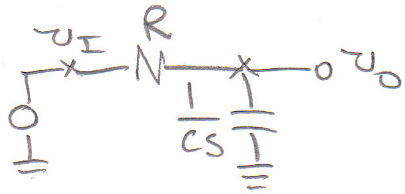
LAB: LOW-PASS Filter   A.YAZDANI   Feb.12, 2017

PRE-LAB

P1



Voltage Division

$$V_o(s) = \frac{V_I(s)}{R + \frac{1}{Cs}} \frac{1}{Cs}$$

$$\Rightarrow \frac{V_o(s)}{V_I(s)} = \frac{1}{\tau s + 1} \; ; \tau = RC$$

For a sinusoidal steady-state response:

$$s = j\omega \; ; \quad \omega = 2\pi f$$

$$\Rightarrow \frac{V_o(j\omega)}{V_I(j\omega)} = \frac{1}{j(\tau\omega) + 1}$$

Magnitude of gain $= \dfrac{1}{\sqrt{(\tau\omega)^2 + 1}}$

Phase of gain $= -\tan^{-1}(\tau\omega)$

The numerical values have been tabulated below:

f[Hz]	ω[rad/s]	τ[s]	τω	Mag.[V/V]	Mag.[dB]	Phase [deg.]
10	62.8	0.001	0.0628	0.998	−0.017	−3.6
100	628	0.001	0.628	0.847	−1.44	−32.1
159	999	0.001	0.999	0.707	−3.01	−45.1
1000	6280	0.001	6.28	0.157	−16.08	−81
10000	62800	0.001	62.8	0.0159	−35.97	−89.1

Note: Mag.[dB] = 20 log (Mag.)

P2: Simulation of the Circuit of Figure 1 using Multisim

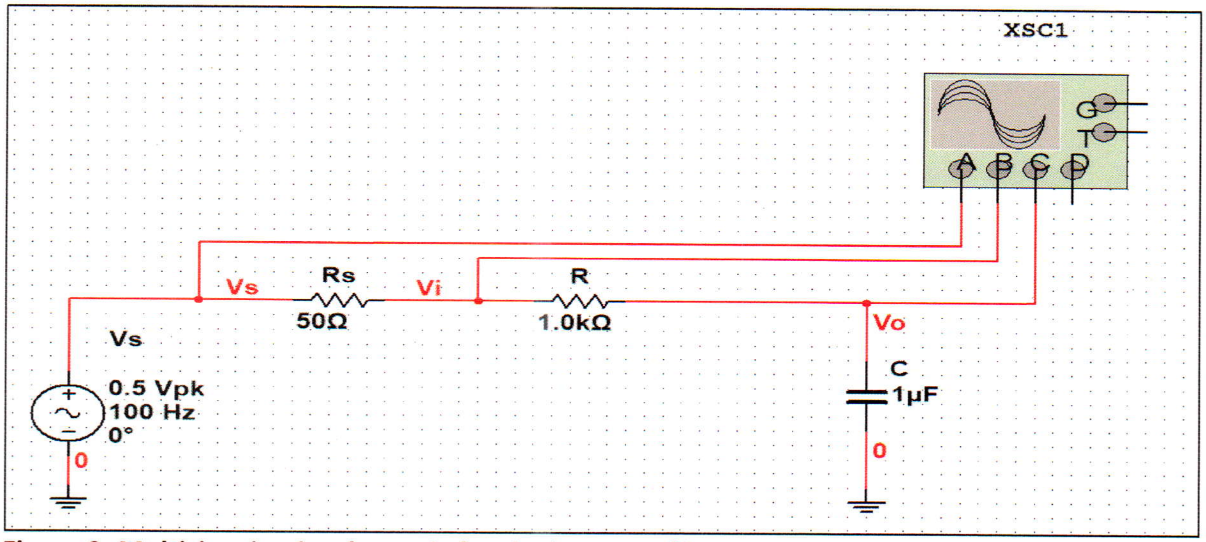
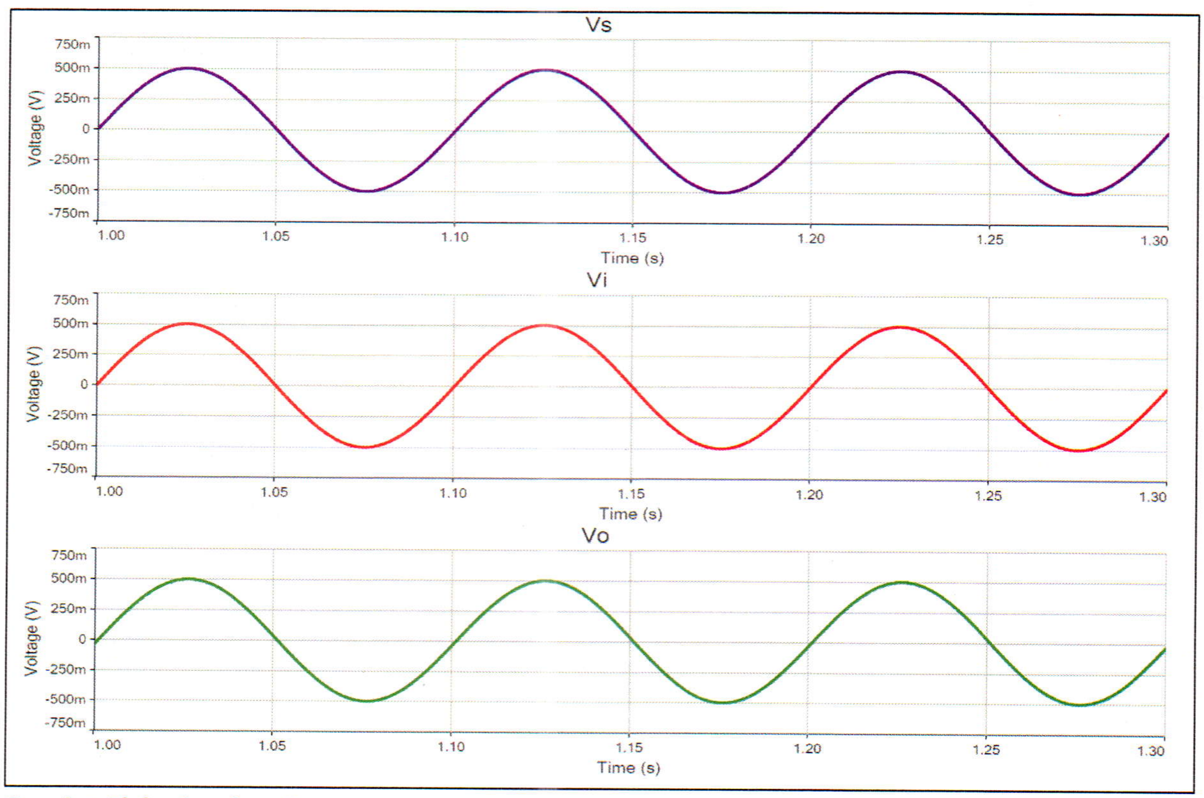
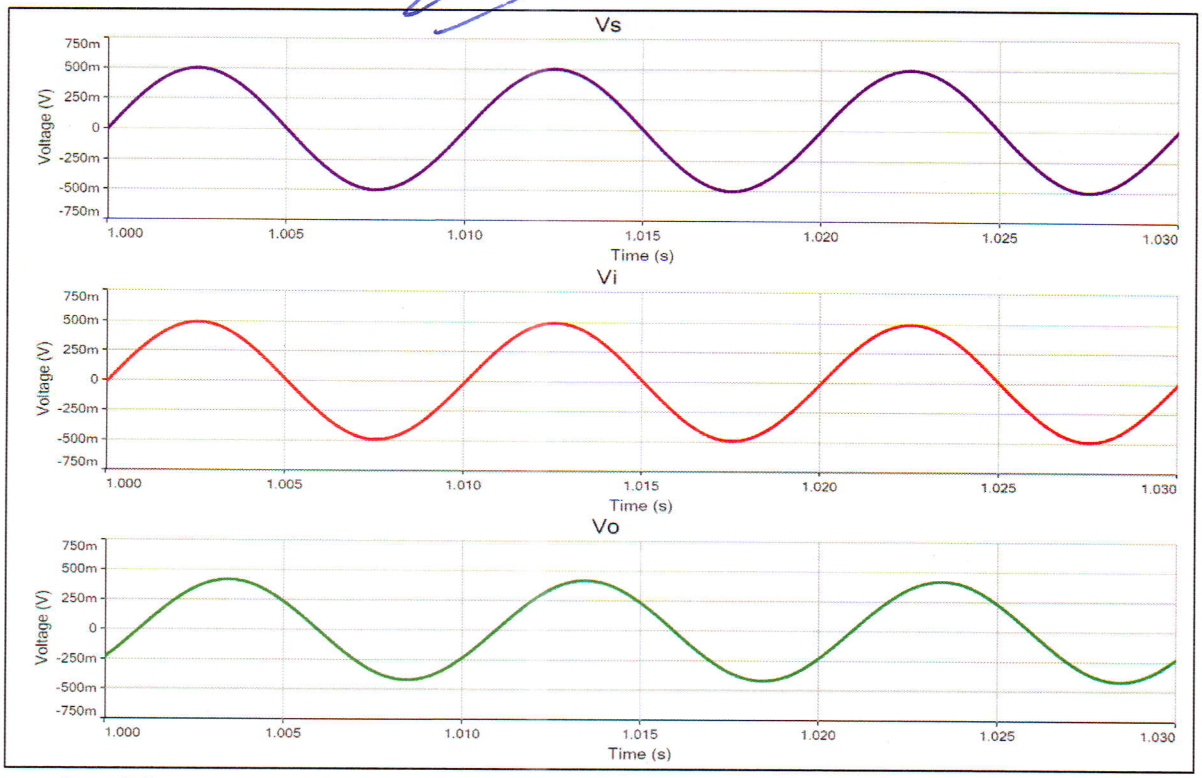


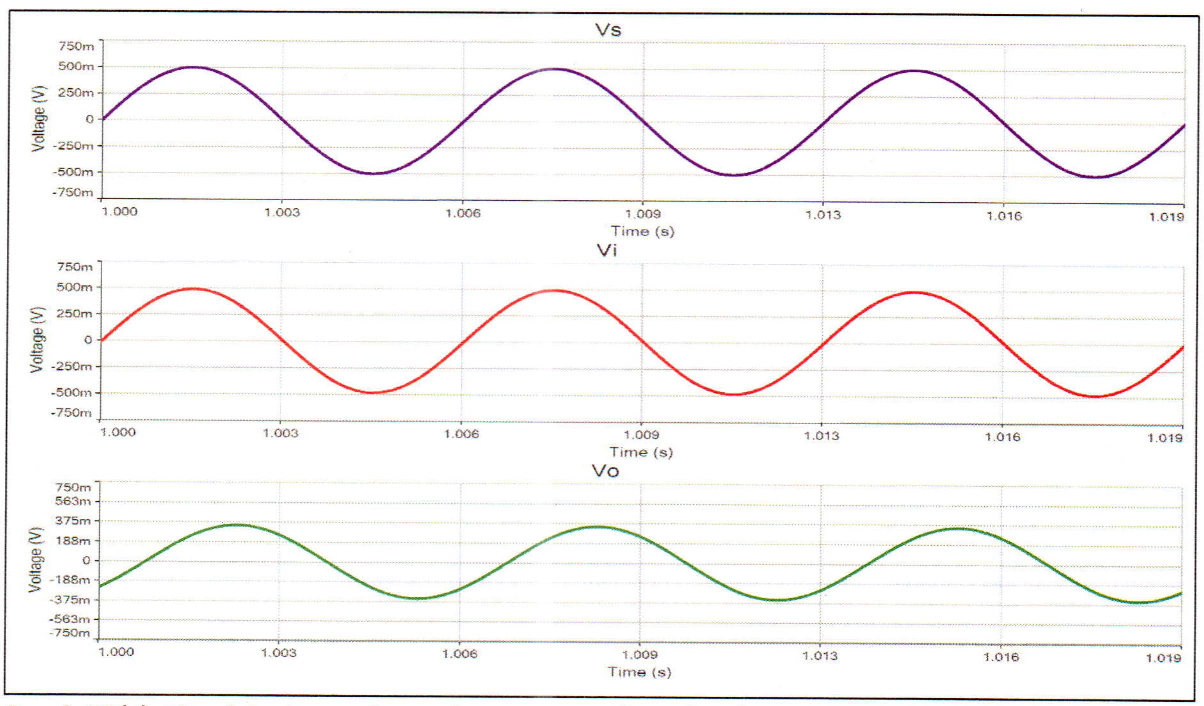
Figure 2. Multisim circuit schematic for the low-pass filter seen in Figure 1 of the lab manual.



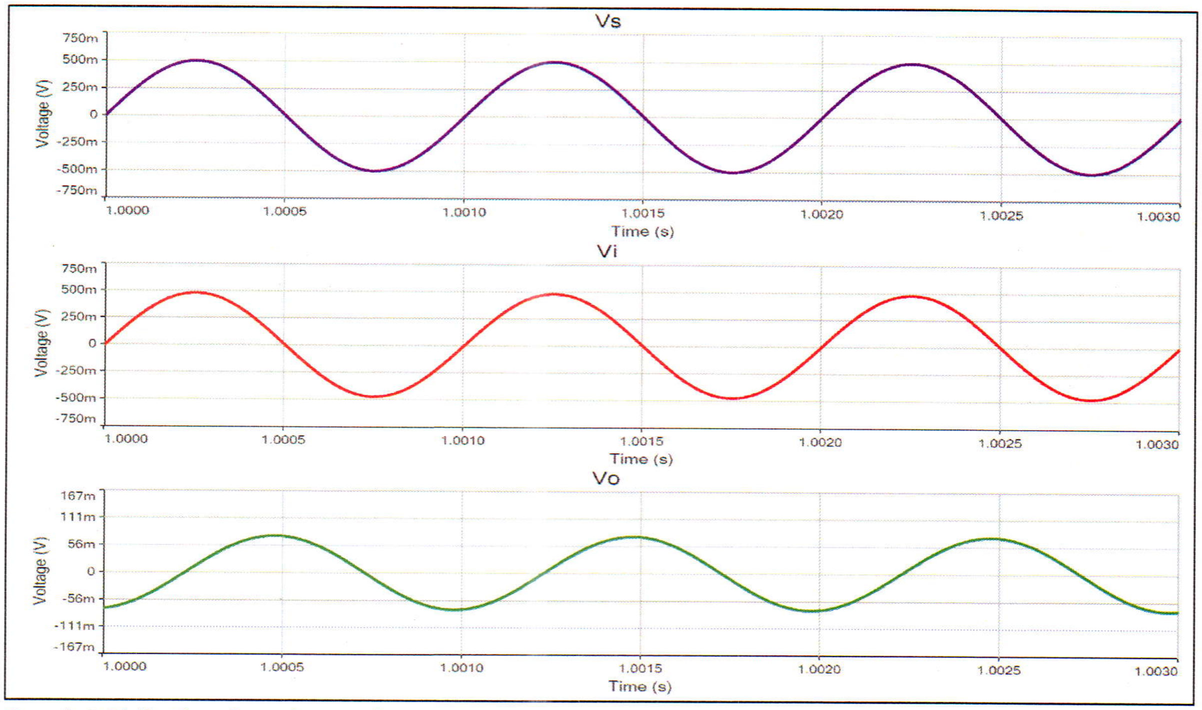
Graph P2(a). Simulated waveforms for v_S, v_I, and v_O, for the circuit seen in Figure 2 using a frequency of 10 Hz.



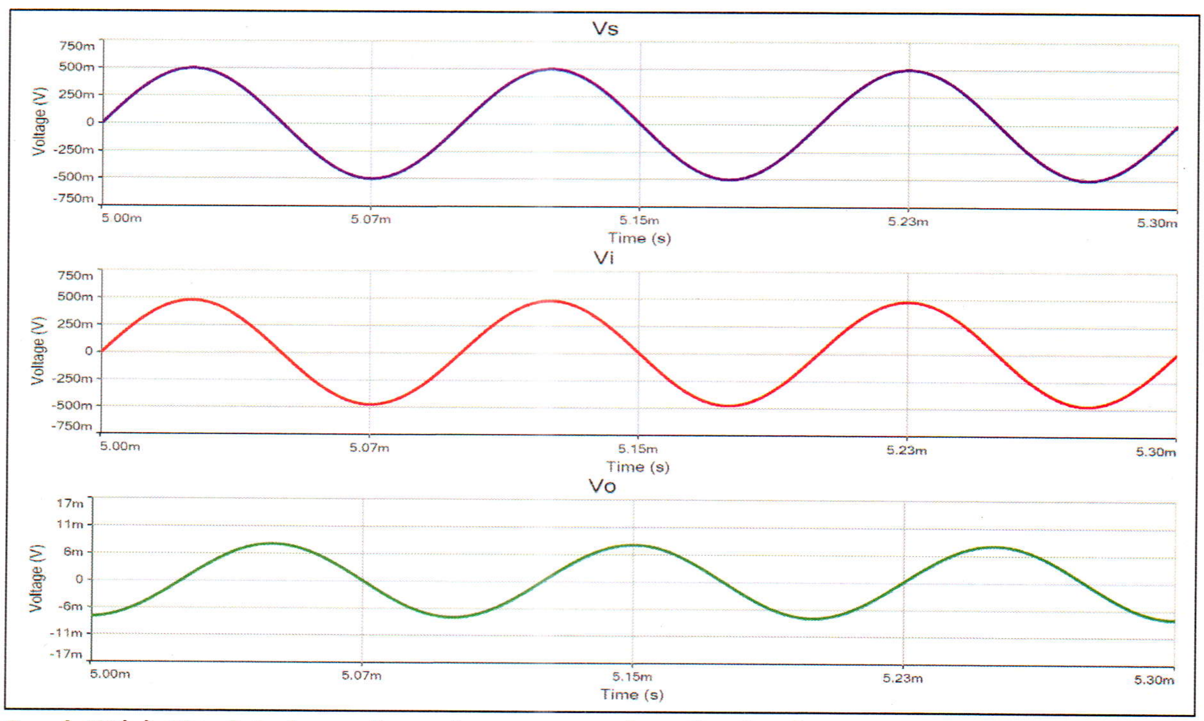
Graph P2(b). Simulated waveforms for v_S, v_I, and v_O, for the circuit seen in Figure 2 using a frequency of 100 Hz.



Graph P2(c). Simulated waveforms for v_S, v_I, and v_O, for the circuit seen in Figure 2 using a frequency of 159 Hz.

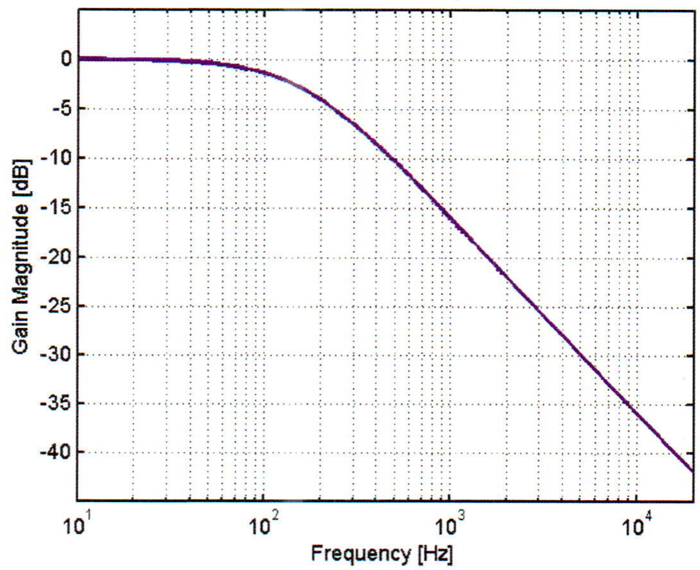


Graph P2(d). Simulated waveforms for v_S, v_I, and v_O, for the circuit seen in Figure 2 using a frequency of 1,000 Hz.



Graph P2(e). Simulated waveforms for v_S, v_I, and v_O, for the circuit seen in Figure 2 using a frequency of 10,000 Hz.

P3: Frequency response plot for the circuit of Figure 1 of the lab manual, and its Matlab code



Graph P3. Frequency response of the circuit of Figure 1.

```
clear all

%Setting Parameters and Frequency Range
C = 1e-6;
R = 1e3;
tau = R*C;
f = 10:10:20000;

%%

omega = 2*pi*f;
gain = ((tau*omega).^2+1).^-0.5;
g = 20*log10(gain);
semilogx(f,g, 'b', 'LineWidth', 2);
set(gca,...
    'ytick',[-40:5:0],'LineWidth',1.5,'FontSize',11,...
    'LineWidth',1.5,'FontSize',11,...
    'xlim',[10,20000],'ylim',[-45,5]);
ylabel('Gain Magnitude [dB]');
xlabel('Frequency [Hz]');
grid on;
```

TA Copy of Results

Table E1. Experimental results for the circuit of **Figure 1**.

Frequency [Hz]	$V_I\ [Vrms]$	$V_O\ [Vrms]$	$g = V_O/V_I$	$20log(g)[dB]$	**Plot**
10	0.3424	0.3411	0.996	-0.035	**Graph E1(a)**
100	0.3486	0.2945	0.845	-1.46	**Graph E1(b)**
159	0.3449	0.2434	0.706	-3.02	**Graph E1(c)**
1,000	0.3375	0.0542	0.161	-15.9	**Graph E1(d)**
10,000	0.3375	0.0054	0.016	-35.9	**Graph E1(e)**

	Partner's Name	Pre-Lab (out of 20)	Set-Up (out of 10)	Data Collection (out of 10)	Participation (out of 5)
1					
2					