

# GATE 2022 -ECE 38

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**Question:** For the circuit shown, the locus of the impedance  $Z(j\omega)$  is plotted as  $\omega$  increases from zero to infinity. The values of  $R_1$  and  $R_2$  are:

- (A)  $R_1 = 2 \text{ k}\Omega, R_2 = 3 \text{ k}\Omega$   
 (B)  $R_1 = 5 \text{ k}\Omega, R_2 = 2 \text{ k}\Omega$   
 (C)  $R_1 = 5 \text{ k}\Omega, R_2 = 2.5 \text{ k}\Omega$   
 (D)  $R_1 = 2 \text{ k}\Omega, R_2 = 5 \text{ k}\Omega$

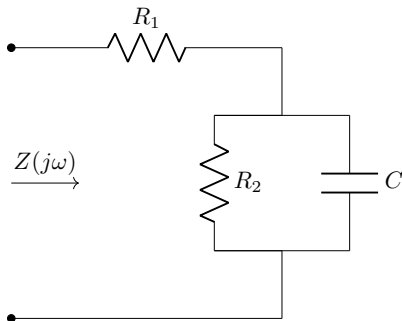


Fig. 1. Figure of circuit

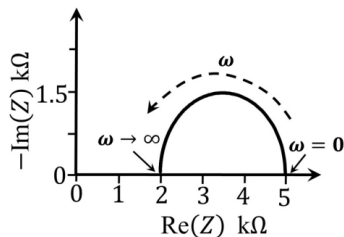


Fig. 2.

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**Solution:**

Parameter	Description	Value
$Z(j\omega)$	Impedance of circuit	?
$R_1$	Resistor 1	?
$R_2$	Resistor 2	?
$C$	Capacitor	?
$\omega$	angular frequency of input voltage	$\omega$

TABLE I  
INPUT VALUES

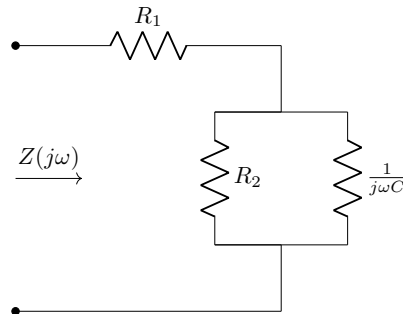


Fig. 3.

the circuit in  $\omega$  domain is:

$$Z(j\omega) = R_1 + \frac{1}{\frac{1}{R_2} + j\omega C} \quad (1)$$

From Fig. 2,  $Z(j\omega) = 2$  as  $\omega \rightarrow \infty$  and  $Z(j\omega) = 5$  as  $\omega \rightarrow 0$

$$2 = R_1 + \lim_{\omega \rightarrow \infty} \frac{1}{\frac{1}{R_2} + j\omega C} \quad (2)$$

$$\Rightarrow 2 = R_1 + \lim_{\omega \rightarrow \infty} \frac{\frac{1}{R_2} - j\omega C}{\left(\frac{1}{R_2}\right)^2 + (\omega C)^2} \quad (3)$$

$$\therefore 2\Omega = R_1 \quad (4)$$

$$5 = R_1 + \frac{1}{\frac{1}{R_2} + j(0)} \quad (5)$$

$$\Rightarrow 5 = R_1 + R_2 \quad (6)$$

$$\therefore 3\Omega = R_2 \quad (7)$$

Hence, option (A) is correct.

In  $\omega$  domain (i.e. after Laplace transform) Fig. 1 can be represented as Fig. 3 So, the impedance for