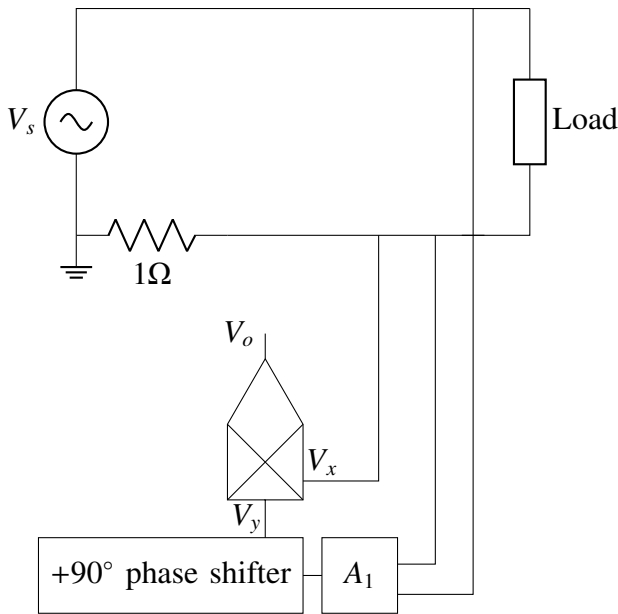


IN-2023

EE23BTECH1153-R.Rahul*

QUESTION:

61. In the diagram shown, the frequency of the sinusoidal source voltage V_s is 50 Hz. The load voltage is 230 V (RMS), and the load impedance is $\frac{230}{\sqrt{2}} + j\frac{230}{\sqrt{2}} \Omega$. The value of attenuator $A_1 = \frac{1}{50\sqrt{2}}$. The multiplier output voltage $V_o = \frac{V_x V_y}{1V}$, where V_x and V_y are the inputs. The magnitude of the average value of the multiplier output V_0 is _____ V



| Parameter | Description | Value |
|------------------------|---------------------------|---|
| V_s | sinusoidal Source voltage | 230 V(RMS) |
| V_1 | voltage across attenuator | |
| $V_x \text{ and } V_y$ | inputs voltages | |
| A_1 | attenuator | $\frac{1}{50\sqrt{2}}$ |
| Z | Load Impedance | $\frac{230}{\sqrt{2}} + j\frac{230}{\sqrt{2}} \Omega$ |
| V_0 | output voltage | $V_0 = \frac{V_x V_y}{1V}$ |

TABLE I
VARIABLES

2) voltage at attenuator

$$V_1 = V_s A_1 \quad (4)$$

$$= 230 \frac{1}{50\sqrt{2}} V \quad (5)$$

$$= \frac{4.6}{\sqrt{2}} V \quad (6)$$

$$V_y = 4.6 \sin(\omega t + 90^\circ) \quad (7)$$

$$V_x = I \times 1\Omega \quad (8)$$

$$= 2\sqrt{2} \sin(\omega t - 45^\circ) \quad (9)$$

$$V_0 = 9.2\sqrt{2} \left(\frac{\cos(135) - \cos(2\omega t)}{2} \right) \quad (10)$$

$$= 4.6 - 4.6\sqrt{2} \cos(2\omega t) \quad (11)$$

$$(12)$$

3) Let $f(t) = 4.6 - 4.6\sqrt{2} \cos(2\omega t)$

$$V_o < \text{avg} > = \frac{1}{T} \int_0^T (4.6 - 4.6\sqrt{2} \cos(2\omega t)) dt \quad (13)$$

$$= \frac{\omega}{\pi} \left[\int_0^{\frac{\pi}{\omega}} 4.6 dt - 4.6\sqrt{2} \int_0^{\frac{\pi}{\omega}} \cos(2\omega t) dt \right] \quad (14)$$

$$= \frac{\omega}{\pi} \left[4.6 \frac{\pi}{\omega} - 4.6\sqrt{2} \left[\frac{\sin(2\pi)}{2\omega} \right] \right] \quad (15)$$

$$= 4.6 \quad (16)$$

Solution:

1) Let the current in load be I

$$I = \frac{V_s(\text{peak})}{Z} \quad (1)$$

$$= \frac{230\sqrt{2}}{\frac{230}{\sqrt{2}} + j\frac{230}{\sqrt{2}}} \quad (2)$$

$$= \sqrt{2}(1 - j) \quad (3)$$

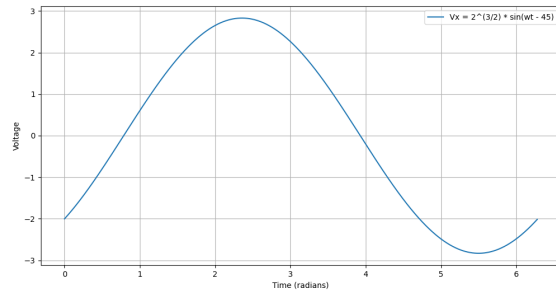


Fig. 1. $\text{plotof}V_x$

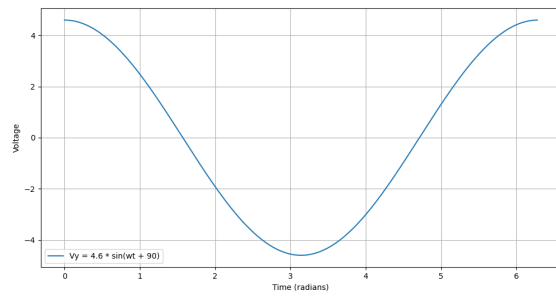


Fig. 2. $\text{plotof}V_y$

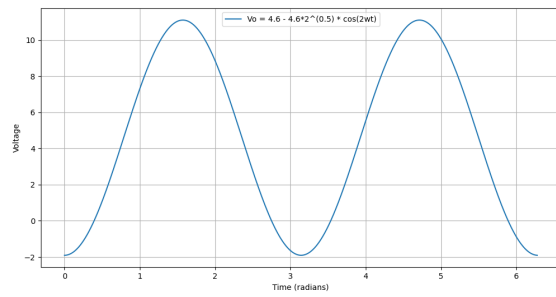


Fig. 3. $\text{plotof}V_o$