Q1

Solution:

given data

$V = 250 \sin(88^5)$

$P = 900 \sin^2(792t)$

$PF = 0.95$.

(a) $V_{rms} = \frac{V_m}{\sqrt{2}} \Rightarrow \frac{250}{\sqrt{2}} = 176.78V$

$$P_{av} = \frac{1}{2\pi} \int_0^{2\pi} 900 \sin^2(792t)\, dt$$

$$= \frac{1}{2\pi} \int_0^{2\pi} 900 \frac{1 - \cos 2(792t)}{2} dt$$

$\simeq 450\,W.$

Now for I_{rms}.

$$PF = \frac{P_{av}}{V_{rms} I_{rms}}$$

(b) $$I_{rms} = \frac{P_{av}}{V_{rms} PF}$$

$$= \frac{450}{176.78 \times 0.75} = 3.39A.$$

(c) $P_{absorbed} = P_{average}$.

$= 450W$

(d) Peak power $= 900W$.

(e) Apparent power $= V_{rms} \times I_{rms}$

$= \frac{250}{\sqrt{2}} \times 3.39 = 600W$.

Q2. from given data.

$$v(t) = \begin{cases} 20V & 0 < t < 10ms \\ 0V & 10ms < t < 20ms \\ 20V & 20ms < t < 30ms \end{cases}$$

$$i(t) = \begin{cases} -30A & 0 < t < 9ms \\ 18A & 9ms < t < 20ms \end{cases}$$

(a) $P(t) = v(t) \times i(t) = \begin{cases} 20 \times -30 & 0 < t < 9ms \\ 20 \times 18 & 9ms < t < 10ms \\ 0 \times 18 & 10ms < t < 20ms \end{cases}$

(a) Average Power.

$$P = \frac{1}{T}\int_0^T P(t)\,dt.$$

$$= \frac{1}{20}\left[\int_0^9 -600\,dt + \int_9^{10} 360\,dt + \int_{10}^{20} 0\,dt\right]$$

$$= \frac{1}{20}\left[-5400 + 360\right] = -252\,W.$$

(b) At each instance. W_2

$$W_1 = \int_0^9 -600\,dt + \overbrace{\int_9^{10} 360\,dt}^{10}$$

$$E_1 = -600 \times 9\times10^{-3} \Rightarrow -5.45\,J$$
$$E_2 = 360 \times 1\times10^{-3} \Rightarrow 0.36\,J$$
$$E_3 = 0 \times 10\times10^{-3} \Rightarrow 0\,J.$$

(c) Voltage Rms.

$$V_{rms} = \sqrt{(18)^2 + \left(\frac{105}{\sqrt{2}}\right)^2 + \left(\frac{650}{\sqrt{2}}\right)^2 + \left(\frac{75}{\sqrt{2}}\right)^2 + \left(\frac{150}{\sqrt{2}}\right)^2}$$

$$= 480.78\,V$$

$$I_{rms} = \sqrt{(100)^2 + \left(\frac{120}{\sqrt{2}}\right)^2 + \left(\frac{25}{\sqrt{2}}\right)^2 + \left(\frac{90}{\sqrt{2}}\right)^2}$$

$$= 146.84\ A.$$

(b) Power absorbed by load.

$$P = V_0 I_0 + \sum V_{rms} I_{rms} \cos(\theta - \alpha)$$

$$P = 20391.87\ W$$

(c) PF

$$PF = \frac{P}{V_{rms} I_{rms}} \Rightarrow \frac{20391.87}{480.78 \times 146.84}$$

$$= 0.289$$

(d) $$THD = \sqrt{\frac{I_{rms}^2 - I_{1rms}^2}{I_{1rms}^2}}$$

$$= 1.41 \Rightarrow 141\ \%$$

Class work Q 3.

$i(\omega t) = 0.30\ A.$

$I_{rms} = 0.47 A.$