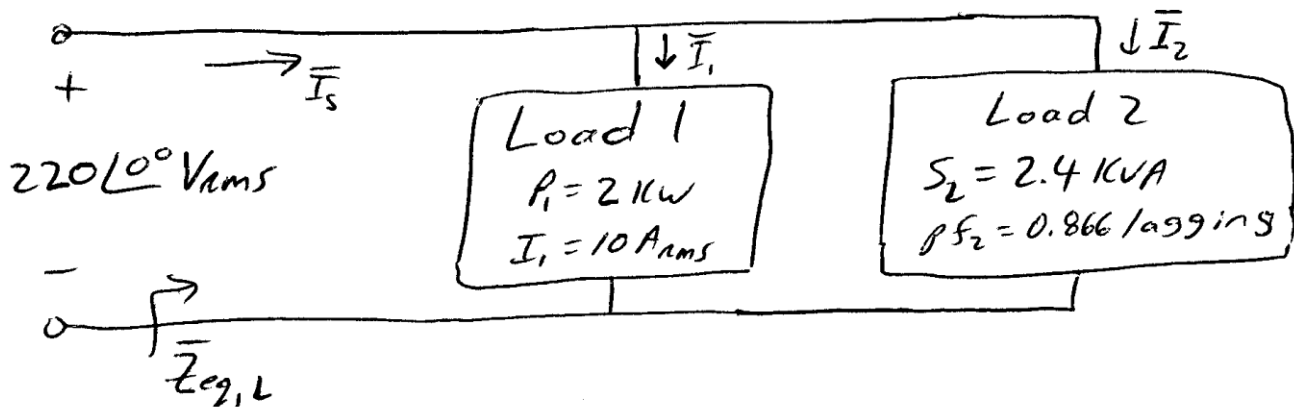


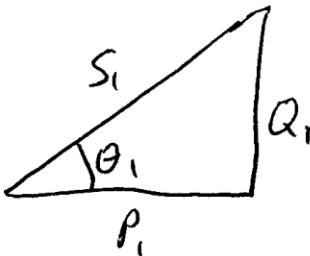
Example- A 220 V_{RMS} power line supplies two load connected in parallel. Load 1 is an AC motor circuit drawing a current of 10 A_{RMS} (measured using a multimeter) and power of 2 kW (measured using a wattmeter). Load 2 is a combination of lights and motors drawing 10.09 A_{RMS} ($S_2 = 220 \cdot 10.09 = 2.4 \text{ kVA}$) with a lagging power factor of 0.866. Analyze each load as well as the overall equivalent load on the power line circuit. [Hint: Motors are resistive-inductive loads.]

⇒ Assume power line is @ 0° (reference)



Load 1

motor ⇒ lagging pf



$$S_1 = V_{1,\text{rms}} I_{1,\text{rms}} = 220(10) = \underline{2200 \text{ VA}}$$

$$P_1 = 2000 \text{ W (given)}$$

$$\cos \theta_1 = \frac{P_1}{S_1} = \frac{2000}{2200} = \underline{0.9091 \text{ lagging} = \text{pf}_1}$$

$$\theta_1 = \cos^{-1} 0.9091 = \underline{24.62^\circ} = \theta_{V_1} - \theta_{I_1}$$

$$\hookrightarrow \theta_{I_1} = \underline{-24.62^\circ}$$

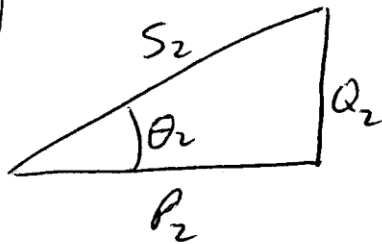
$$\underline{\vec{I}_1 = 10 \angle -24.62^\circ \text{ A}_{\text{rms}}}$$

$$Q_1 = S_1 \sin \theta_1 = 2200 \sin 24.62^\circ = \underline{916.516 \text{ VAR}}$$

$$\vec{Z}_1 = \frac{\vec{V}_1}{\vec{I}_1} = \frac{220 \angle 0^\circ}{10 \angle -24.62^\circ} = \underline{22 \angle 24.62^\circ \Omega} = \underline{20 + j9.16516 \Omega}$$

$$\underline{\vec{S}_1 = P_1 + jQ_1 = 2000 + j916.516 \text{ VA} = 2200 \angle 24.62^\circ \text{ VA}}$$

Load 2



$$S_2 = 2400 \text{ VA}$$

$$\text{pf}_2 = 0.866 \text{ lagging} = \cos \theta_2$$

$$\hookrightarrow \theta_2 = +30^\circ = \phi_{V_2} - \theta_{I_2}$$

lagging

$$\theta_{I_2} = -30^\circ$$

$$I_2 = \frac{S_2}{V_2} = \frac{2400}{220} = 10.9091 \text{ A}_{\text{rms}}$$

$$\underline{\underline{\bar{I}_2 = 10.9091 \angle -30^\circ \text{ A}_{\text{rms}}}}$$

$$\bar{S}_2 = \bar{V}_2 \bar{I}_2^* = (220 \angle 0^\circ) (10.9091 \angle +30^\circ)$$

$$= 2078.46 + j 1200 \text{ VA}$$

$$\uparrow$$

$$P_2 (\text{W})$$

$$\uparrow$$

$$Q_2 (\text{VAR})$$

$$\bar{Z}_2 = \frac{\bar{V}_2}{\bar{I}_2} = \frac{220 \angle 0^\circ}{10.9091 \angle -30^\circ} = 20.166 \angle 30^\circ \Omega$$

$$= 17.465 + j 10.083 \Omega$$

$$\bar{S}_{\text{power line}} = \bar{S}_1 + \bar{S}_2 = 2200 \angle 24.62^\circ + 2400 \angle 30^\circ$$

$$= 4594.94 \angle 27.427^\circ \text{ VA} = 4078.46 + j 2116.516 \text{ VA}$$

$$\uparrow$$

$$P_{\text{power line}}$$

$$\uparrow$$

$$Q_{\text{power line}}$$

$$\text{pf}_{\text{overall}} = \cos 27.427^\circ = 0.8876 \text{ (lagging)}$$

$$\bar{I}_s = \bar{I}_1 + \bar{I}_2 = 10 \angle -24.62^\circ + 10.9091 \angle -30^\circ = 20.886 \angle -27.427^\circ \text{ A}_{\text{RMS}}$$

$$\bar{Z}_{\text{overall}} = \bar{Z}_1 \parallel \bar{Z}_2 = \frac{\bar{V}_s}{\bar{I}_s} = 10.53 \angle 27.427^\circ \Omega = 9.35 + j 4.85 \Omega$$