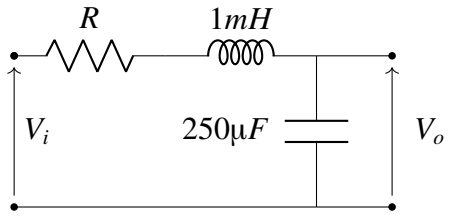
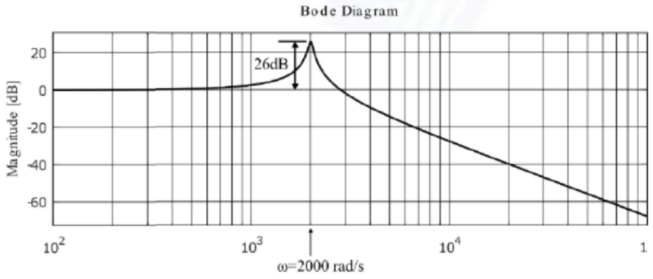
GATE 2021 EE.20

EE23BTECH11010 - VENKATESH BANDAWAR*

Question: The Bode magnitude plot for the transfer function $\frac{V_o(s)}{V_i(s)}$ of the circuit is as shown. The value of R is _____Ω. (GATE 2021 EE Q20)





Solution: Applying KVL,

Parameter	Description	Value
C	Capacitance	$250\mu F$
L	Inductor	$1mH$
I	Current	
$I(0)$	Initial Current	0A
V_o	Voltage across capacitor	
V_i	Input Voltage	
$T(s)$	Transfer Function	$\frac{V_o(s)}{V_i(s)}$

TABLE I: Given Parameters table

$$V_i - RI - L\frac{dI}{dt} - \frac{\int Idt}{C} = 0 \tag{1}$$

Taking Laplace Transform ,

$$V_i(s) - RI(s) - LsI(s) + LI(0^+) - \frac{I(s)}{sC} = 0 \tag{2}$$

$$I(s) = \frac{V_i(s) + LI(0)}{R + sL + \frac{1}{sC}} \tag{3}$$

$$V_o = \frac{V_i(s) + LI(0)}{RsC + s^2LC + 1} \tag{4}$$

Substituting $I(0) = 0$ and $s = j\omega$,

$$\frac{V_o(j\omega)}{V_i(j\omega)} = \frac{1}{\omega RC\,j - \omega^2 LC + 1} \tag{5}$$

$\because$ Magnitude in bode plot $= 20\log|T(s)|$
From given graph,At $\omega = 2000$

$$26 = 20\log\frac{V_o}{V_i} \tag{6}$$

$$\frac{V_o}{V_i} = 20 \tag{7}$$

$$\implies 20 = \frac{1}{\omega RC\,j - \omega^2 LC + 1} \tag{8}$$

$$R = 0.1\Omega \tag{9}$$

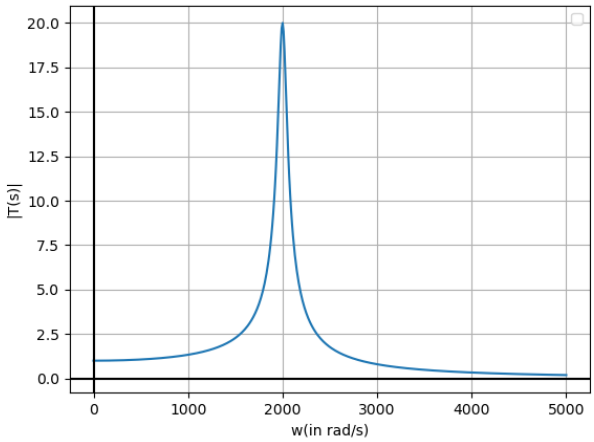


Fig. 1: Frequency response of V_o