Question 1

Obtain the power factor and the apparent power of a load whose impedance is Z=60+j40 Ω when the applied voltage is v(t)= 320 cos (377t +10º) V.

Ans: 0.8321 lagging, 710<33.69º VA.

Question 2

For a load, $V_{rms} = 110 < 85^o$V and $I_{rms} = 0.4 < 15^o A$. Determine: (a) the complex and apparent powers, (b) the real and reactive powers, and (c) the power factor and the load impedance.

Ans: (a) 40<70º VA, 44 VA, (b) 15.05 W, 41.35 VAR, (c) 0.342 lagging, 94.06 + j258.4 Ω.

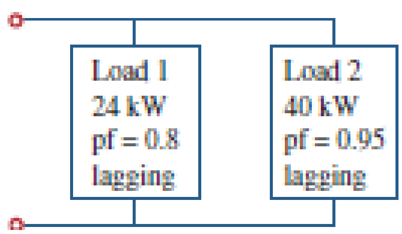
Question 3

Three loads are connected in parallel to a 120 <0º rms source. Load 1 absorbs 60 kVAR at pf 0.85 lagging, load 2 absorbs 90 kW and 50 kVAR leading, and load 3 absorbs 100 kW at pf 1. (a) Find the equivalent impedance. (b) Calculate the power factor of the parallel combination. (c) Determine the current supplied by the source.

Ans:

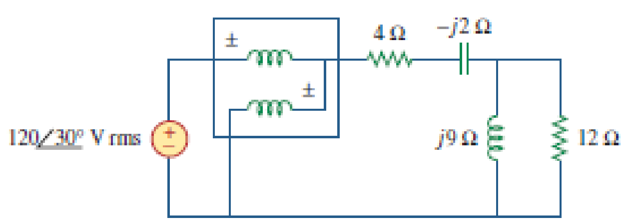
Question 4

A 120-V rms 60-Hz source supplies two loads connected in parallel, as shown in Fig. 11.89. (a) Find the power factor of the parallel combination. (b) Calculate the value of the capacitance connected in parallel that will raise the power factor to unity.



Question 5

For the circuit in following Fig., find the wattmeter reading.



Ans: 1.437 kW.

1.

The load impedance is

$$\mathbf{Z} = 60 + j40 = 72.11\angle 33.7°\ \Omega$$

The power factor is

$$\text{pf} = \cos(33.7°) = \underline{\mathbf{0.832 \quad (lagging)}}$$

Since the load is inductive

$$\mathbf{I} = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{150\angle 10°}{72.11\angle 33.7°} = 2.08\angle -23.7°\ \text{A}$$

The apparent power is

$$S = V_{rms} I_{rms} = \frac{1}{2}(150)(2.08) = \underline{\mathbf{156\ VA}}$$

2.

(a) $\mathbf{S} = \mathbf{V}_{rms}\mathbf{I}^*_{rms} = (110\angle 85°)(0.4\angle -15°)$

$\mathbf{S} = \underline{\mathbf{44\angle 70°\ VA}}$

$S = |\mathbf{S}| = \underline{\mathbf{44\ VA}}$

(b) $\mathbf{S} = 44\angle 70° = 15.05 + j41.35$

$P = \underline{\mathbf{15.05\ W}}$, $Q = \underline{\mathbf{41.35\ VAR}}$

(c) $\text{pf} = \cos(70°) = \underline{\mathbf{0.342 \quad (lagging)}}$

$$\mathbf{Z} = \frac{\mathbf{V}_{rms}}{\mathbf{I}_{rms}} = \frac{110\angle 85°}{0.4\angle -15°} = 275\angle 70°$$

$$\mathbf{Z} = \mathbf{94.06 + j258.4\ \Omega}$$

3.

(a) For load 1,

$Q_1 = 60$ kVAR, pf = 0.85 or $\theta_1 = 31.79°$

$Q_1 = S_1 \sin\theta_1 = 60k$ or $S_1 = 113.89k$ and $P_1 = 113.89\cos(31.79) = 96.8kW$

$\mathbf{S_1} = 96.8 + j60$ kVA

For load 2, $\mathbf{S_2} = 90 - j50$ kVA

For load 3, $\mathbf{S_3} = 100$ kVA

Hence,

$\mathbf{S} = \mathbf{S_1} + \mathbf{S_2} + \mathbf{S_3} = 286.8 + j10\text{kVA} = 287\angle 2°\text{kVA}$

But $\mathbf{S} = (V_{rms})^2/Z^*$ or $Z^* = 120^2/287\angle 2°\text{k} = 0.05017\angle{-2°}$

Thus, $Z = \underline{\mathbf{0.05017\angle 2°\Omega}}$ or $\underline{\mathbf{0.05014 + j0.0017509\Omega}}$.

(b) From above, pf = cos2° = $\underline{\mathbf{0.9994}}$.

(c) $I_{rms} = V_{rms}/Z = 120/0.05017\angle 2° = \underline{\mathbf{2.392\angle{-2°}kA}}$ or $\underline{\mathbf{2.391 - j0.08348kA}}$.

4.

(a)

$$\theta_1 = \cos^{-1}(0.8) = 36.87°$$

$$S_1 = \frac{P_1}{\cos\theta_1} = \frac{24}{0.8} = 30 \text{ kVA}$$

$$Q_1 = S_1 \sin\theta_1 = (30)(0.6) = 18 \text{ kVAR}$$

$$\mathbf{S}_1 = 24 + j18 \text{ kVA}$$

$$\theta_2 = \cos^{-1}(0.95) = 18.19°$$

$$S_2 = \frac{P_2}{\cos\theta_2} = \frac{40}{0.95} = 42.105 \text{ kVA}$$

$$Q_2 = S_2 \sin\theta_2 = 13.144 \text{ kVAR}$$

$$\mathbf{S}_2 = 40 + j13.144 \text{ kVA}$$

$$\mathbf{S} = \mathbf{S}_1 + \mathbf{S}_2 = 64 + j31.144 \text{ kVA}$$

$$\theta = \tan^{-1}\left(\frac{31.144}{64}\right) = 25.95°$$

$$\text{pf} = \cos\theta = \underline{\mathbf{0.8992}}$$

(b)

$$\theta_2 = 25.95°, \qquad \theta_1 = 0°$$

$$Q_c = P[\tan\theta_2 - \tan\theta_1] = 64[\tan(25.95°) - 0] = 31.144 \text{ kVAR}$$

$$C = \frac{Q_c}{\omega V_{rms}^2} = \frac{31{,}144}{(2\pi)(60)(120)^2} = \underline{\mathbf{5.74\ mF}}$$

5.

Let $\mathbf{Z}_1 = 4 - j2$

$$\mathbf{Z}_2 = 12 \parallel j9 = \frac{(12)(j9)}{12 + j9} = 4.32 + j5.76$$

$$\mathbf{Z} = \mathbf{Z}_1 + \mathbf{Z}_2 = 8.32 + j3.76 = 9.13\angle 24.32^\circ$$

$$\mathbf{S} = \mathbf{V}\,\mathbf{I}^* = \frac{\left|\mathbf{V}\right|^2}{\mathbf{Z}^*} = \frac{(120)^2}{9.13\angle -24.32^\circ} = 1577.2\angle 24.32^\circ \text{ kVA}$$

$$\mathrm{P} = \left|\mathbf{S}\right| \cos\theta = \underline{\mathbf{1437\ kW}}$$