In a series LCR circuit $R = 200\Omega$ and the voltage and the frequency of the main supply is $220V$ and $50\ Hz$ respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30°. On taking out the inductor from the circuit the current leads the voltage by 30°. The power dissipated in the LCR circuit is

A. $305\ W$

B. $210\ W$

C. $zero\ W$

D. $242\ W$

4. In given LCR circuit,

$R = 200\Omega$ and $V_{rms} = 220V$, $\nu = 50 Hz$

$\Rightarrow \omega = 2\pi\nu \Rightarrow$ ~~100π~~ 100π rad/s

When capacitor is taken out, then it becomes L-R:-

$\Rightarrow \tan\phi = \frac{X_L}{R}$ ($\phi = 30°$ given)

$\Rightarrow \tan 30° = \frac{X_L}{200}$

$\Rightarrow X_L = \frac{200}{\sqrt{3}}\Omega$

When inductor is taken out, then it becomes R-C circuit:-

$\therefore \tan\phi = \frac{X_C}{R}$ ($\phi = 30°$ given)

$\Rightarrow \tan 30° = \frac{X_C}{200}$

$\Rightarrow X_C = \frac{200}{\sqrt{3}}\Omega$

Now, $X_C - X_L = \frac{200}{\sqrt{3}} - \frac{200}{\sqrt{3}} \Rightarrow 0$

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

$= \sqrt{(200)^2 + 0}$

$\Rightarrow \boxed{Z = 200\Omega}$

Hence $P_{dissipated} = (\mathcal{E}_{rms})(I_{rms})\cos\phi$

$$= (\mathcal{E}_{rms})\left(\frac{\mathcal{E}_{rms}}{Z}\right)\left(\frac{R}{Z}\right) \quad \left(\because \cos\phi = \frac{R}{Z}\right)$$

$$= \frac{(\mathcal{E}_{rms})^2 R}{(Z)^2}$$

$$= \frac{(220)^2 (200)}{(200)^2}$$

$$\boxed{P_{dissipated} = 242\,W}$$