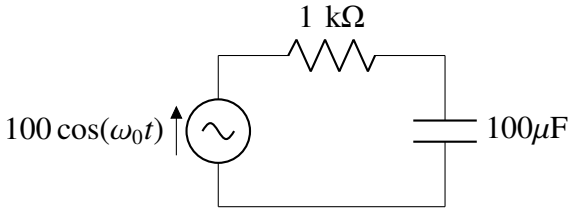
Gate Assignment

EE:1205 Signals and Systems
Indian Institute of Technology, Hyderabad

Kunal Thorawade
EE23BTECH11035

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:

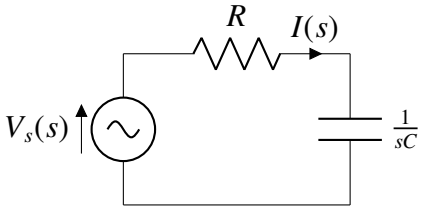
Parameter	Value	Description
$v(t)$	$100cos(\omega_0 t)$	Input Voltage
R	1 kΩ	Resistance
C	100μF	Capacitance
ω_0	?	Angular Frequency
$Z_R = R$	10^3	Impedance for resistor
$Z_C = \frac{1}{sC}$	$\frac{10^4}{s}$	Impedance for capacitor
$H(s)$	$\frac{I(s)}{V(s)}$	Transfer Function

TABLE 1
Parameter Table

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

$$C \overset{\mathcal{L}}{\longleftrightarrow} \frac{1}{sC} \tag{2}$$

$$\tag{3}$$



$$H(s) = \frac{I(s)}{V(s)} \tag{4}$$

$$H(s) = \frac{1}{R + \frac{1}{sC}} \tag{5}$$

$$H(s) = \frac{1}{10^3 + \frac{10^4}{s}} \tag{6}$$

$$H(s) = \frac{10^{-3}s}{10 + s} \tag{7}$$

Put $s = j\omega$,

$$H(\omega) = \frac{10^{-3}j\omega}{10 + j\omega} \tag{8}$$

$$|H(\omega)| = \frac{10^{-3}\omega}{\sqrt{100 + \omega^2}} \tag{9}$$

At resonant frequency $H(\omega)$ will have maximum value, $H(\omega)$ will be maximum at $\omega = 10$

$$\therefore \omega_0 = 10.0 rad/s \tag{10}$$