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Homework 3: due 2/3/2020

12. A single-phase motor draws a current of $12A$ at a power factor of 60%. Calculate the in phase and quadrature components of current I_p and I_q with respect to the line voltage.

$$I_S = 12A;\ pf = 0.6 \tag{1}$$
$$I_p = I_S(pf);\ I_q = I_S(sin(cos^{-1}(pf)))$$
$$I_p = 12A \times 0.6$$
$$|\underline{\overline{I_p = 7.2A}}|$$
$$I_q = 12A \times (sin(cos^{-1}(0.6))) = 12A \times 0.8$$
$$|\underline{\overline{I_q = 9.6A}}|$$

15. Using only power triangle concepts and without drawing any phasor diagrams, calculate the impedance of the circuits below.

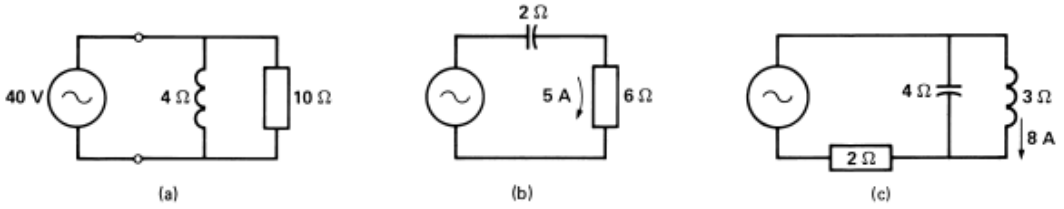

Figure 25
See Problem 15.

$$Q_L = \frac{V^2}{X_L} = \frac{(40V)^2}{4\Omega} = 400VAR \tag{2}$$
$$P = \frac{V^2}{R} = \frac{(40V)^2}{10\Omega} = 160W$$
$$S = \sqrt{P^2 + Q^2} = \sqrt{(160W)^2 + (400VAR)^2}$$
$$S \approx 431VA$$
$$Z = \frac{V^2}{S}\angle(cos^{-1}(\frac{P}{S})) = \frac{(40V)^2}{431VA}\angle(cos^{-1}(\frac{160W}{431VA}))$$
$$|\underline{\overline{Z \approx 3.71\Omega\angle 68^\circ}}|$$
$$Q_L = I^2X_C = (5A)^2 2\Omega = -50VAR \tag{3}$$
$$P = I^2R = (5A)^2 6\Omega = 150W$$
$$S = \sqrt{P^2 + Q^2} = \sqrt{(150W)^2 + (-50VAR)^2}$$
$$S \approx 158VA$$
$$Z = \frac{S}{I^2}\angle(cos^{-1}(\frac{P}{S})) = \frac{158VA}{(5A)^2}\angle(cos^{-1}(\frac{150W}{158VA}))$$
$$|\underline{\overline{Z \approx 6.3\Omega\angle 18^\circ}}|$$

$$
\begin{aligned}
Q_L = I^2 X_C = (5A)^2 2\Omega = -50VAR \\
P = I^2 R = (5A)^2 6\Omega = 150W \\
S = \sqrt{P^2 + Q^2} = \sqrt{(150W)^2 + (-50VAR)^2} \\
S \approx 158VA \\
Z = \frac{S}{I^2} \angle (cos^{-1}(\frac{P}{S})) = \frac{158VA}{(5A)^2} \angle (cos^{-1}(\frac{150W}{158VA})) \\
|\underline{\overline{Z \approx 6.3\Omega \angle 18^\circ}}|
\end{aligned} \tag{4}
$$

20. If a $500VAR$ is put in parallel with a $3840VA; pf = 0.72$ motor, calculate

    1. Active power.
       The active power is unchanged at $2765W$, because the only thing we added was a capacitor, which is purely reactive power.
    2. The apparent power of the system.

$$
\begin{aligned}
S = \sqrt{P^2 + Q^2};\ P = 2765W; \\
Q_C = -500VAR;\ Q_L \approx 2664VAR \\
S = \sqrt{(2765W)^2 + (2664 - 500VAR)^2} \\
sqrt((2765^2) + (answer(18) - 500)^2) |\underline{\overline{S \approx 3511VA}}|
\end{aligned} \tag{5}
$$

    3. The power factor of the system.

$$
\begin{aligned}
pf = \frac{P}{S};\ P = 2765W;\ S = 3511VA \\
pf = \frac{2765W}{3511VA} \\
|\underline{\overline{pf \approx 0.79}}|
\end{aligned} \tag{6}
$$

21. A coil having a reactance of 10Ω and a resistance of 2Ω is connected in parallel with a capacitive reactance of 10Ω. If the supply voltage is $200V$, calculate

    1. The reactive power generated by the coil

$$
\begin{aligned}
Q = \frac{V^2}{X_L} = \frac{(200V)^2}{10\Omega} \\
|\underline{\overline{Q = 4kVAR}}|
\end{aligned} \tag{7}
$$

    2. The reactive power generated by the capacitor

$$
\begin{aligned}
Q = \frac{V^2}{X_C} = \frac{(200V)^2}{10\Omega} \\
|\underline{\overline{Q = -4kVAR}}|
\end{aligned} \tag{8}
$$

    3. The active power dissipated by the coil

$$P = \frac{V^2}{R} = \frac{(200V)^2}{2\Omega} \tag{9}$$
$$|\underline{\overline{P = 20kW}}|$$

4. The apparent power of the circuit

$$S = \sqrt{P^2 + (\sum Q)^2} \tag{10}$$
$$S = \sqrt{(20kW)^2 + (4kVAR - 4kVAR)^2}$$
$$|\underline{\overline{S = 20kVA}}|$$

26. A capacitor bank has a resistor connected to it, to dissipate voltage after its been disconnected. It should have $\leq 50V$ after 1 minute of disconnection. Calculate the discharge resistance required for a $30kVAR,\ 480V$ capacitor. Then, calculate the wattage rating for the resistor.

$$30kVAR;\ 480V;\ C \approx 345\mu F \tag{11}$$
$$V(0) = 480V;\ V_0 = 480V$$
$$V_0 e^{\frac{-t}{RC}} = V(t)$$
$$R = \frac{60}{\approx 345\mu F(ln(\frac{5}{48}))}$$
$$R \approx 76k\Omega$$
$$P = \frac{V^2}{R} = \frac{480^2}{76k\Omega}$$
$$|\underline{\overline{R \approx 76k\Omega;\ P \approx 3W}}|$$