

生機系電工學第十次隨堂測驗 2011/06/01

學號：_____ 姓名：_____

PROBLEM 1

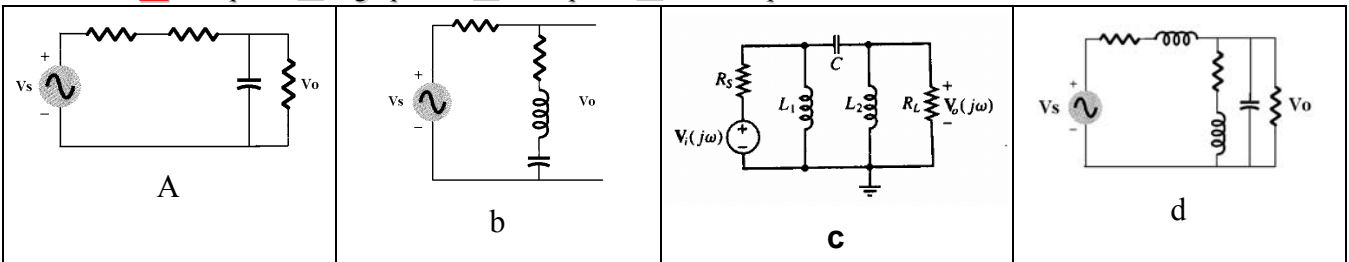
請分別由 $\omega \rightarrow \infty$ 及 $\omega \rightarrow 0$ 時，電路中個別元件的行為，推論 V_o 與 V_i 的關係，進而判斷下列電路屬於哪一種 filter?

Circuit a : Low pass High pass Band pass Band stop

Circuit b : Low pass High pass Band pass Band stop

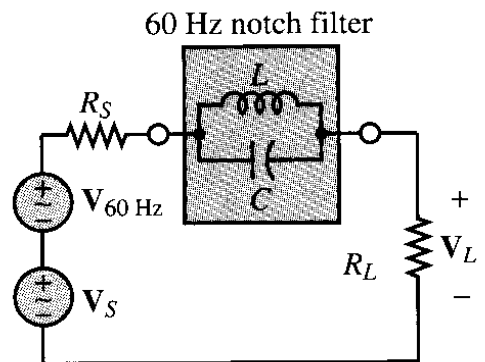
Circuit c : Low pass High pass Band pass Band stop

Circuit d : Low pass High pass Band pass Band stop



PROBLEM 2 Reject interference due to AC line power

由於源自 AC line power 的 60Hz signal 會對一些高敏感性的儀器產生干擾，如心電圖儀器，因此常用 60Hz notch filter 來消除。How to design a 60-Hz narrow-band (or notch) filter to remove the unwanted 60-Hz noise? 若 $R_S = 50\Omega$ ， $L = 100\text{ mH}$ ，則 $C = ?$ 請畫出設計出來的電路的 frequency response (Bode plot)。 **$R_L = 90\Omega$**



The expression for the notch filter impedance :

$$Z_{//} = Z_L // Z_C = \frac{j\omega L / j\omega C}{j\omega L + \frac{1}{j\omega C}} = \frac{j\omega L}{1 - \omega^2 LC}$$

當 $\omega^2 LC = 1$ ，the impedance of the circuit is infinite，the frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ is the resonant

frequency of the LC circuit。

$\omega_0 = 2\pi \times 60\text{Hz}$ ，the series circuit would show an infinite impedance to 60Hz currents (對 60Hz current 展現 infinite impedance)。

效果展現：Blocking the interference signals + Passing most of the other frequency components.

Let $L=100\text{mH} \rightarrow C = \frac{1}{\omega_0^2 L} = \frac{1}{(2\pi \times 60)^2 L} = 70.36\mu\text{F}$

The frequency response of the complete circuit :

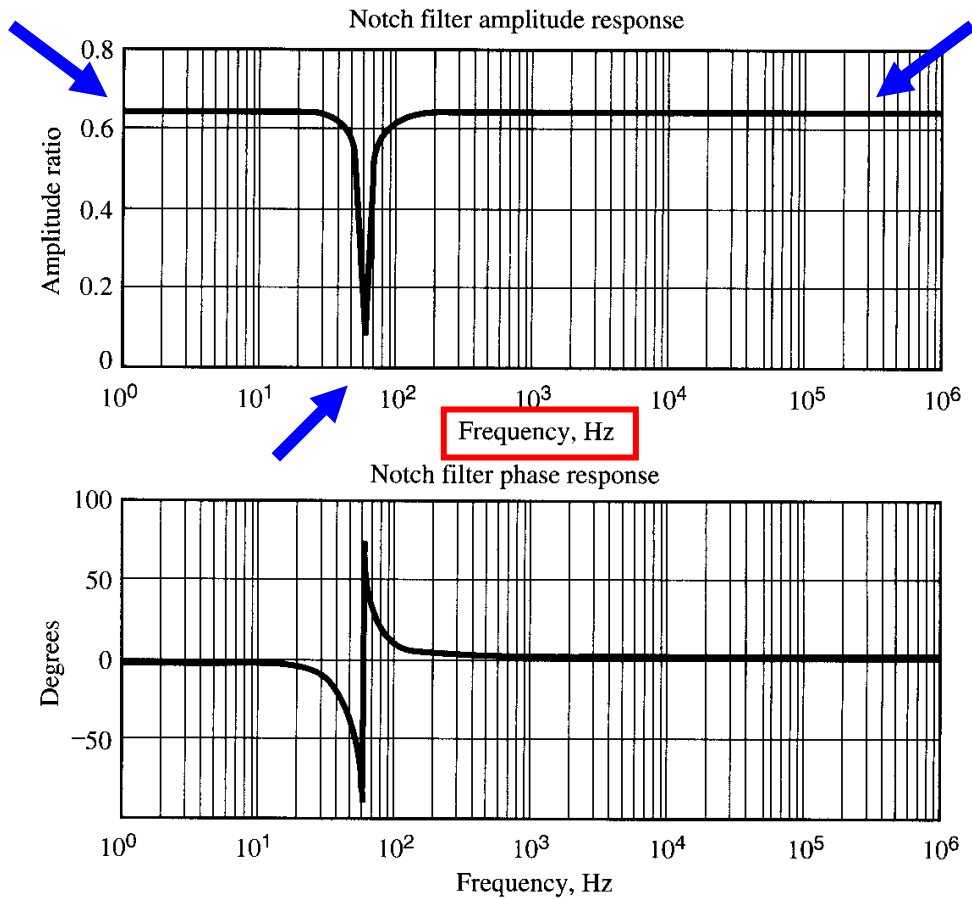
$$H_v(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = \frac{R_L}{R_s + R_L + Z_{//}} = \frac{R_L}{R_s + R_L + \frac{j\omega L}{1 - \omega^2 LC}}$$

$$= \frac{(1 - \omega^2 LC)^2 (R_s + R_L) R_L - j\omega L R_L (1 - \omega^2 LC)}{(1 - \omega^2 LC)^2 (R_s + R_L)^2 + \omega^2 L^2} = |H(j\omega)| \angle H(j\omega)$$

Amplitude = $|H(j\omega)| =$

Phase = $\angle H(j\omega) =$

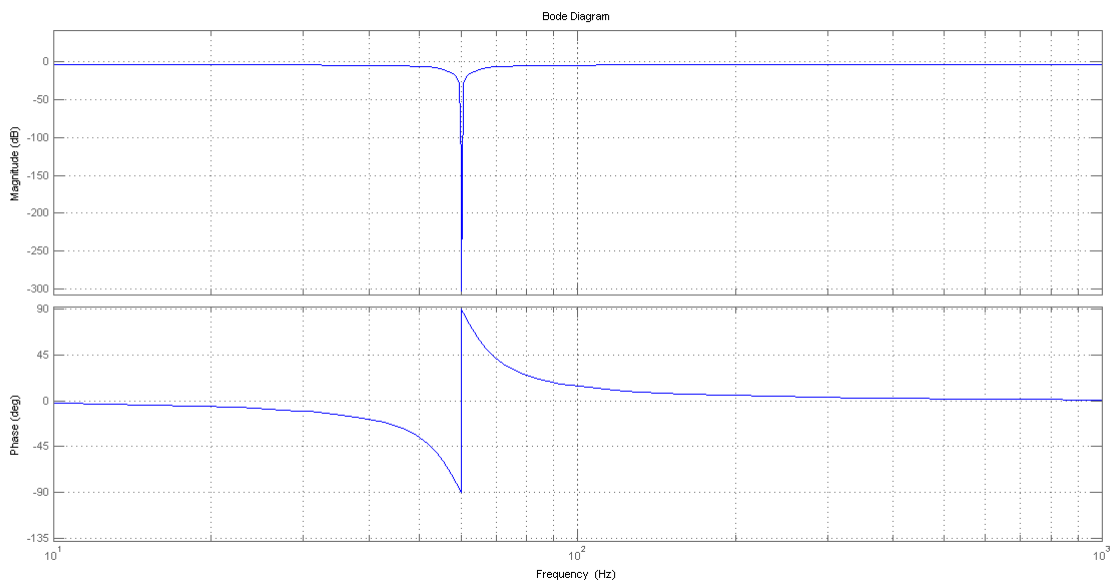
【注意 $H(j\omega)$ 在極大、極小與 ω_0 處的 amplitude 與 phase angle】
畫圖時，必須清楚呈現在極大、極小與 ω_0 處的大小，以及 ω_0 的值。



【注意 $H(j\omega)$ 在 ω_0 處的 amplitude 非常小，理論上趨近於 0】

使用 MATLAB 畫圖

※BODE PLOT (縱軸單位是 dB，水平軸單位是 Hz)



※BODE PLOT (縱軸單位是 Magnitude，水平軸單位是 Hz)

