Constructor University Bremen

Prelab: RLC Frequency Response

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1. Prelab

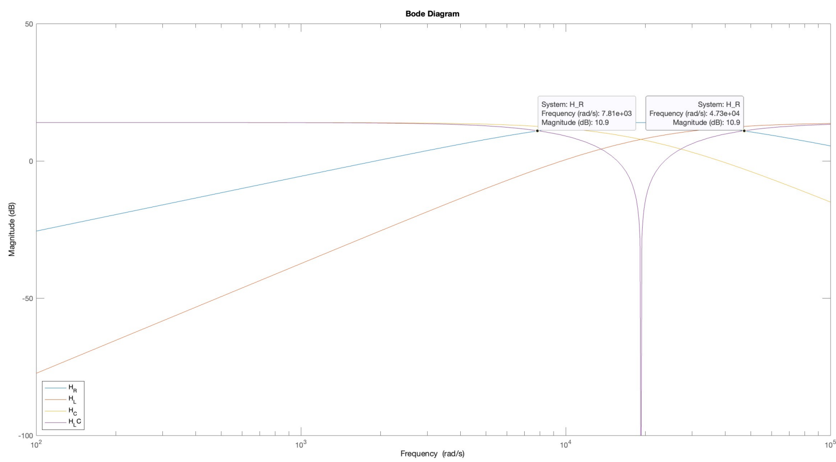

Figure 1.1: RLC Series Voltages taken over different components

From the plot, we find that the corner frequencies are given as

$$\omega_1 = 7.81E3 \text{ rad/s and } \omega_2 = 4.73E4 \text{ rad/s} \tag{1.1}$$

We also find that the bandwidth is, in the series RLC circuit:

Calculated: $3.9E4$
Plotted: $3.94E4$

The quality factor is calculated to be(by knowing that $Q = \frac{X_0}{R} = \frac{\sqrt{\frac{L}{C}}}{R}$)

$$Q = 0.49346$$

We find that the voltage taken over the resistor makes the circuit act as a **bandpass** filter, the voltage taken over the inductor makes the circuit act as a **high-pass** filter, the voltage taken over the capacitor makes the circuit act as a **low-pass** filter, and the voltage taken over the inductor and the capacitor makes the circuit act as a **band-stop** filter. The bode magnitude of the RLC series circuit plot and the MATLAB code used to obtain the corner frequencies and create the plot is given below:

```
R = 390; % in ohm
C = 270E-9; % in F
L = 10E-3; % in H

H_R = 5*tf([R*C, 0], [L*C, R*C, 1]);
% The transfer function of the voltage taken across the resistor shows a
% bandpass filter.

H_L = 5*tf([L*C, 0, 0], [L*C, R*C, 1]);
% The transfer function of the voltage across the inductor shows a
% high-pass filter.

H_C = 5*tf(1,  [L*C, R*C, 1]);
% The transfer function of the voltage across the capacitor shows a
% low-pass filter.

H_LC = 5*tf([L*C, 0, 1], [L*C, R*C, 1]);
% The transfer function of the voltage taken across the inductor and the
% capacitor shows a band-stop filter.

% Calculated bandwidth and quality factor:
B_calculated = R/L;
w_0 = 1/sqrt(L*C);
X_0 = sqrt(L/C);
Q_s = X_0/R;

bodemag(H_R,H_L,H_C,H_LC,{1E2, 1E5});
ylim([-100, 50])

% Obtained from the plot, respectively at their 11dB cutoff
% points: -20log10(1/sqrt(2) * 5) and 20log10(1/sqrt(2)*5)
w_2 = 4.73E4;
w_1 = 7.81E3;

B_plot = w_2 - w_1;

legend("H_R", "H_L", "H_C", "H_LC", 'Location', 'southwest');
```

```
disp("Plot Bandwidth: " + (w_2 - w_1));

disp("Calculated Quality Factor: " + Q_s);
disp("Calculated Bandwidth: " + B_calculated);
```