538.

Problem 39.25 (RHK)

In an LCR circuit let $R = 160\ \Omega$, $C = 15\ \mu\text{F}$, $L = 230\ \text{mH}$, $\nu = 60\ \text{Hz}$ *and* $\text{E}_m = 36\ \text{V}$. *We have to calculate average power dissipated assuming* (a) *that the inductor is removed from the circuit and* (b) *that the capacitor is removed.*

Solution:

The inductive load

$$X_L = L\omega = 2\pi\nu L = 2\pi \times 60 \times 230 \times 10^{-3}\ \Omega = 87\ \Omega.$$

The capacitive load

$$X_C = \frac{1}{C\omega} = \frac{1}{15 \times 10^{-6} \times (2\pi \times 60)}\ \Omega = 177\ \Omega.$$

The *rms*-emf will be

$$\text{E}_{rms} = \frac{\text{E}_m}{\sqrt{2}} = \frac{36}{\sqrt{2}}\ \text{V} = 25.45\ \text{V}.$$

(a)

When the inductor is removed from the circuit the impedance will be

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{160^2 + 177^2}\ \Omega = 238.6\ \Omega.$$

The *rms*-current will be

$$i_{rms} = \frac{\mathrm{E}_{rms}}{Z} = \frac{25.45}{238.6}\ \mathrm{A} = 0.1066\ \mathrm{A}.$$

Therefore, the average power dissipated will be

$$\bar{P} = i_{rms}^2 R = \left(0.1066\right)^2 \times 160\ \mathrm{W} = 1.82\ \mathrm{W}.$$

(b)

When the capacitor is removed from the circuit the impedance will be

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{160^2 + 87^2}\ \Omega = 182.1\ \Omega.$$

The *rms*-current will be

$$i_{rms} = \frac{\mathrm{E}_{rms}}{Z} = \frac{25.45}{182.1}\ \mathrm{A} = 0.1397\ \mathrm{A}.$$

Therefore, the average power dissipated will be

$$\bar{P} = i_{rms}^2 R = \left(0.1397\right)^2 \times 160\ \mathrm{W} = 3.13\ \mathrm{W}.$$