# GATE 2023 Assignment
# **EE1205** Signals and Systems

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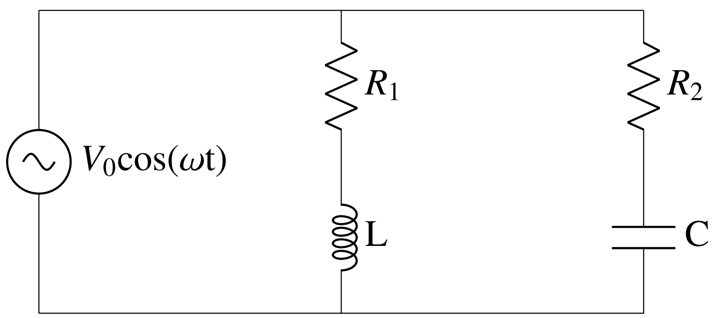
**Question(IN 46):** In the circuit shown ,$\omega$ = 100$\pi$rads/s, R1=R2=2.2$\Omega$ and L=7mH. the capacitance C for which $Y_{in}$ is purely real is mF




(GATE ST 2023)

**Solution:**

| variable | value | description |
|---|---|---|
| $Y_{in}$ | | Admittance of circuit |
| $X_L$ | $7s\Omega$ | Inductive reactance |
| $X_C$ | $\frac{1}{sC}\Omega$ | Capacitive reactance |
| $\omega$ | 100$\pi$rads/s | Angular frequency |

TABLE I
TABLE: INPUT PARAMETERS

$$X_L = \text{sL} \tag{1}$$
$$= 7s\Omega \tag{2}$$
$$X_C = \frac{1}{s\text{C}}\Omega \tag{3}$$
$$Y_{in} = \frac{1}{2.2 + 7s} + \frac{1}{2.2 + \frac{1}{\text{sC}}} \tag{4}$$
$$s = j\omega \tag{5}$$
$$\implies Y_{in} = \frac{1}{2.2 + 7j\omega} + \frac{1}{2.2 + \frac{1}{j\omega\text{C}}} \tag{6}$$
$$\implies Y_{in} = \frac{1 - j}{4.4} + \frac{2.2 + \frac{j}{\omega\text{C}}}{(2.2)^2 + \left(\frac{1}{\omega\text{C}}\right)^2} \tag{7}$$

According to the question given, $Y_{in}$ is purely real , so imaginary part should be equal to zero

$$\implies \frac{-1}{4.4} + \frac{\frac{1}{\omega C}}{(2.2)^2 + \left(\frac{1}{\omega C}\right)^2} = 0 \tag{8}$$

$$\implies \frac{\frac{1}{\omega C}}{(2.2)^2 + \left(\frac{1}{\omega C}\right)^2} = \frac{1}{4.4} \tag{9}$$

$$\implies (2.2)^2 - \frac{4.4}{\omega C} + \left(\frac{1}{\omega C}\right)^2 = 0 \tag{10}$$

$$\implies \left(2.2 - \frac{1}{\omega C}\right)^2 = 0 \tag{11}$$

$$\implies \frac{1}{\omega C} = 2.2 \tag{12}$$

$$\implies C = \frac{700}{484}\text{mF} \tag{13}$$

$$\implies C = 1.446281\text{mF} \tag{14}$$

The capacitance of capacitor C is 1.45mF

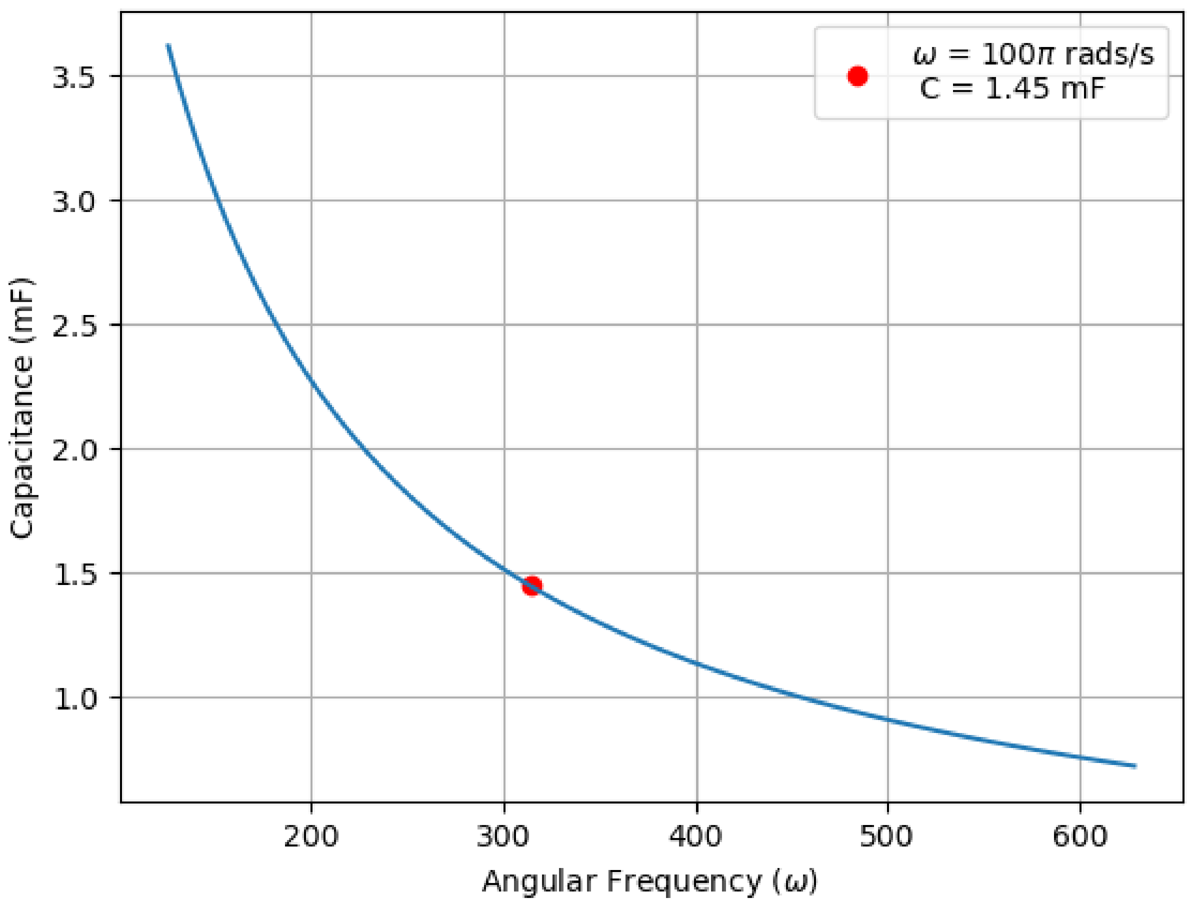



Fig. 1. Graph of Capacitance(mF) vs Angular Frequency($\omega$)