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ADANA ALPARSLAN TÜRKEŞ SCIENCE AND TECHNOLOGY UNIVERSITY

FACULTY OF ENGINEERING

EEE 222 ELECTRICAL CIRCUIT LABORATORY II

2020-2021 Spring Term

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EXPERIMENT VI

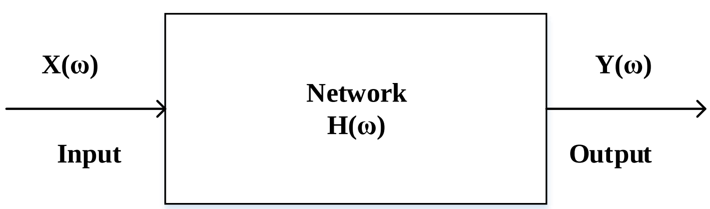
FREQUENCY RESPONSE &

RESONANT CIRCUITS

INTRODUCTION

In sinusoidal circuit analysis, voltages and currents are founded in a circuit with a constant frequency source. If the amplitude of the sinusoidal source remain constant and vary the frequency, the circuit's frequency response will be obtained. The frequency response of a circuit is the variation of the gain and phase in its behavior with change in signal frequency.

The transfer function **H(ω)** (network function) is used for finding the frequency response of a circuit with w varying from **ω=0** to **ω=∞** and is a complex quantity with a magnitude $H(\omega)$ and a phase ϕ, defined in Figure 1.



$$\mathbf{H(\omega)} = \frac{\mathbf{Y(\omega)}}{\mathbf{X(\omega)}}$$

Y(ω) an element voltage or current

X(ω) source voltage or current

$$\mathbf{H(\omega)} = H(\omega)\angle\phi$$

Figure 1. The transfer function.

The frequency response of an RLC circuit may cause resonance frequency occurs when the capacitive and inductive reactance cancel each other.

PRELIMINARY WORK

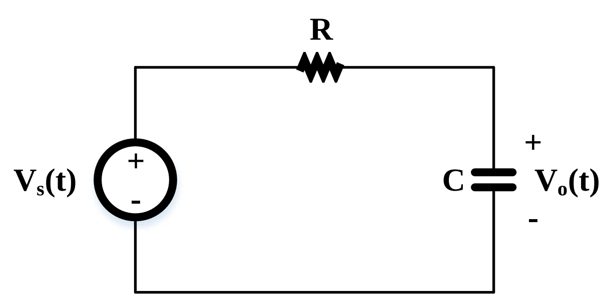


Figure 2. The RC circuit.

P1 For the RC circuit given in Figure 2

a) Obtain the transfer function ***Vo/Vs*** for $Vs=Vm\cos\omega t$.
b) Draw the amplitude response and the phase response.
c) According to the value of ω/ω_0 as 0, 1, 2, 3, 10, 20, 100 and ∞, calculate the H and ϕ.

d) Use LTSPICE to plot frequency response for Vm=10 V, R=10 Ω and L=4.7 mH.

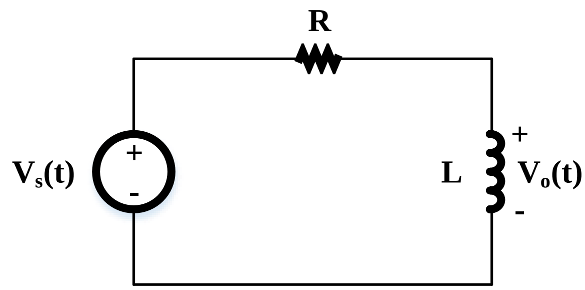


Figure 3. The RL circuit.

P2 Repeat P1 from "***a***" to "***c***" for the circuit shown in Figure 3

a) Use LTSPICE to plot frequency response for Vm=10 V, R=4.7 Ω and L=4.7 mH.

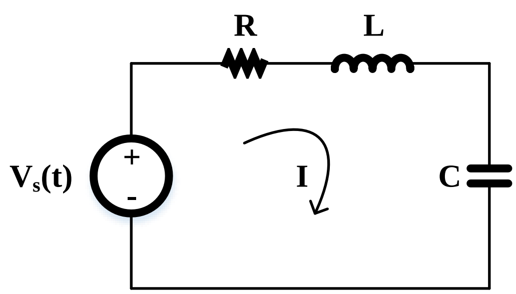


Figure 4. The series RLC circuit.

P3 For the series RLC circuit given in Figure 4 for $Vs=10\sin\omega t$ R=2.2 Ω, L=100 µH and C=1000 µF

a) Obtain the resonant frequency and the half-power frequencies.
b) Calculate the quality factor and bandwidth.
c) Determine the amplitude of the current at ω_0, ω_1 and ω_2.
d) Plot the current amplitude versus frequency
e) Use LTSPICE to plot frequency response.

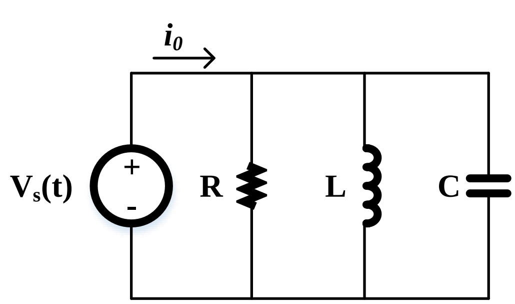


Figure 5. The parallel RLC circuit.

P4 For the parallel RLC circuit given in Figure 5 for $Vs=10\sin\omega t$ R=2.2 Ω, L=100 μH and C=1000 μF

a) Obtain the resonant frequency ω_0, the quality factor Q and the bandwidth B.
b) Calculate the half-power frequencies ω_1 and ω_2.
c) Determine the power consumption at ω_0, ω_1, and ω_2.
d) Plot the current amplitude versus frequency
e) Use LTSPICE to plot frequency response.

EXPERIMENTAL WORK

1. **E1:** Build the circuit in figure 1 but make sure to measure the values of R and C beforehand.

E1 Build the RC circuit in Figure 2 and fill the Table 1.

Table 1. The Output voltage and the phase angle for the RC circuit.

f (Hz)	**V_o (V)**	**V_o/V_s**	**ϕ (°)**	**f (Hz)**	**V_o (V)**	**V_o/V_s**	**ϕ (°)**
60				160			
70				170			
80				180			
90				190			
100				200			
110				210			
120				220			
130				230			
140				240			
150				250			

E2 Build the RL circuit in Figure 3 and fill the Table 2.

Table 2. The Output voltage and the phase angle for the RL circuit.

f (Hz)	**V_o (V)**	**V_o/V_s**	**ϕ (°)**	**f (Hz)**	**V_o (V)**	**V_o/V_s**	**ϕ (°)**
60				160			
70				170			
80				180			
90				190			
100				200			
110				210			
120				220			
130				230			
140				240			
150				250			

E3 Build the RLC circuit in Figure 4 and fill the Table 3.

Table 3. The current and the phase angle for the series RLC circuit.

f (Hz)	**I (A)**	**V_m/R**	**ϕ (°)**	**f (Hz)**	**I (A)**	**V_m/R**	**ϕ (°)**
6000				16000			
7000				17000			
8000				18000			
9000				19000			
10000				20000			
11000				21000			
12000				22000			
13000				23000			
14000				24000			
15000				25000			

E4 Build the RLC circuit in Figure 5 and fill the Table 4.

Table 4. The current and the phase angle for the parallel RLC circuit.

f (Hz)	**I (A)**	**V_m/R**	**ϕ (°)**	**f (Hz)**	**I (A)**	**V_m/R**	**ϕ (°)**
6000				16000			
7000				17000			
8000				18000			
9000				19000			
10000				20000			
11000				21000			
12000				22000			
13000				23000			
14000				24000			
15000				25000			

CONCLUSION