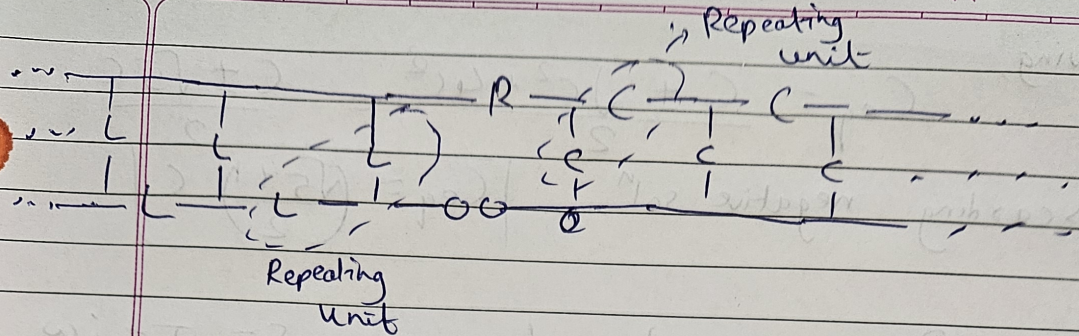

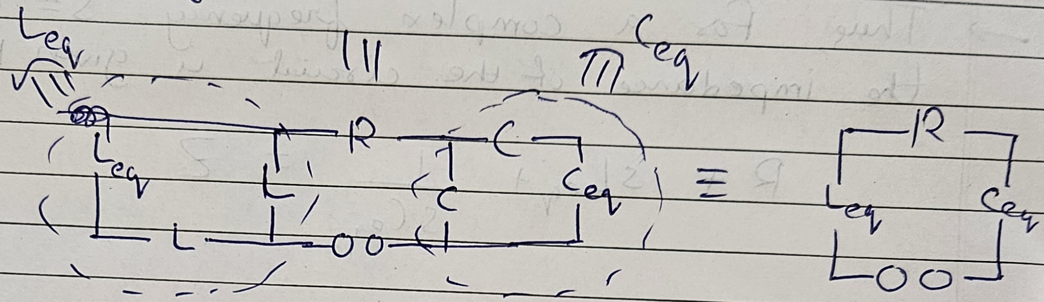

Now

(i) $$\frac{1}{L_{eq}} = \frac{1}{L} + \frac{1}{L+L_{eq}}$$

$$\Rightarrow \quad L_{eq} = \frac{L^2 + L \cdot L_{eq}}{2L + L_{eq}}$$

$$\Rightarrow \quad L_{eq}^2 + L \cdot L_{eq} - L^2 = 0$$

Solving, $$L_{eq} = \frac{-L \pm \sqrt{L^2 + 4L^2}}{2}$$
$$= \frac{-L \pm \sqrt{5}L}{2}$$

Discarding negative sol^n $\boxed{L_{eq} = \left(\frac{\sqrt{5}-1}{2}\right) L}$

(ii) $$C_{eq} = C + \frac{C \cdot C_{eq}}{C + C_{eq}}$$

$$\Rightarrow \quad C_{eq}^2 - C^2 = C \cdot C_{eq}$$

$$\Rightarrow \quad C_{eq}^2 - C \cdot C_{eq} - C^2 = 0$$

Solving,

$$C_{eq} = \frac{C \pm \sqrt{C^2 + 4C^2}}{2} = \frac{C \pm \sqrt{5}\,C}{2}$$

Discarding negative solⁿ, $\boxed{C_{eq} = \left(\frac{\sqrt{5}+1}{2}\right) C}$

→ Thus, for a complex frequency $s = \sigma + j\omega$ the impedance of the circuit is given by

$$R + sL_{eq} + \frac{1}{sC_{eq}} = Z$$

Resonance pole ⇒ $Z = 0$

$$\Rightarrow s^2 L_{eq} C_{eq} + sRC_{eq} + 1 = 0$$

Solving for 's': we get

$$s = \frac{-RC_{eq} \pm \sqrt{R^2 C_{eq}^2 - 4L_{eq}C_{eq}}}{2L_{eq}C_{eq}}$$

Now poles 's' depend on the value of discriminant, $D = R^2 C_{eq}^2 - 4L_{eq}C_{eq}$

(i) $D = 0$

$$\Rightarrow \sigma = s = \boxed{\frac{-R}{2L_{eq}}} \Rightarrow \text{One real pole } (\omega = 0)$$

(ii) $D > 0 \Rightarrow$

$$\boxed{\sigma = s = \frac{-RC_{eq} \pm \sqrt{D}}{2L_{eq}C_{eq}}} \Rightarrow \text{Two real poles } (\omega = 0)$$

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(iii) $D < 0$

$$\Rightarrow \quad s = \frac{-RC_{eq} \pm j\sqrt{4L_{eq}C_{eq} - R^2C_{eq}^2}}{2L_{eq}C_{eq}}$$

$$\Rightarrow \quad \boxed{\begin{aligned} \sigma &= -\frac{R}{2L_{eq}} \\ \omega &= \sqrt{\frac{1}{L_{eq}C_{eq}} - \left(\frac{R}{2L_{eq}}\right)^2} \end{aligned}}$$