7.27 An electrical device draws 2kW power from AC mains (voltage 223V (rms) = $\sqrt{50,000}$ V). The current differs (lags) in phase by $\phi\left(\tan\phi = \frac{-3}{4}\right)$ as compared to voltage. Find (i) R, (ii) $X_C - X_L$, and (iii) I_M. Another device has twice the values for R, X_C and X_L. How are the answers affected?

27. $P = 2000\,\omega$; As current lags voltage ; so

$V^2 = 50,000$; $\tan\phi = -\frac{3}{4}$

As $P = \frac{V^2}{Z}$

$\Rightarrow 2000 = \frac{50000}{Z}$

$\Rightarrow \boxed{Z = 25\,\Omega}$

$\Rightarrow Z = \sqrt{R^2 + (X_C - X_L)^2}$

$\Rightarrow (25)^2 = R^2 + (X_C - X_L)^2$ — (1)

$$\Rightarrow \tan\phi = -\frac{3}{4}$$

$$\Rightarrow \frac{X_C - X_L}{R} = -\frac{3}{4} \quad \text{— (2)}$$

$$\Rightarrow (X_C - X_L)^2 = \frac{9}{16} R^2 \quad \text{— (3)}$$

From (1) & (3)

$$R^2 = 16 \times 25$$

$$\Rightarrow \boxed{R = 20\,\Omega}$$

From (2)

$$X_C - X_L = \left(-\frac{3}{4}\right)(20)$$

$$\Rightarrow \boxed{X_C - X_L = -15\,\Omega}$$

$$I_{rms} = \frac{V}{Z} = \frac{223}{25} \approx 9\,A$$

$$\therefore I_0 = \sqrt{2}\, I_{rms}$$

$$= 9\sqrt{2}\,A$$

$$= 12.6\,A$$

When all R, X_C, X_L are doubled; then $\tan\phi = \frac{X_C - X_L}{R}$ will remain same.

When Z is doubled; $I = \frac{V}{Z}$ becomes half as value of V doesn't change.

As I becomes half $P = VI$ will become again half as voltage remains same.