IN-2023

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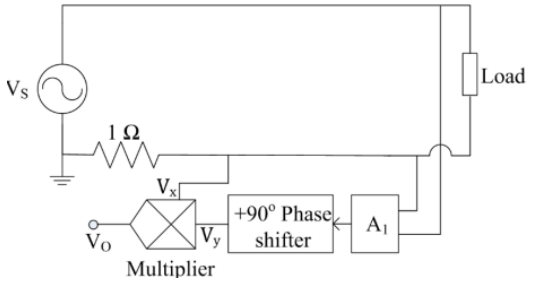
QUESTION:

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 $\frac{230}{\sqrt{2}}+j\frac{230}{\sqrt{2}}$ Ω. 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	
$V_x and V_y$	inputs voltages	
A_1	attenuator	$\frac{1}{50\sqrt{2}}$
Z	Load Impedance	$\frac{230}{\sqrt{2}} + j\frac{230}{\sqrt{2}}$ Ω
V_0	output voltage	$V_0 = \frac{V_x V_y}{1V}$

TABLE I
VARIABLES

Let the curret in load be I

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

$$= \frac{230\sqrt{2}}{\frac{230}{\sqrt{2}} + j\frac{230}{\sqrt{2}}} \tag{2}$$

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

voltage at attenuator

$$V_1 = V_s A_1 \tag{4}$$

$$= 230\frac{1}{50\sqrt{2}}V \tag{5}$$

$$= \frac{4.6}{\sqrt{2}}V \tag{6}$$

$$V_y = 4.6\sin(\omega t + 90) \tag{7}$$

$$V_x = 2\sqrt{2}\sin(\omega t - 45) \tag{8}$$

$$V_0 = 9.2\sqrt{2}(\frac{\cos(135) - \cos(2\omega t)}{2}) \tag{9}$$

$$= 4.6 - 4.6\sqrt{2}\cos(2\omega t) \tag{10}$$

$$V_0 < avg > = 4.6 \tag{11}$$