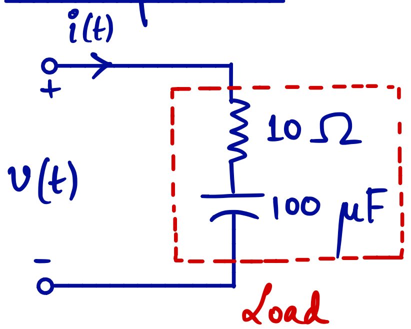
Let us put our knowledge to good use.

Example 1



Suppose $v(t) = 120\sqrt{2}\cos(377t)$, where t is measured in seconds.

Compute $i(t)$, the apparent power drawn by the load, and its power factor

Remark: If we do not use phasors, notice that we have to utilize $i(t) = C \cdot \frac{d}{dt} v_c$, where $C = 100\,\mu F$, and v_c equals the voltage across the capacitor. Computing the current may require the solution of a differential equation. Using phasors, that computation becomes extremely simple!

Impedance of load $(\bar{Z}) := 10\,\Omega + \dfrac{1}{j\omega(100\,\mu F)}$,

where $\omega = 377$ rad/s.

$\therefore\ \bar{Z} = (10.00 - j\,26.53)\,\Omega$

Voltage phasor $\bar{V}$ corresponding to $v(t)$ is given by $120\,e^{j0}$ .... written as $120\angle 0$.

$$\Rightarrow \bar{I} = \frac{\bar{V}}{\bar{Z}} = \frac{120\angle 0}{10.00 - j\,26.53}\ A = (1.49 + j3.96)\ A$$

In "polar" form, $\bar{I} = 4.23\angle 1.21\ A$

$= 4.23\angle 69.33^\circ\ A.$

$$\Rightarrow i(t) = 4.23\sqrt{2}\cos(377t + 1.21).$$

$$= 5.98\cos(377t + 1.21).$$

$$\bar{S} = \bar{V}\bar{I}^*$$

$$= (120\angle 0)\cdot(4.23\angle 69.33^\circ)^*\ VA$$

$$= 507.60\angle -69.33^\circ\ VA.$$

Power factor $= \cos(-69.33°) = 0.35$ leading.

Example #2

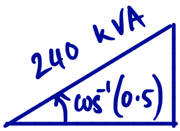
Consider a parallel array of loads drawing :

- 240 kVA at a power factor of 0.5 lagging
- 150 kW at a power factor of 0.9 leading
- $200 + j100$ kVA.

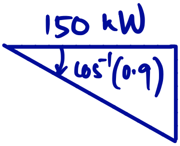
Q1. Find the net apparent power drawn by the load array.

Q2. How much VAR should be injected in parallel to the load array to make the resulting load have a power factor of 0.5 leading.

Let the apparent power draws of the three loads be given by $\bar{S}_1$, $\bar{S}_2$, and $\bar{S}_3$.



$$\bar{S}_1 = 240 \angle{+60^\circ} \text{ kVA}.$$



$$\bar{S}_2 = \frac{150}{\underbrace{0.9}} \angle{-\cos^{-1}(0.9)} \text{ kVA}.$$

why? answer it yourself!

$$= 166.67 \angle{-25.8^\circ} \text{ kVA}.$$

$$\bar{S}_3 = 200 + j100 \text{ kVA}$$

$$= 223.61 \angle 26.57^\circ$$

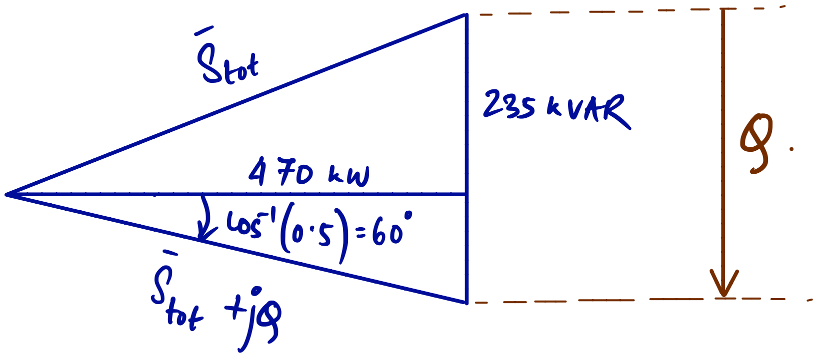
$\therefore$ Total power consumed by the load array is

$$\bar{S}_{tot} = 240\angle 60^\circ + 166.67\angle{-25.8^\circ} + 223.61\angle 26.57^\circ \text{ kVA}$$

$$= 525.67 \angle 26.6^\circ \text{ kVA}.$$

$$= (470 + j235) \text{ kVA}$$

To answer the second question, we need Q such that $\bar{S}_{tot} + jQ$ has a power factor of 0.5 leading. Let's solve graphically.



$$235 \text{ kVAR} + Q = -470 \tan 60^\circ \text{ kVAR}.$$

$$\Rightarrow Q = -1049 \text{ kVAR}.$$

$\therefore$ Reactive power to the tune of 1049 kVAR needs to extracted to achieve the desired power factor.