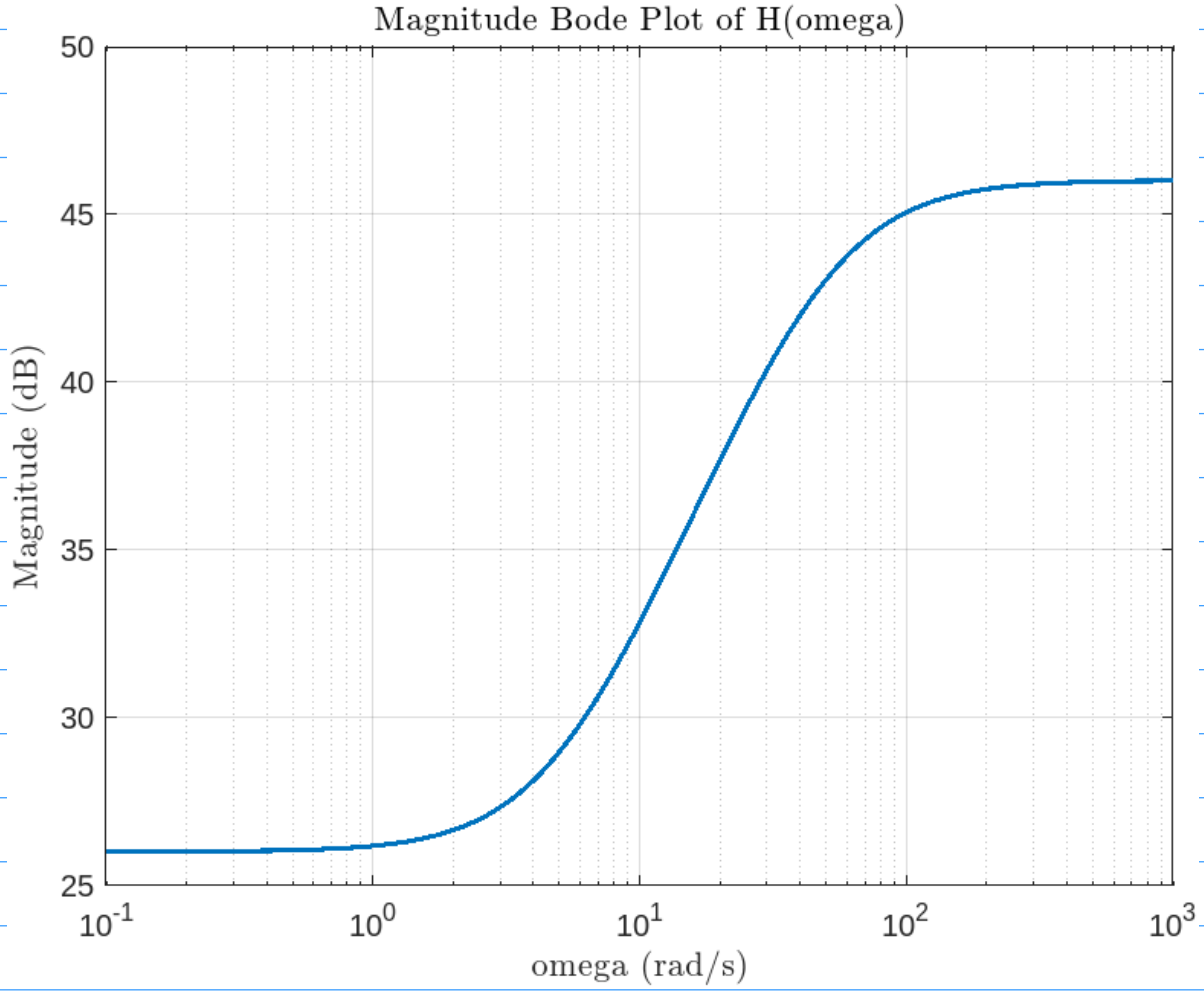
1. Sketch using MATLAB the magnitude Bode plot of $H(\omega) = \frac{4\,(5+j\omega)}{1+j\frac{\omega}{50}}$



2. For the circuits in Figure 1, Find the resonant frequency ω_o, the quality factor Q, and the bandwidth B.

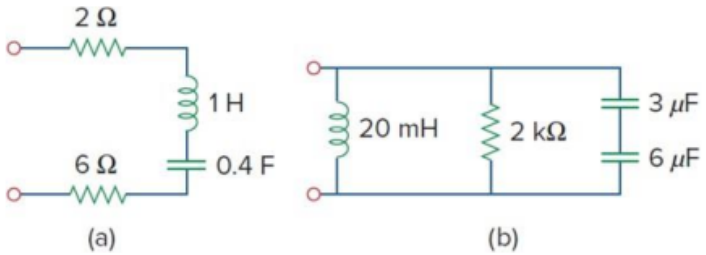


Figure 1

a) $R = 2+6 = 8\,\Omega$, $L = 1H$, $C = 0.4F$ (series)

$\omega_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1\times 0.4}} = 1.58$ rad/s

$Q = \frac{\omega_o L}{R} = \frac{1.58 \times 1}{8} = 0.1975$

b) $R = 2k\Omega$, $L = 20mH$, $C = (3\mu^{-1} + 6\mu^{-1})^{-1} = 2\mu F$ (parallel)

$\omega_o = \frac{1}{\sqrt{LC}} = 5k$ rad/s, $Q = \frac{R}{\omega_o L} = 20$

3. A parallel RLC circuit has R = 10 kΩ, L = 100 mH, and a resonant frequency of 200 krad/s. Calculate the value of C, the value of the quality factor, and the bandwidth.

(parallel)

$R = 10\,k\Omega,\ L = 100\,mH,\ \omega_o = 200\ k\ rad/s,\ C = ??$

$\omega_o = 1/\sqrt{LC} \Rightarrow C = 1/L\omega_o^2 = 1/100m \times 200k^2 = \boxed{50p}$

$Q = R/\omega_o L = 10k/200k \times 100m = \boxed{500m}$, $B = \omega_o/Q = 200k/500m = \boxed{400k}$

4. A quartz crystal exhibits the property that when mechanical stress is applied across its faces, a potential difference develops across opposite faces. When an alternating voltage is applied, mechanical vibrations occur, and electromechanical resonance is exhibited. A crystal can be represented by a series RLC circuit. A specific crystal has a model with L = 1 mH, C = 10 μF, and R = 1 Ω. Find ω_0, Q and the bandwidth.

Hint : Another capacitor (Co) is added across the motional arm to account for the electrodes capacitance with the piezoelectric crystal acting as the dielectric material, where its capacitance value is dependent on the crystal geometry and is typically in the pF range.(can be neglected)

(series)

$\omega_o = 1/\sqrt{LC} = 1/\sqrt{1 \times 10\mu} = \boxed{316.23}$, $Q = \omega_o L/R = 316.23 \times 1m/1 = \boxed{316m}$

$B = \omega_o/Q = 316/316m = 1k\ rad/s$