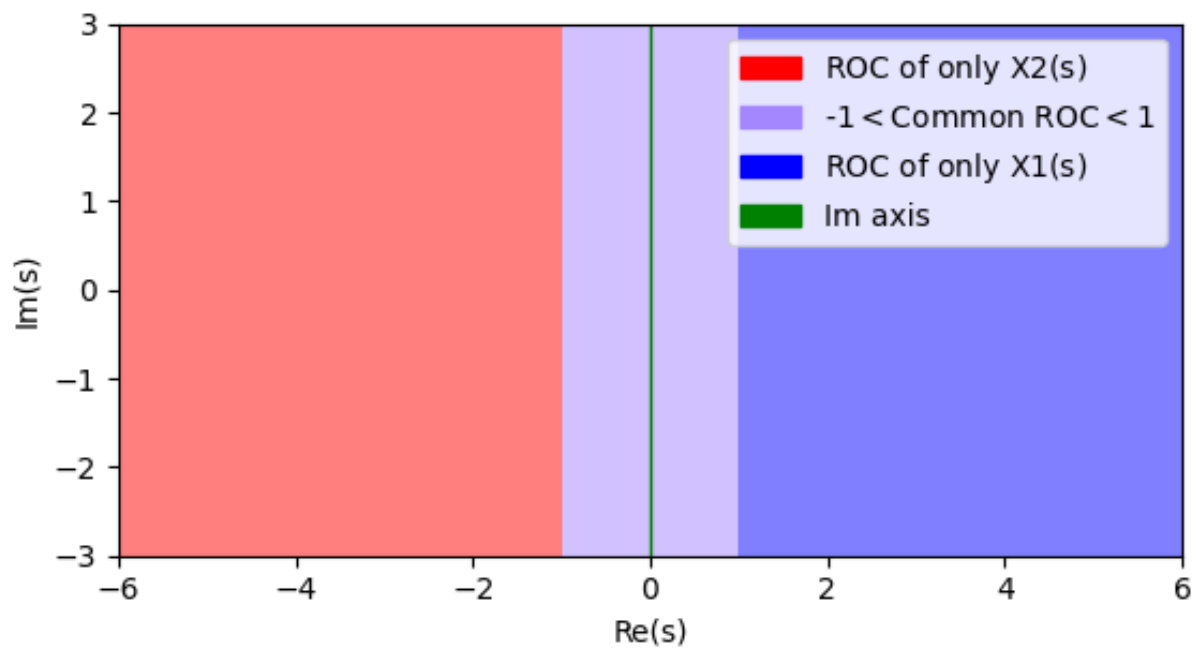


Fig. 1. ROC of  $X_1(s)$  and  $X_2(s)$