電路學(10510EE221002)第十次隨堂考

2016年12月21日
時間：10 分鐘
Close Book

學號：________________________

姓名：________________________

For $v_I(t)$ being sinusoidal input, please answer the following questions according to the circuit given below :

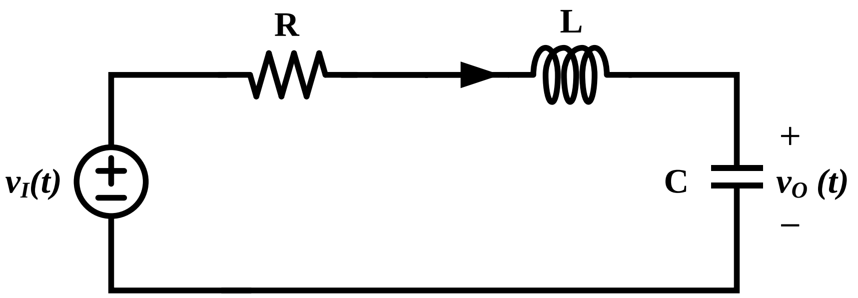
(a) Find the transfer function $\mathbf{H}(j\omega)= \mathbf{V_O}(j\omega)/ \mathbf{V_I}(j\omega)$. (20%)

(b) Find the resonant frequency ω_0 . (20%)

(c) Find the quality factor Q . (20%)

(d) Sketch the Bode plot of log magnitude versus log frequency (Please point out Q, ω_0, and slope in the plot). (40%)

(Assuming $R = 5\Omega$, $L = 250\text{mH}$ and $C = 1\mu\text{F}$)



Solution:

(a)

$$v_O = \frac{\frac{1}{j\omega C}}{R + j\omega L + \frac{1}{j\omega C}} v_I$$

$$\text{H}(j\omega) = \frac{v_O(j\omega)}{v_I(j\omega)} = \frac{\frac{1}{j\omega C}}{R + j\omega L + \frac{1}{j\omega C}}$$

(b)

To analysis the response for the undriven RLC circuit, we write KVL equation for its loop.

KVL: $v_R + v_L + v_C = 0$

$$\Rightarrow i_C R + L\frac{di_L}{dt} + v_C = 0, \text{ where } i_L = i_C = C\frac{dv_C}{dt}$$

$$\Rightarrow RC\frac{dv_C}{dt} + LC\frac{d^2v_C}{dt^2} + v_C = 0$$

$$\Rightarrow \frac{d^2v_C}{dt^2} + \frac{R}{L}\frac{dv_C}{dt} + \frac{1}{LC}v_C = 0$$

Thus, the characteristic equation can be written as

$$s^2 + 2\alpha s + \omega_0^2 = s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$$

Where

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{250\text{mH} \times 1\mu\text{F}}} = 2000\text{rads/sec}$$

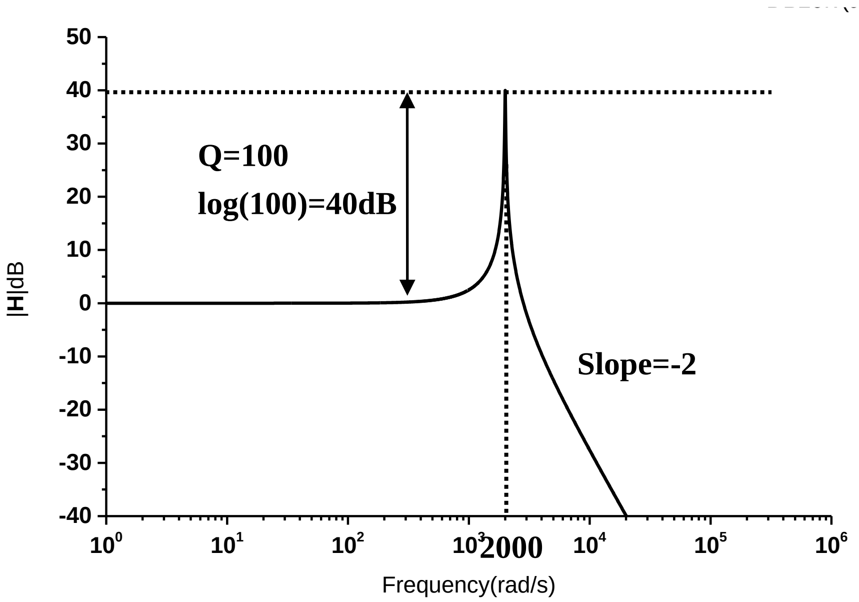
$$\alpha = \frac{R}{2L} = \frac{5}{2 \times 250\text{mH}} = 10\text{rads/sec}$$

(c)

The quality factor is

$$Q = \frac{\omega_0}{2\alpha} = \frac{2000}{20} = 100$$

(d)



(a) $\mathbf{H}(j\omega) =$ ____,

(b) $\omega_0 =$ ____________________, (c) $Q =$ ____________________,

(d)