# GATE 2022 33.BM

EE23BTECH11012 - Chavan Dinesh*

***Question:*** A series $RLC$ circuit with $R = 10\Omega$, $L = 50mH$ and $C = 100\mu F$ connected to 200 $V$, 50 Hz supply consumes power $P$. The value of $L$ is changed such that this circuit consumes same power $P$ but operates with lagging power factor. The new value of L is ____ $mH$ (rounded off to two decimal places). (GATE 33 BM 2022)

**Solution:**

| Parameter | Description | Value |
|---|---|---|
| $R$ | Resistance | $10\Omega$ |
| $C$ | Capacitance | $100\mu F$ |
| $L_{old}$ | Inductor | $50mH$ |
| $L_{new}$ | New Inductor | |
| $Z_{old}$ | Old Impedance | |
| $Z^*$ | New Impedance | |

TABLE 1

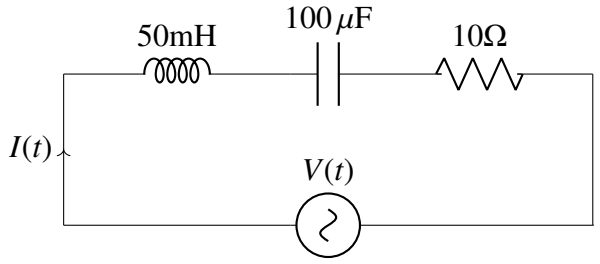
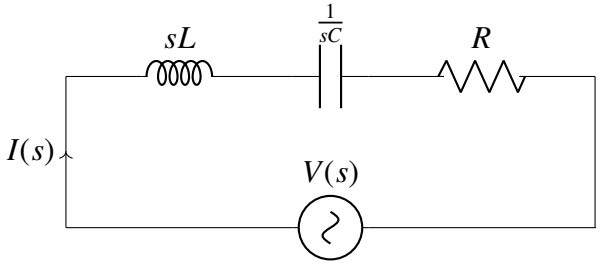



Fig. 1

From Fig. 1

In $s$ - domain,




$$Z = R + sL_{old} + \frac{1}{sC} \tag{1}$$

As the circuit consumes same power $P$ but operates with lagging power factor :

The new impedance($Z^*$) will be :

$$Z^* = R + sL_{new} + \frac{1}{sC} \tag{2}$$

Comparing the imaginary parts of the impedances:

$$sL_{old} + \frac{1}{sC} = -\left(sL_{new} + \frac{1}{sC}\right) \tag{3}$$

Taking $s = j2\pi f$ :

$$j\left(2\pi f L_{old} - \frac{1}{2\pi f C}\right) = -j\left(2\pi f L_{new} - \frac{1}{2\pi f C}\right) \tag{4}$$

From Table 1:

$$L_{new} \approx 152.7\text{mH} \tag{5}$$