GATE -BM 16

EE23BTECH11057 - Shakunaveti Sai Sri Ram Varun

Question: For the circuit given below, choose the angular frequency ω_0 at which voltage across capacitor has maximum amplitude?

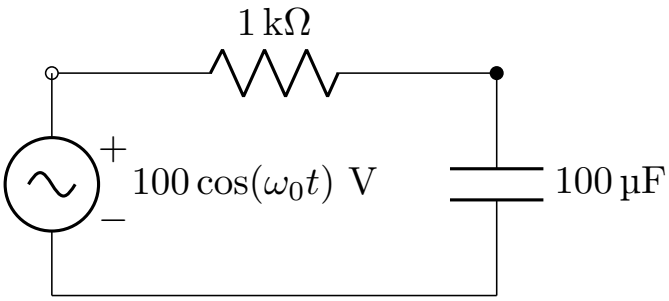

Fig. 1. circuit

(A) 1000

(B) 100

(C) 1

(D) 0

(GATE BM 2023 question 16)

Solution:

Parameter	Description	Value
$V_i(j\omega)$	Input voltage	100
$v_c(t)$	Potential difference across Capacitor	?
$V_c(s)$	Potential difference across Capacitor	$V_c(s)$
$H(s)$	Transfer function	$\frac{V_c(s)}{V_i(s)}$
V_o	Amplitude of input voltage	100 V
R	Resistance in circuit	1 kΩ
C	Capacitace in circuit	100 µF
ω_o	angular frequency of input voltage	ω_o

TABLE I
INPUT VALUES

$$V_c(s) = \frac{V_1(s)\frac{1}{sC}}{R + \frac{1}{sC}} \tag{1}$$

$$\implies H(s) = \frac{1}{1 + sRC} \tag{2}$$

$$\implies H(j\omega) = \frac{1}{1 + j\omega RC} \tag{3}$$

$$|H(j\omega)| = \frac{1}{\sqrt{1 + (\omega RC)^2}} \tag{4}$$

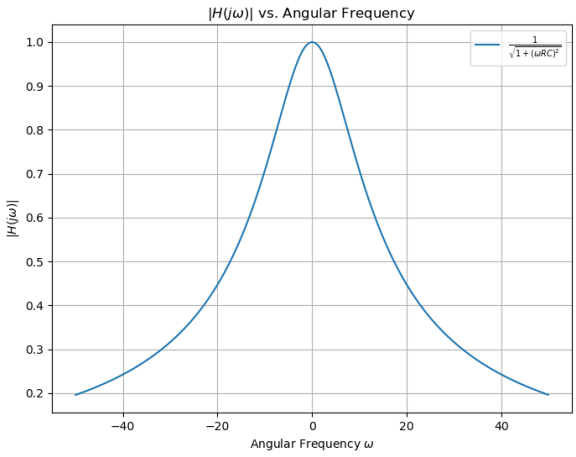

Fig. 2. $|H(j\omega)|$

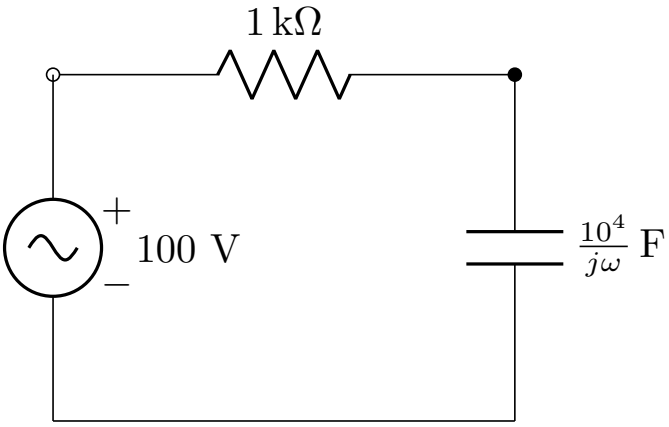

Fig. 3. circuit in ω-domain

$$v_c(t) = \frac{100}{\sqrt{1 + (\omega_o RC)^2}} \left(\cos \omega_o t + \arctan\left(\frac{1}{\omega_o RC} \right) \right) \tag{5}$$

Maximum amplitude of $v_c(t)$ occurs at $\omega_o = 0$

$$\therefore \omega_o = 0 \tag{6}$$

$\therefore$ maximum value of $v_c(t)$ at steady state is 100 Volts.