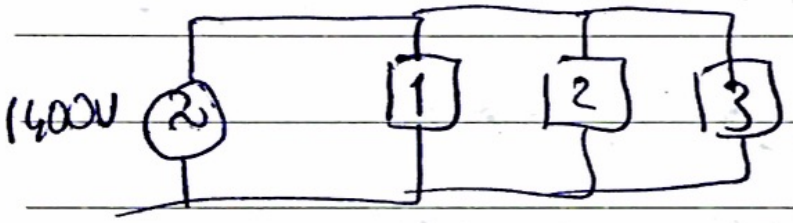
Example-2 :

Three loads are connected in parallel across a 1400V rms, 60Hz single-phase supply

Load 1: Inductive load, 125kVA, at 0,28pf

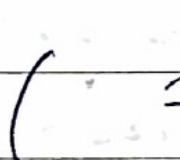
Load 2: Capacitive load, 10kW and 40kVAR

Load 3: Resistive load of 15kW



a) Find the total kW, kVAR, kVA and the supply power factor.

Load 1: (0,28 pf) $\Rightarrow$ $125 \times 0,28 = 35kW$



$\Rightarrow \sqrt{1^2 - 0,28^2} = 0,96 \Rightarrow 125 \times 0,96 = 120kVAR$

or $\cos(\theta) = 0,28 \Rightarrow \theta = 73,74°$ $S = \underbrace{|S|\cos(\theta)}_{\text{real part}} + j|S|\sin(\theta)$

$= 125 \times 0,28 + j|125| \cdot \frac{\sin(73,74)}{0,96}$

$S_1 = 35 + j\,120kVAR$

Load 2: $10kW - 40kVAR$

↳ inductive (+)
capacitive (−)

Load 3 $\Rightarrow 15kW + j0kVAR$

no reactive power on a resistor

$S_{tot} = S_1 + S_2 + S_3$

$= 35kW + j120kVAR$

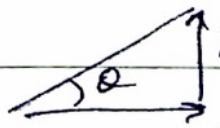
$10kW - j40kVAR$

$15kW + j0kVAR$

$60kW + 80kVAR$ → reactive power

$P \quad Q$

↳ inductive current ($\theta < 0°$)



$\Rightarrow S = 100k \angle 53°$

$I = \frac{S^*}{V^*}$ } $S = VI^*$ $I^* = S/V$

$\frac{100\angle 53}{1400} \Rightarrow 71.43 \angle -53°$

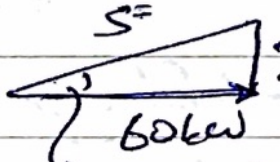
$pf = \cos(53°) \Rightarrow 0.6$ pf lagging

b) A capacitor of negligible resistance is connected in parallel with the above loads to improve the power factor to 0.8 lagging. Determine the kVAR rating of this capacitor and the capacitance in μF.

Capacitors don't consume real power.

$P = 60kW$

$pf = 0.8$



$\cos(\theta) = 0.8 \Rightarrow S = 75kVA$

$Q = 45kVAR$

$Q_{old} = 80kVAR \rightarrow Q_{new} = 45kVAR$

$Q_{capacitor} = -35kVAR$!

$$S_c^* = \frac{V^2}{X_c^*} = \frac{1400^2}{X_c^*} = 35kVAR \Rightarrow X_c = -J56\Omega$$

$$\frac{1}{j\omega C} = -J56 \Rightarrow C = 47{,}37pF$$

ω ↑ $2\pi f \Rightarrow$ ↑ 60Hz

$$I_{new} = \frac{S^*}{V^*} = \frac{60000 - J45000}{1400} = 53{,}57\angle -37°$$

~~71,43A~~ Instead of 71,4A now 53,5A is used