B O Ğ A Z İ Ç İ   U N İ V E R S İ T Y
E L E C T R I C A L & E L E C T R O N I C   E N G I N E E R I N G   D E P A R T M E N T

EE327-ELECTRICAL NETWORK LABORATORY REPORT

Number of The Experiment : 10-11..
Name of The Experiment : Simulation Homework..

Name of The Student: Onur Derin

Grading

General		/20
Data		/30
Discussion		/20
Answers		/30
Total		/100
Delay		
SCORE		/100

Experiment:1 Characteristics of Linear and Nonlinear Devices

Step 4: for diode with I_S= 0.1pA

Point #	1	2	3	4	5	6	7	8	9	10	11
V_{supply}(V)	0	0.4	0.5	0.6	1.0	1.2	-2	-4	-5	-10	-12
V_{diode}(V)	0	.3998	.4916	.5416	.5919	.6018	-2.0	-4.0	-5.0	-10.0	-12.0
I_{diode}(A)	0	5.16E-07	1.79E-05	1.24E-04	8.68E-04	1.27E-03	-2.10E-12	-4.10E-12	-5.10E-12	-1.01E-11	-1.21E 11

```
***** Exp#1 Step 4 ******
V1 1 0 <V>
r1 1 2 470
d1 2 0 diodename
.model diodename D ( Is=0.1p )
.op
.PROBE
.END
```

```
***** Exp#1 Step 5 ******
V1 1 0 <V>
r1 1 2 470
d1 2 0 diodename
.model diodename D ( BV=5.1 )
.op
.PROBE
.END
```

Step 5: for zener diode BV=5.1V

Point #	1	2	3	4	5	6	7	8	9	10	11
V_{supply}(V)	0	0.5	0.65	0.75	1.0	1.2	-5	-8	-10	-11	-12
V_{diode}(V)	0	.4989	.5981	.6215	.6476	.6588	-5.0	-5.5595	-5.5749	-5.5801	-5.584
I_{diode}(A)	0	2.38E-06	1.10E-04	2.73E-04	7.50E-04	1.15E-03	-7.10E-12	-5.19E-03	-9.42E-03	-1.15E-02	-1.37E 02

Experiment:2 Frequency Response of Linear Circuits

Step 4

Frequency (kHz)	0.2	0.5	1	2	5	10	20
Output(mV)	495.6	474.5	416.7	301.0	144.4	74.6	37.6
Output(dB)	0.0	-0.38	-1.50	-4.33	-10.7	-16.5	-22.4

Table: Voltage measurements for the low pass filter circuit

```
***** Exp#2 Step 4 ******
V1 1 0 sin(0 0.707 <freq>)
r1 1 2 10K
c1 2 0 10n
.op
.PROBE
.tran 0.1 1 0 0.1
.END
```

```
***** Exp#2 Step 9 ******
V1 1 0 sin(0 0.707 <freq>)
r1 2 0 10K
c1 1 2 10n
.op
.PROBE
.tran 0.01 0.1 0 0.01
.END
```

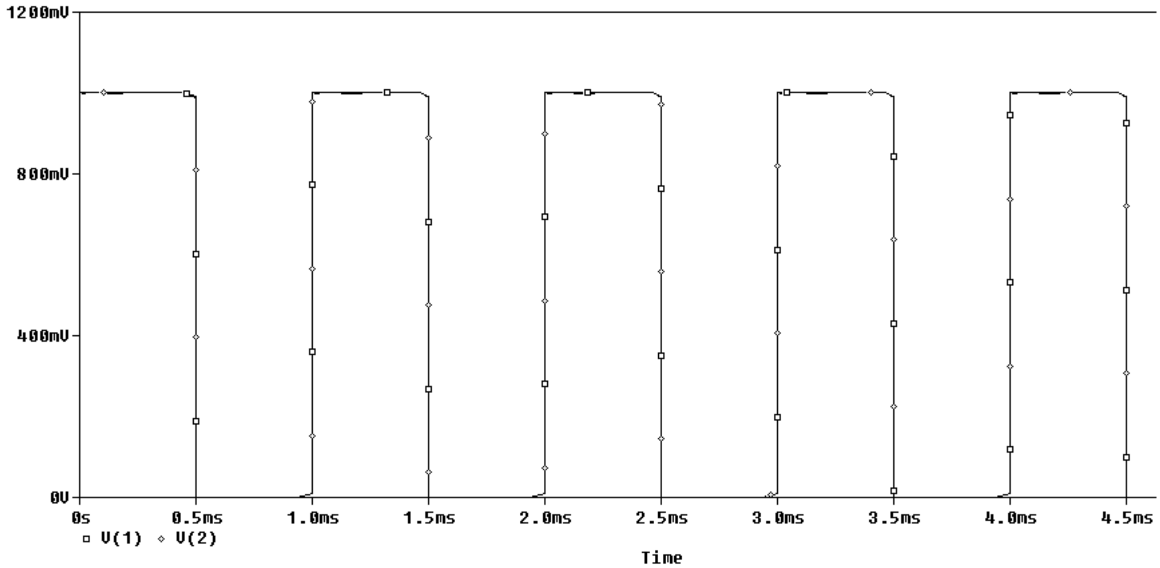
Step 9

Frequency (kHz)	0.2	0.5	1	2	5	10	20
Output(mV)	65.4	156.9	275.8	398.7	478.5	494.3	498.5
Output(dB)	-17.64	-10.06	-5.16	-1.96	-0.38	-0.099	-0.026

Table: Voltage measurements for the high pass filter circuit

Experiment:3 Transients in Linear Circuits (RC, RL)

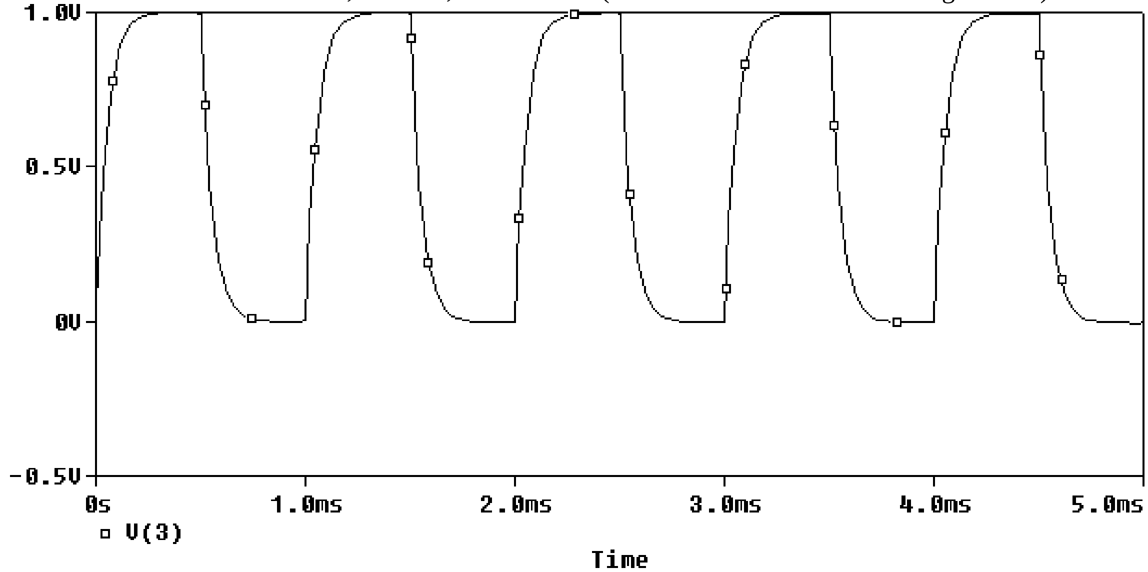
Step 3



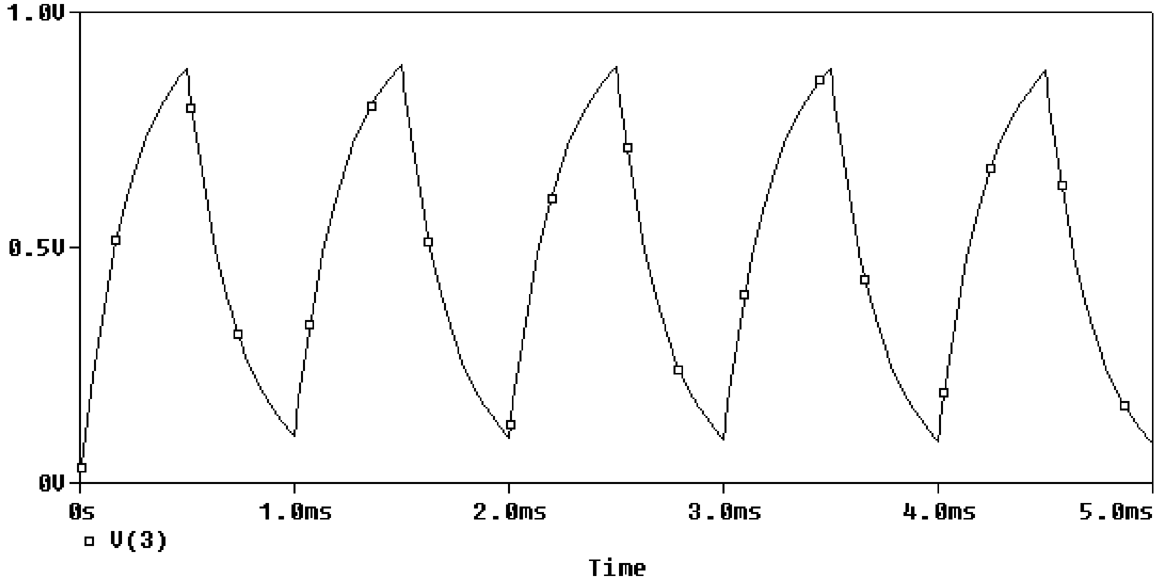
******* Exp#3 Step 3 ******** **V1 1 0 pulse(0 1 0 1p 1p 0.5m 1m)** **r1 1 2 10K** **c1 2 0 47p** **.op** **.tran 0.1m 5m 0 0.1m** **.PROBE** **.END**	******* Exp#3 Step 15 ******** **V1 1 0 pulse(0 1 0 1p 1p 0.5m 1m)** **r1 3 0 <R>** **c1 2 3 0.47m** **l1 1 2 54m** **.op** **.tran 0.05m 5m 0 0.05m** **.PROBE** **.END**

Step 15

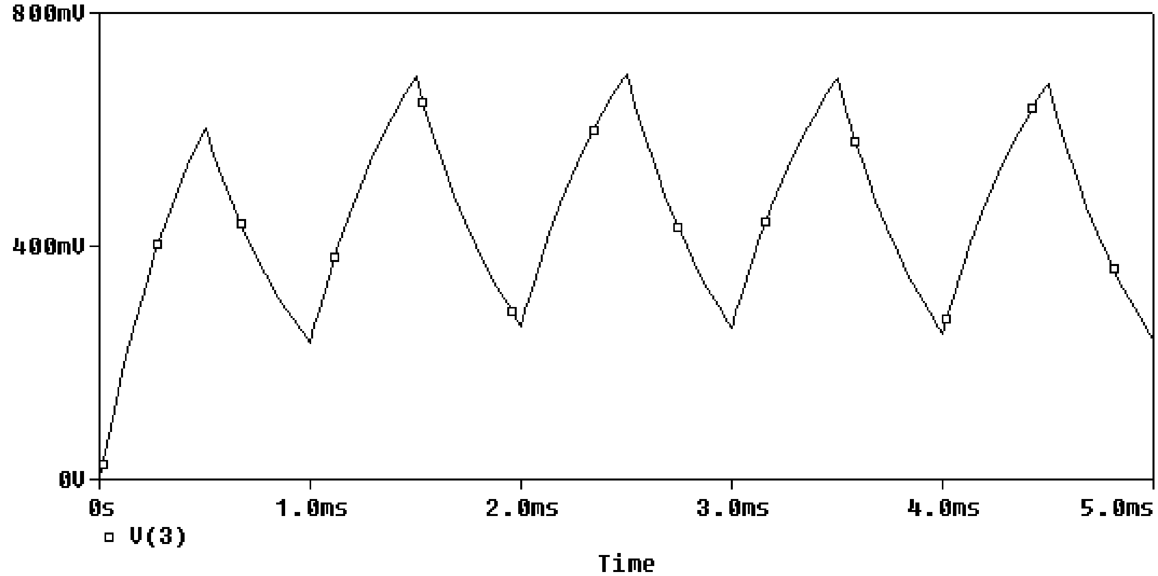
RC/2L > 1   L=54mH, R=1KΩ, C= 0.47mF   (We didn't have 100mH's during the lab.)



RC/2L = 1   L=54mH, R=230Ω, C= 0.47mF

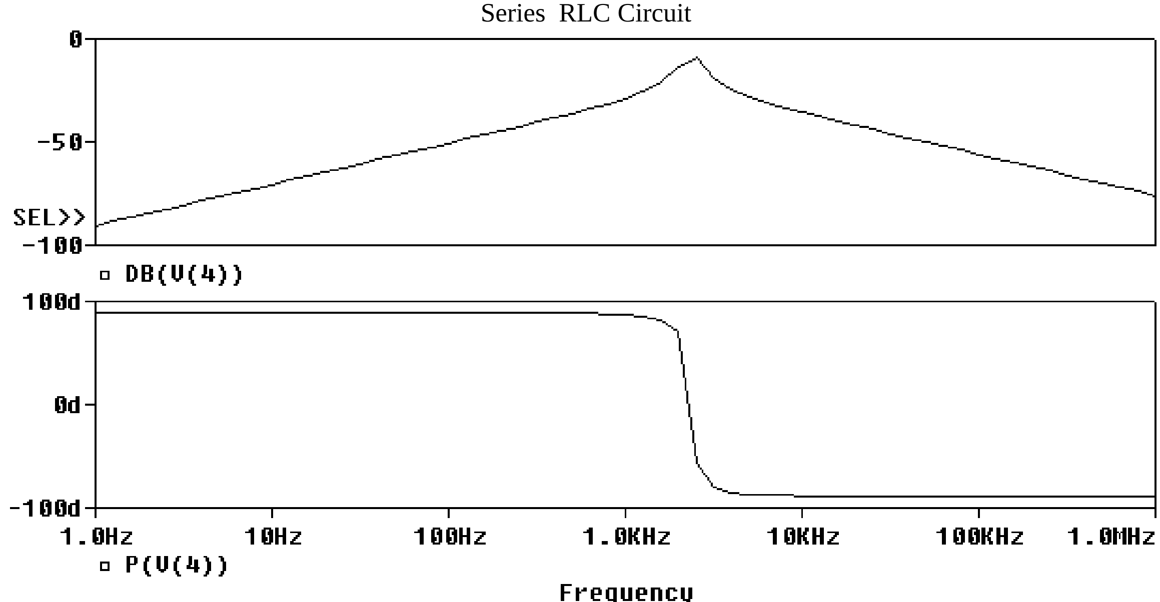


RC/2L < 1   L=54mH, R=100Ω, C= 0.47mF



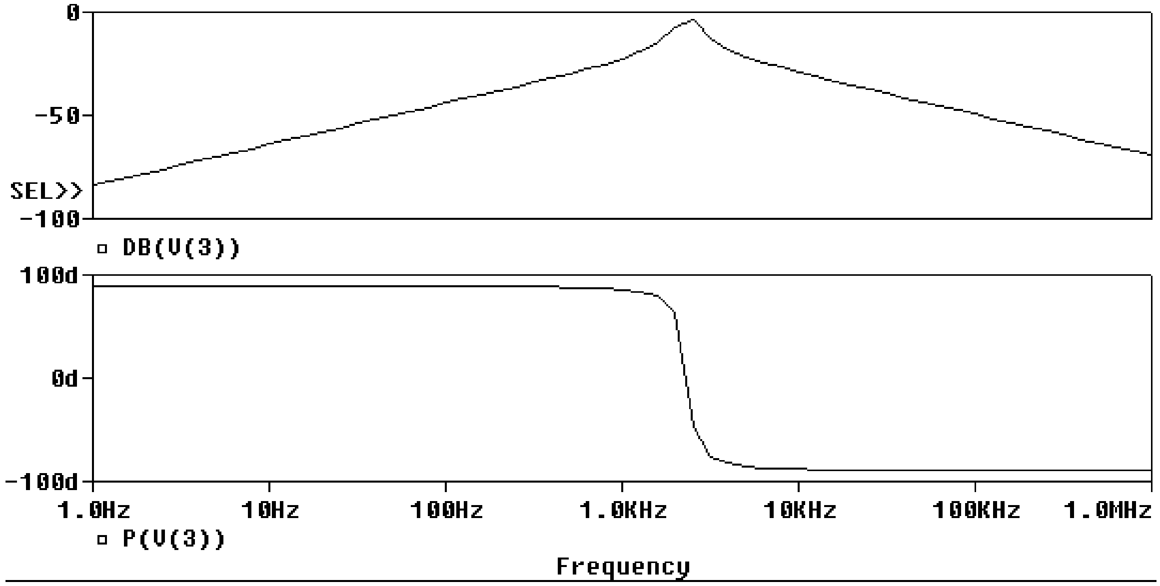
Experiment:4 Resonance Circuits

Series RLC Circuit



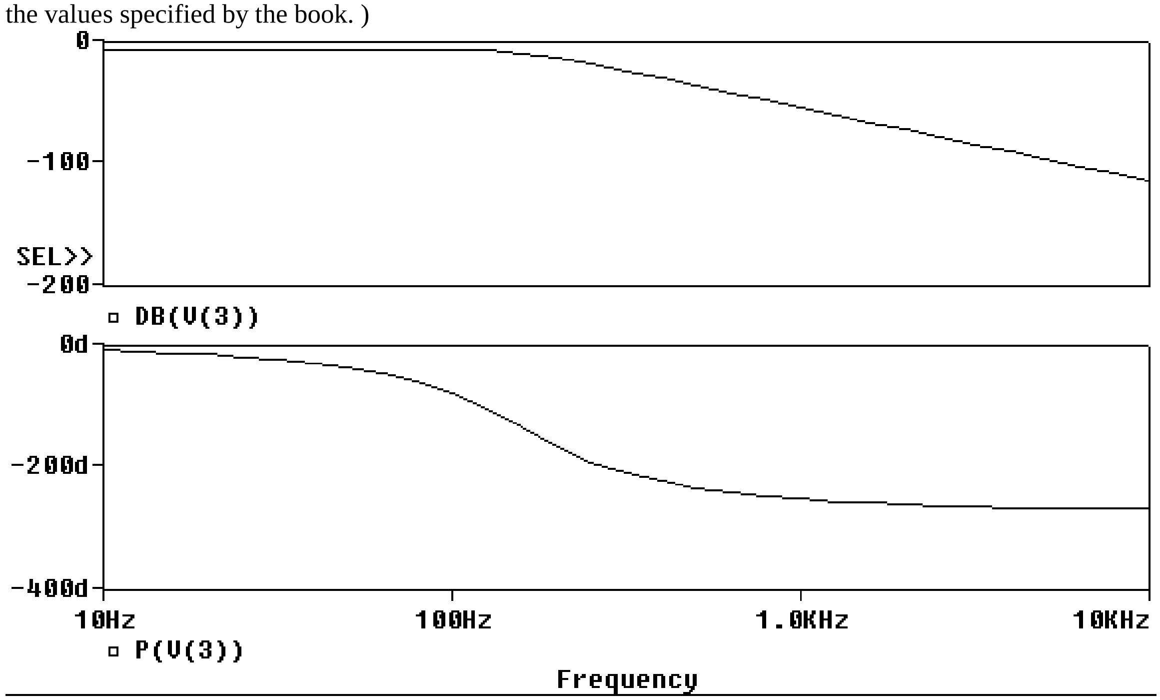
***** Exp#4 Series RLC ******	***** Exp#4 Parallel RLC ******
V1 1 0 AC 1	V1 1 0 AC 1
r1 1 2 50	r1 1 2 50
l1 2 3 100m	l1 3 0 100m
c1 3 4 47n	c1 3 0 47n
r2 4 0 100	r2 2 3 10K
.ac DEC 10 1 1meg	.ac DEC 10 1 1meg
.op	.op
.PROBE	.PROBE
.END	.END

Parallel RLC Circuit



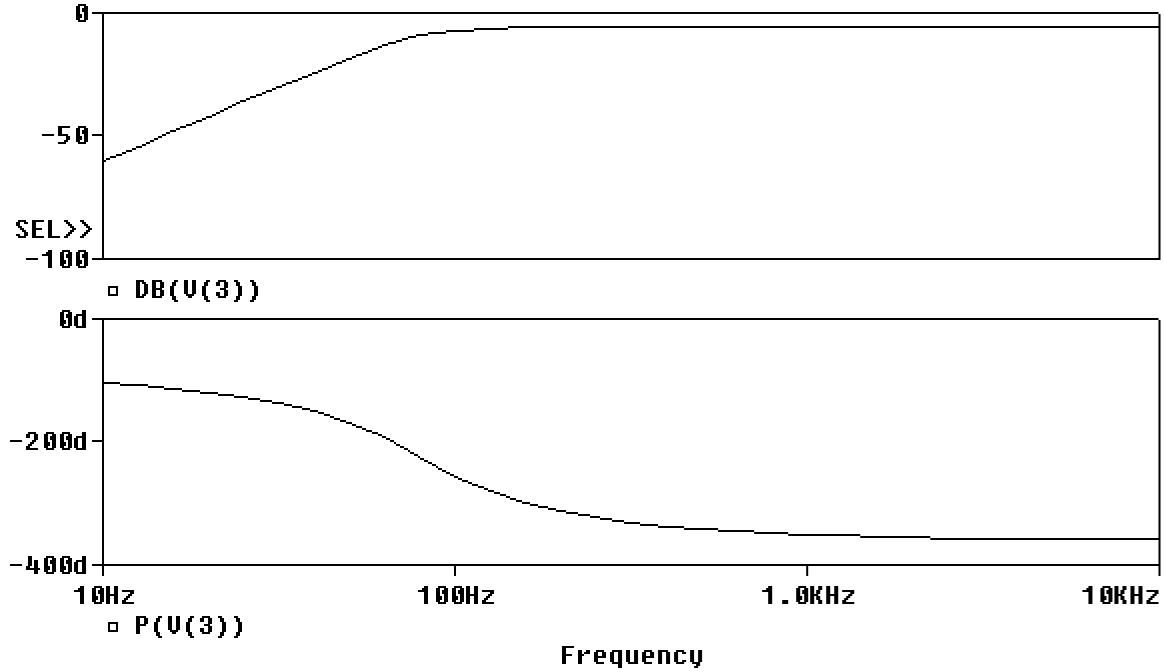
Experiment:5 RLC Filters

3. order Low Pass Butterworth Filter: R_S = 50Ω, R_L = 50Ω, C_1= 20uF, C_2= 20uF, L_2= 100mH f= 159Hz
(We did not implement this due to lack of 100mH inductors. However I choose to simulate the circuit with the values specified by the book.)

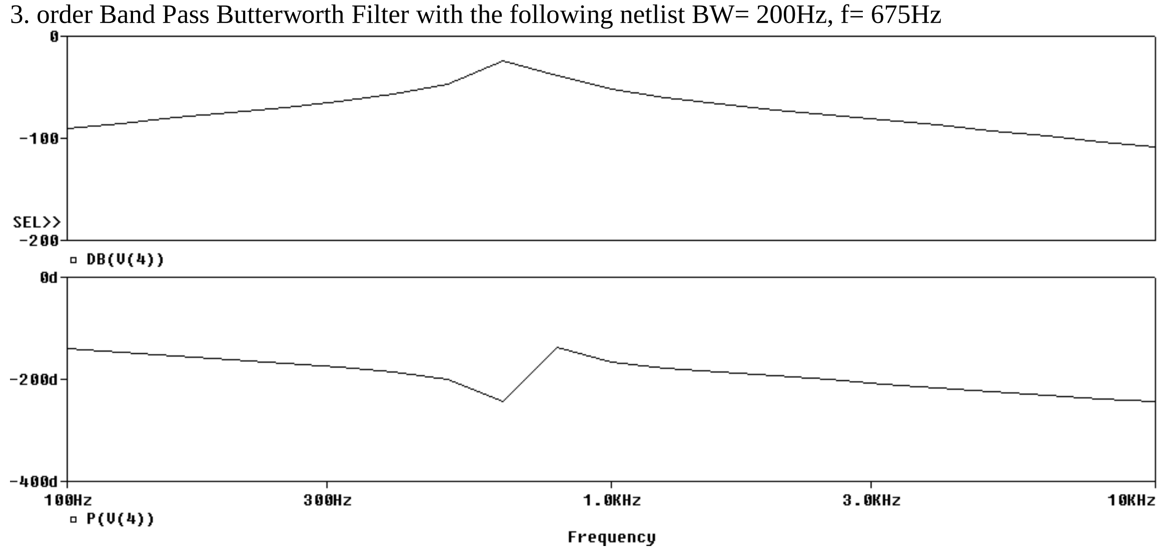


***** Exp#5 3. order Low Pass Butterworth Filter ******	***** Exp#5 3. order High Pass Butterworth Filter ******	***** Exp#5 3. order Band Pass Butterworth Filter ******
V1 1 0 AC 1 r1 1 2 50 l1 2 3 100m c1 2 0 20u c2 3 0 20u r2 3 0 50 .ac DEC 10 10 10K .op .PROBE .END	V1 1 0 AC 1 r1 1 2 50 c1 2 3 20u l1 2 0 100m l2 3 0 100m r2 3 0 50 .ac DEC 10 10 10K .op .PROBE .END	V1 1 0 AC 1 r1 1 2 50 c1 2 0 16u c2 4 0 16u c3 3 4 0.7u l1 2 3 80m l2 4 0 3.5m l3 2 0 3.5m r2 3 0 50 .ac DEC 10 100 10K .op .PROBE .END

3. order High Pass Butterworth Filter: R_S = 50Ω, R_L = 50Ω, C_1= 20uF, L_1= 100mH, L_2= 100mH, f= 80Hz

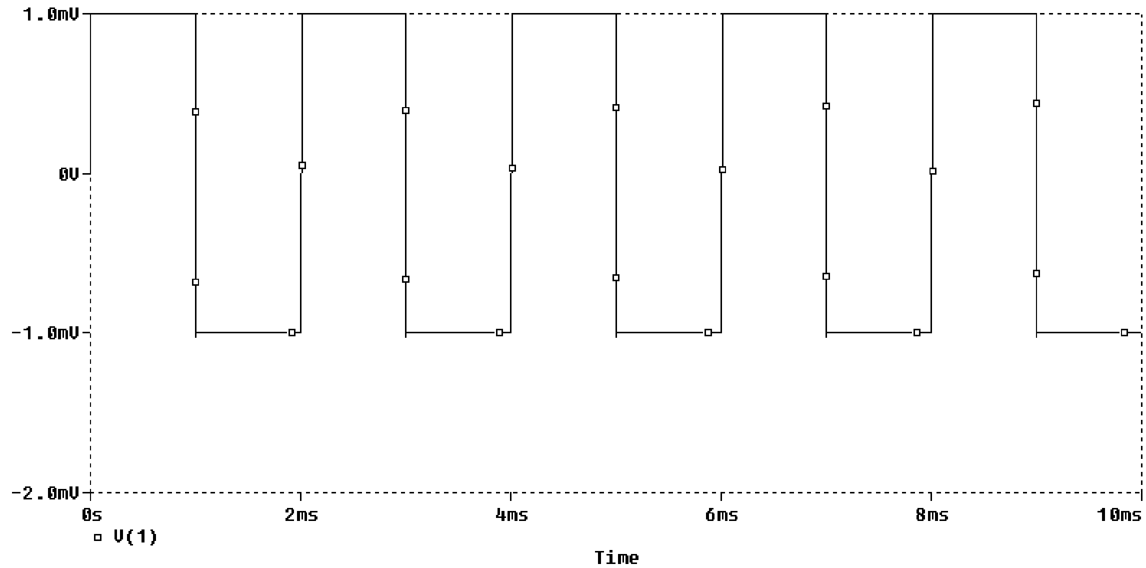


3. order Band Pass Butterworth Filter with the following netlist BW= 200Hz, f= 675Hz



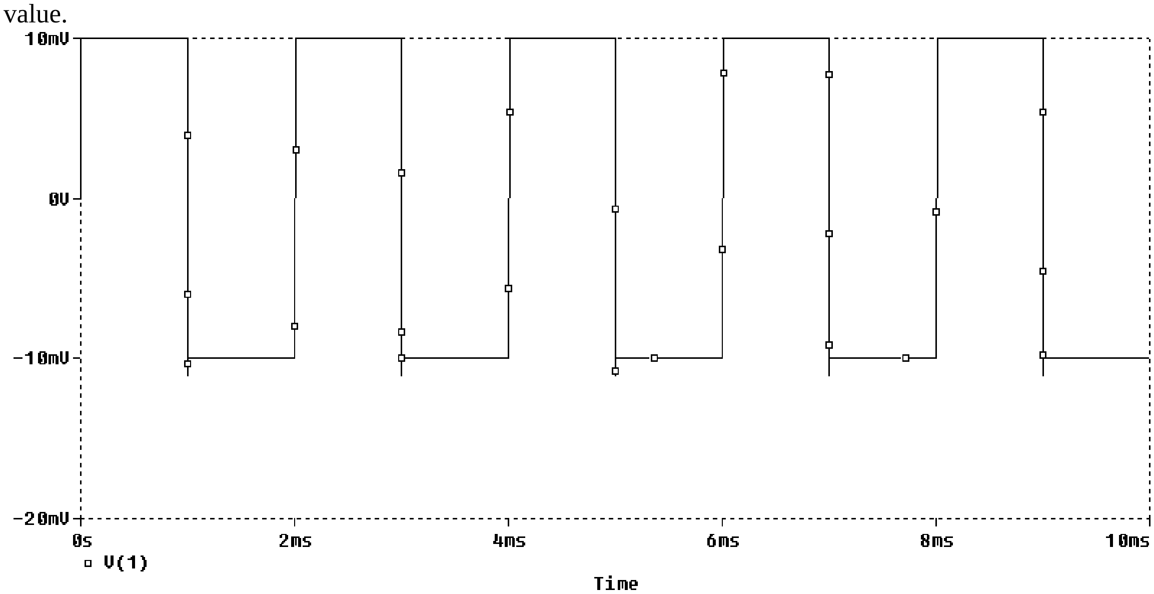
Experiment:9 Active Simulation of Inductors

Step 1-2



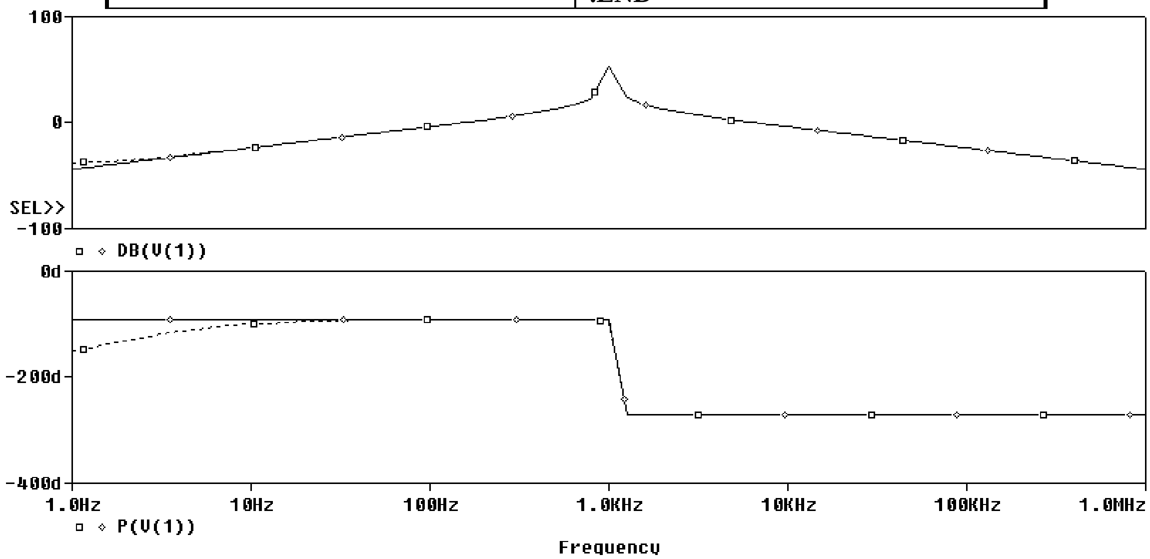

```
***** Exp#9 Step 1-2 ******
I1 0 1 pulse(-0.5m 0.5m 0 1m 1m 1p
2m)
r1 1 2 1K
r2 2 5 1K
r3 5 3 1K
r4 4 0 1K
c1 3 4 1n
xop1 5 1 3 ideal_opamp
xop2 5 4 2 ideal_opamp
.subckt ideal_opamp 1 2 3
E 3 0 1 2 -1G
.ends ideal_opamp
.op
.tran 0.01 10m 0 0.01
.PROBE
.END
```

I changed R_2 to 100Ω, as seen from the graph below, the inductor value turned out to be 10 times the first value.



Step 3:

***** Exp#9 Step3 Ideal Case ******	***** Exp#9 Step3 Non-Ideal Case ******
I1 6 0 AC 1 r1 1 2 1K r2 2 5 1K r3 5 3 1K r4 4 0 1K c1 3 4 1n xop1 5 1 3 ideal_opamp xop2 5 4 2 ideal_opamp r5 6 1 1K c2 1 0 25u .subckt ideal_opamp 1 2 3 E 3 0 1 2 -1G .ends ideal_opamp .op .ac DEC 10 1 1meg .PROBE .END	**I1 6 0 AC 1 r1 1 2 1K r2 2 5 1K r3 5 3 1K r4 4 0 1K c1 3 4 1n xop1 5 1 3 nonideal_opamp xop2 5 4 2 nonideal_opamp r5 6 1 1K c2 1 0 25u .subckt nonideal_opamp 1 2 4 Ri 1 2 2meg E 3 0 1 2 -200K Ro 4 3 75 .ends nonideal_opamp .op .ac DEC 10 1 1meg .PROBE .END**



Both bode diagrams put together on the same graph. Dotted graph is the non-ideal one.

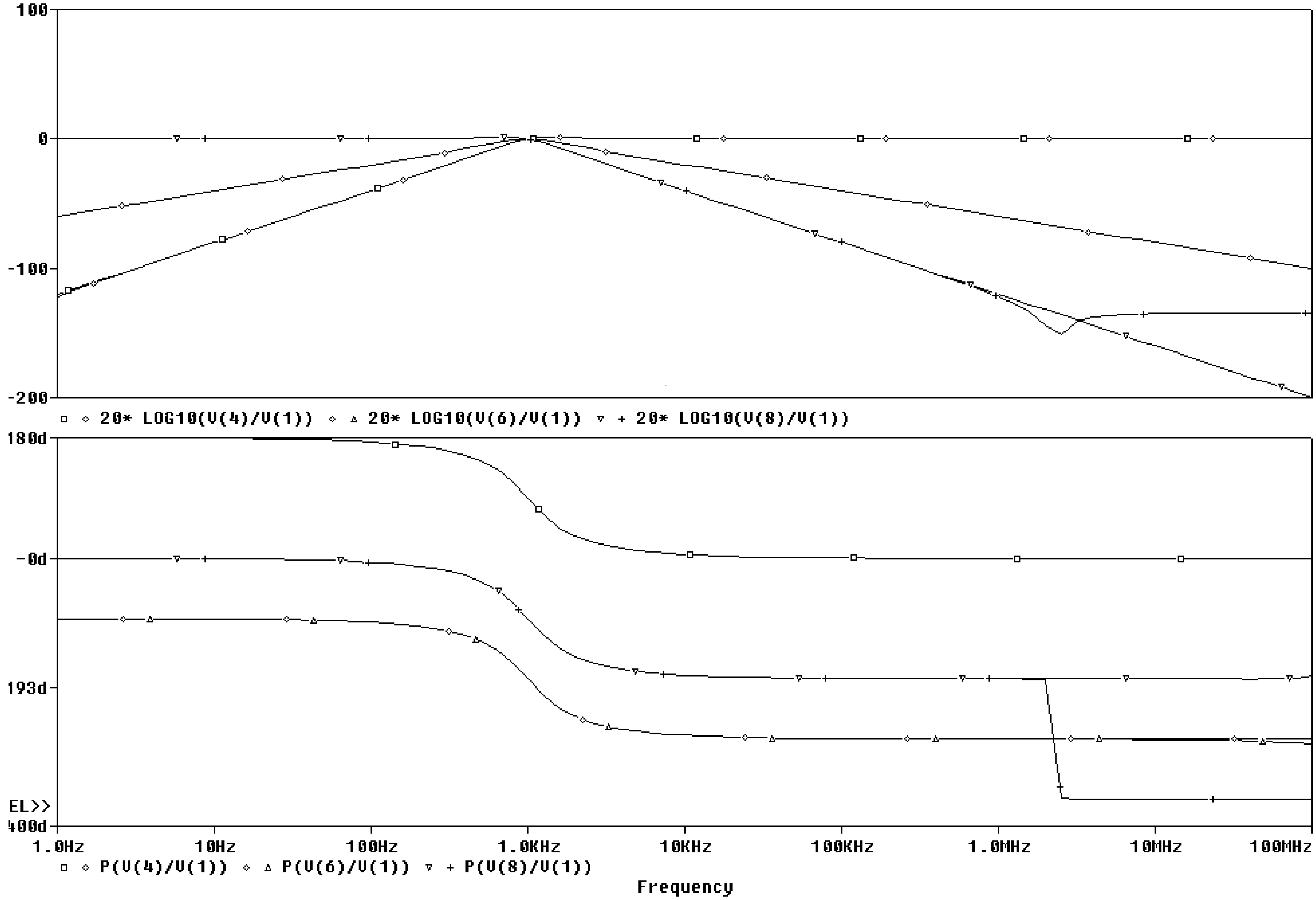
Experiment 11 Multifunction Filter Simulation

First Part

***** Exp#11 First part with Ideal Opamp ******	***** Exp#11 First part with Ideal Opamp ******
V1 1 0 AC 1 r0 3 4 1K r1 3 8 1K r2 1 2 1K r3 2 6 1K r4 4 5 338.6 r5 6 7 338.6 c1 5 6 470n c2 7 8 470n xop1 3 2 4 ideal_opamp xop2 5 0 6 ideal_opamp	**V1 1 0 AC 1 r0 3 4 1K r1 3 8 1K r2 1 2 1K r3 2 6 1K r4 4 5 338.6 r5 6 7 338.6 c1 5 6 470n c2 7 8 470n xop1 3 2 4 nonideal_opamp xop2 5 0 6 nonideal_opamp**

xop3 7 0 8 ideal_opamp	**xop3 7 0 8 nonideal_opamp**
.subckt ideal_opamp 1 2 3	**.subckt nonideal_opamp 1 2 4**
E 3 0 1 2 -1G	**Ri 1 2 2meg**
.ends ideal_opamp	**E 3 0 1 2 -200000**
.op	**Ro 4 3 75**
.ac DEC 10 1 100meg	**.ends nonideal_opamp**
.PROBE	**.op**
.END	**.ac DEC 10 1 100meg**
	.PROBE
	.END

Q=1 f_0= 1KHz Component values are shown in the netlist



Second Part

******* Exp#11 Second Part with ideal Opamps ********	******* Exp#11 Second Part with Non-ideal Opamps ********
V1 1 0 AC 1	**V1 1 0 AC 1**
r0 3 4 1K	**r0 3 4 1K**
r1 3 8 1K	**r1 3 8 1K**
r2 1 2 1K	**r2 1 2 1K**
r3 2 6 9K	**r3 2 6 9K**
r4 4 5 338	**r4 4 5 338**
r5 6 7 338	**r5 6 7 338**
c1 5 6 47n	**c1 5 6 47n**
c2 7 8 47n	**c2 7 8 47n**

xop1 3 2 4 ideal_opamp **xop2 5 0 6 ideal_opamp** **xop3 7 0 8 ideal_opamp** **.subckt ideal_opamp 1 2 3** **E 3 0 1 2 -1G** **.ends ideal_opamp** **.op** **.ac DEC 10 1 100meg** **.PROBE** **.END**	**xop1 3 2 4 nonideal_opamp** **xop2 5 0 6 nonideal_opamp** **xop3 7 0 8 nonideal_opamp** **.subckt nonideal_opamp 1 2 4** **Ri 1 2 2meg** **E 3 0 1 2 -200000** **Ro 4 3 75** **.ends nonideal_opamp** **.op** **.ac DEC 10 1 100meg** **.PROBE** **.END**

Q=5 f_0= 10KHz The calculated values for the components are shown in the netlist