EE23BTECH11054 - Sai Krishna Shanigarapu*

Gate EE 2023

54. In a circuit, there is a series connection of an ideal resistor and an ideal capacitor. The conduction current (in Amperes) through the resistor is $2\sin\left(t+\frac{\pi}{2}\right)$. The displacement current (in Amperes) through the capacitor is _____.

(A) $2\sin(t)$
(B) $2\sin(t+\pi)$
(C) $2\sin\left(t+\frac{\pi}{2}\right)$
(D) 0

(GATE EC 2022)

Solution:

Parameter	Description	Remarks
i_c	Conduction Current	$2\sin\left(t+\frac{\pi}{2}\right)$
i_d	Displacement current	?
J	Current density	$\overline{J_c}+\overline{J_d}$
J_c	Conduction current density	
J_d	Displacement current density	

TABLE I
Parameters

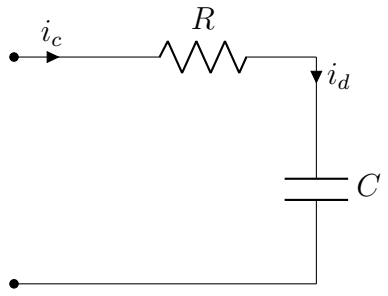

Fig. 1. Circuit 1

From Table I

$$J = \overline{J_c} + \overline{J_d} \tag{1}$$

From figure 3,
$\overline{J_d}$ leads $\overline{J_c}$ by $\frac{\pi}{2}$ $\implies$ i_d leads i_c by $\frac{\pi}{2}$

Hence,

$$i_d = 2\sin\left(t+\frac{\pi}{2}+\frac{\pi}{2}\right) \tag{2}$$

$$\implies i_d = 2\sin(t+\pi) \tag{3}$$

$\therefore$ (B) is correct.

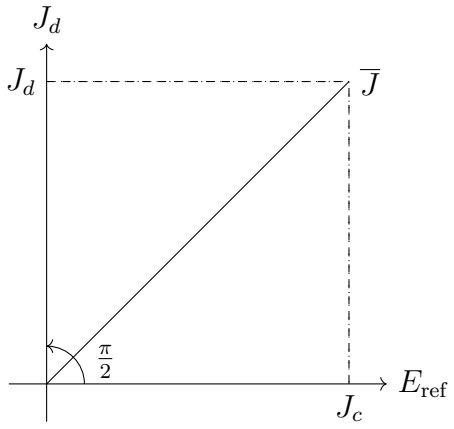

Fig. 2. Phasor plot

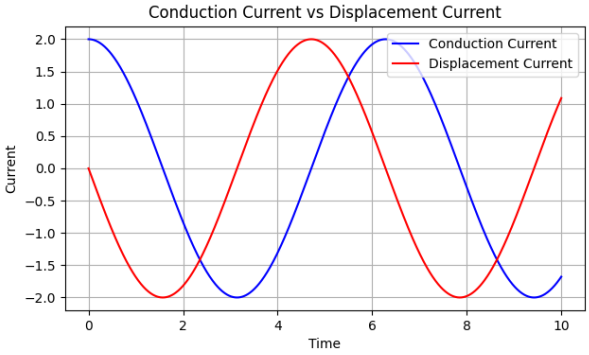

Fig. 3. Plot of i_c and i_d vs time