Gate Assignment

EE:1205 Signals and Systems
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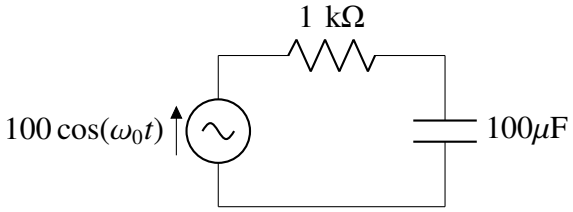
Question: In the circuit shown below, the amplitudes of the voltage across the resistor and the capacitor are equal. What is the value of the angular frequency ω_o (in rad/s)? (Round off the answer to one decimal place.) (GATE BM 32 2023)



Solution:

Parameter	Value	Description
$v(t)$	$100cos(\omega_0 t)$	Input Voltage
R	1 kΩ	Resistance
C	100μF	Capacitance
ω_0	?	Angular Frequency
$Z_R = R$	10^3	Impedance for resistor
$Z_C = \frac{1}{j\omega C}$	$\frac{10^4}{j\omega_0}$	Impedance for capacitor
$Z = R + \frac{1}{j\omega C}$	$10^3 + \frac{10^4}{j\omega_0}$	Total Impedance

TABLE 1
PARAMETER TABLE

$$R \overset{\mathcal{F}}{\longleftrightarrow} R \tag{1}$$

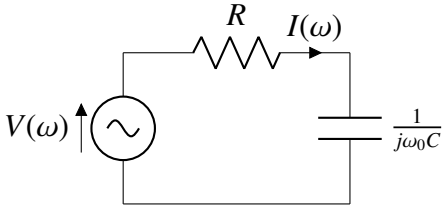
$$C \overset{\mathcal{F}}{\longleftrightarrow} \frac{1}{j\omega_0 C} \tag{2}$$

$$|V_R(\omega)| = |V_C(\omega)| \tag{3}$$

$$\implies |Z_R| = |Z_C| \tag{4}$$

$$10^3 = \frac{10^4}{\omega_0} \tag{5}$$

$$\therefore \omega_0 = 10.0 \tag{6}$$



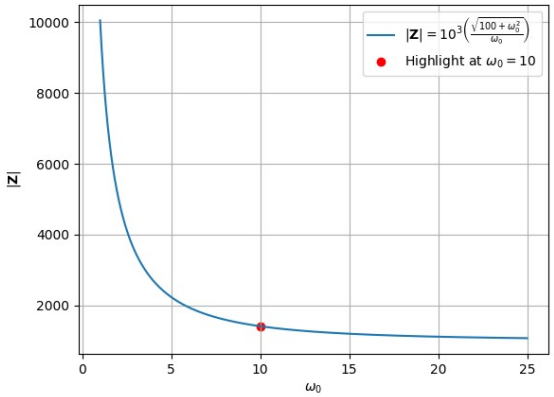


Fig. 1. Plot of $|Z| = 10^3(\frac{\sqrt{100+\omega_0^2}}{\omega_0})$

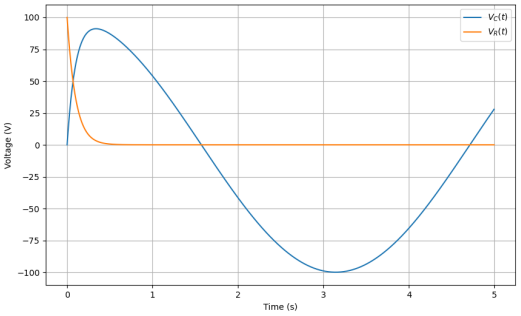


Fig. 2. Plot of Voltage Across Capacitor and Resistor