A Basic Introduction of How to EECT Guide

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Spring 2014

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Combine multiple resistors in series and parallel

Combining resistors in series:

Calculating the total resistance for two or more resistors strung end to end — that is, in series — is simple: You simply add the resistance values to get the total resistance.

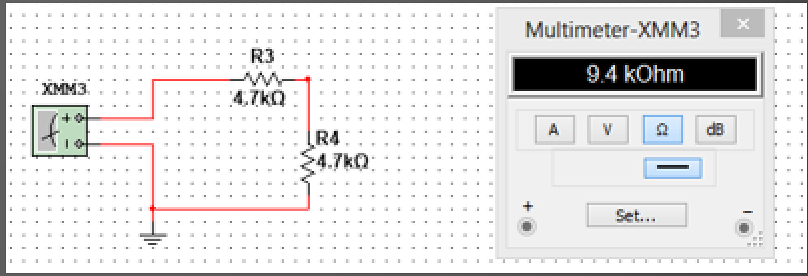
$R_{total}=R_1+R_2+R...$

$4.7\Omega+4.7\Omega=9.4\Omega$

Calculations in Excel

R_1=	4.7	Ω
R_2=	4.7	Ω
R_T=	4.7	Ω

Resistors Simulated in Multisim



Combining Resistors in Parallel

Reciprocal rule

When Resistors are connected in parallel, the total total resistance (R_t) is equal to:

$1/R_t=1/R_1+1/R_2+1/R_3+.......$

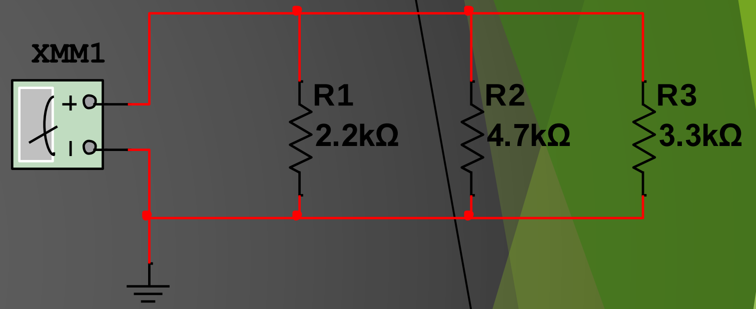
Note: Due to this reciprocal relationship, the total resistance is always smaller than any individual resistance:

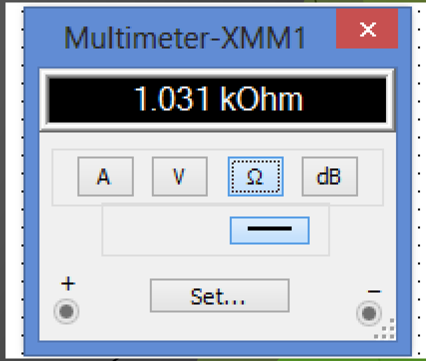
$R_{total}=1/(1/2.2k\Omega+1/4.7\Omega+1/3.3\Omega)=1.031k\Omega$

Calculated by excel

R_1=	2.20E+03
R_2=	4.70E+03
R_3=	3.30E+03
R_T=	1.03E+03

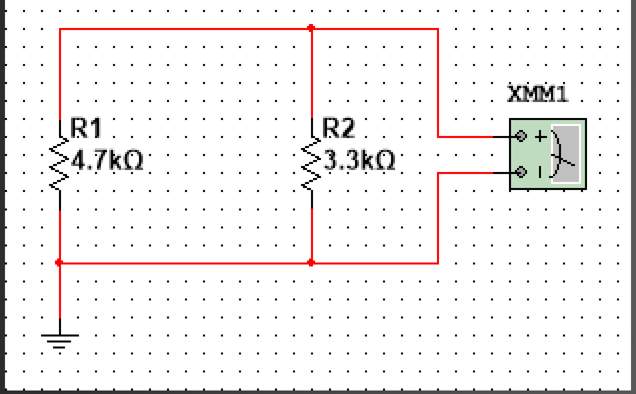
Simulation

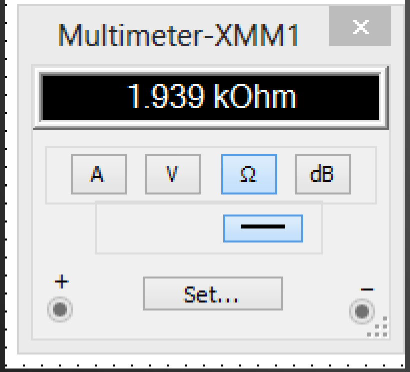




Product over the sum Method

Multisim Simultaion





Calculation by hand an Excel

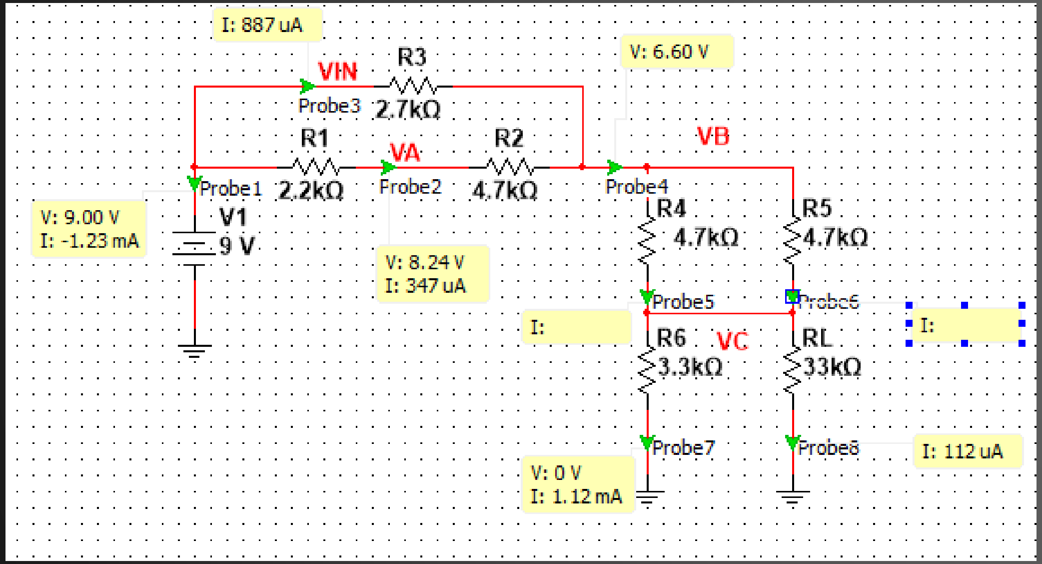
R1	4.70E+03	Ω
R2	3.30E+03	Ω
R_T	1.94E+03	Ω

$$R_T = \frac{R_2 \times R_3}{R_2 + R_3}$$

$$R_T = \frac{4.7K \times 3.3K}{4.7K + 3.3K} = \frac{15.51}{8K} = 1.938K\ \Omega$$

By example calculate RT, IT, PT, and all the nodal voltages, branch currents and power

Calculate RT, IT, PT, and all the nodal voltages, branch currents and power dissipation of a resistor network.



Vin =	9		
R1 =	2.2E+3		
R2 =	4.7E+3		
R3 =	2.7E+3		
R4 =	4.7E+3		
R5 =	4.7E+3		
R6 =	3.3E+3		
RL =	33.0E+3		
R12 =	6.9E+3		
R123 =	1.9E+3		
R45 =	2.4E+3		
RL6 =	3.0E+3		
RL456 =	5.4E+3		
RT =	7.3E+3		
IT =	1.2E-3		
VB =	6.60	PR1 =	265.2E-6
VC =	3.70	PR2 =	566.6E-6
IProbe5 =	617.2E-6	PR3 =	2.1E-3
IProbe6 =	617.2E-6	PR4 =	1.8E-3
IProbe3 =	887.3E-6	PR5 =	1.8E-3
IProbe2 =	347.2E-6	PR6 =	4.2E-3
IProbe7 =	1.1E-3	PRL =	415.6E-6
IProbe8 =	112.2E-6	PT =	11.110E-3
VA =	8.24	PT check =	11.110E-3

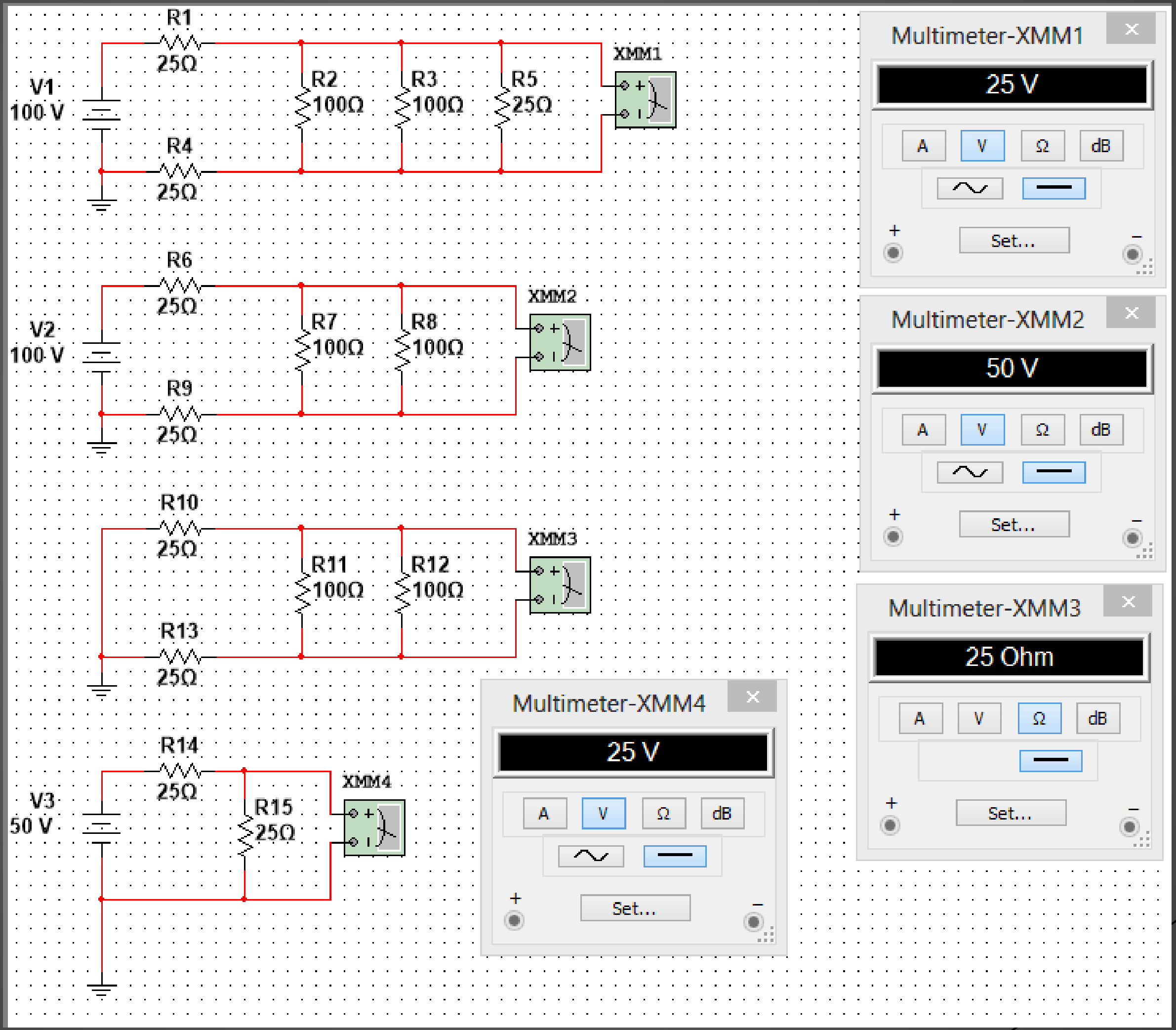
R12=R1+R2
R123=(R3*R12)/(R3+R12)
R45=R4/2
RL6=(R6*RL)/(R6+RL)
RL456=R45+RL6
RT=R123+RL456
IT=Vin/RT
VB=RL456*IT
VC=RL6*BIT
IProbe5=(VB-VC)/R4
IProbe6=(VB-VC)/R5
IProbe3=(VIN-VB)/R3
IProbe2=IT-IPROBE3
IProbe7=VC/R6
IProbe8=VC/RL
VA=B1-(R1*IPROBE2)

PR1=Iprobe^2*R1
PR2=IPROBE2^2*R2
PR3=IPROBE3^2*R3
PR4=IPROBE5^2*R4
PR5=IPROBE6^2*R5
PR6=(VC^2)/R6
PRL=(VC^2)/R7
PT=Vin*IT
PT check=SUM(ALL PROBES)

By example calculate the Thevenin Resistance and Voltage of a resistor network

By example calculate the Thevenin Resistance and Voltage of a resistor network.

- Thevenin's theory is used to simplify complex networks so the calculations of voltage across any two given points in a circuit.



Step 1		
R1=	10.0E+3	Ω
R2=	10.0E+3	Ω
R3=	10.0E+3	Ω
R4=	10.0E+3	Ω
R5=	10.0E+3	Ω
R6=	10.0E+3	Ω

Step 2		
R1=	10.0E+3	Ω
R2=	10.0E+3	Ω
R34=	5.0E+3	Ω
R5=	10.0E+3	Ω
R6=	10.0E+3	Ω

Step 3		
R1=	10.0E+3	Ω
R2=	10.0E+3	Ω
R3456=	25.0E+3	Ω

Step 4		
R1=	10.0E+3	Ω
R23456=	7.1E+3	Ω

Step 5		
R123456=	17.1E+3	Ω

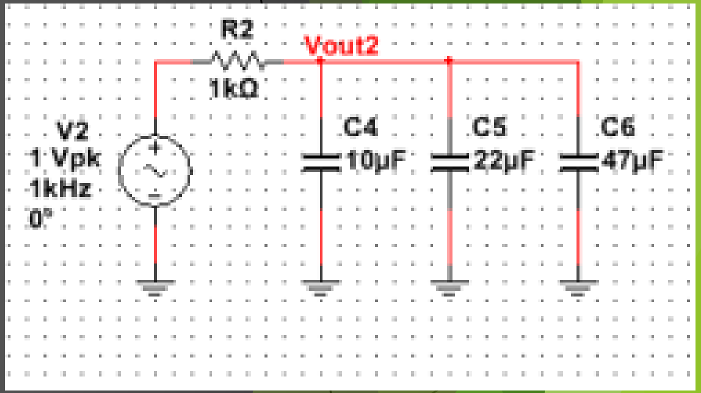
Multiple capacitors combine in series and parallel

Multiple capacitors combined in parallel

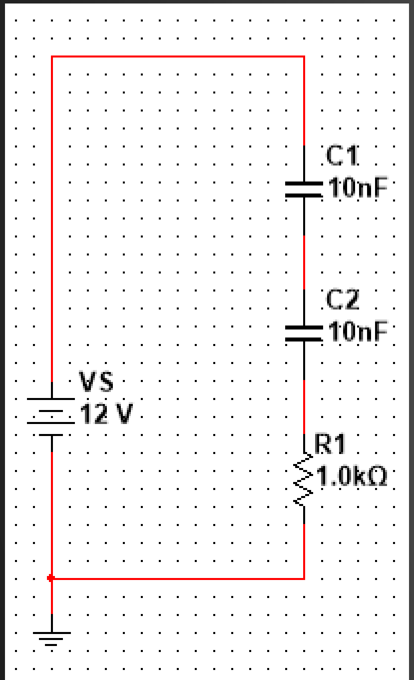
C_1=	10.0E-6
C_2=	22.0E-6
C_3=	47.0E-6
C_t=	79.0E-6

Calculating capacitance for capacitors in parallels is very simple, it is actually the same as calculating resistors in parallel. This is done by adding the capacitors.

Ctotal=C1+C2+C3……



Multiple capacitors combined Series



- For series capacitors:
  - Sum of the reciprocals

$$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \cdots + \frac{1}{C_n}}$$

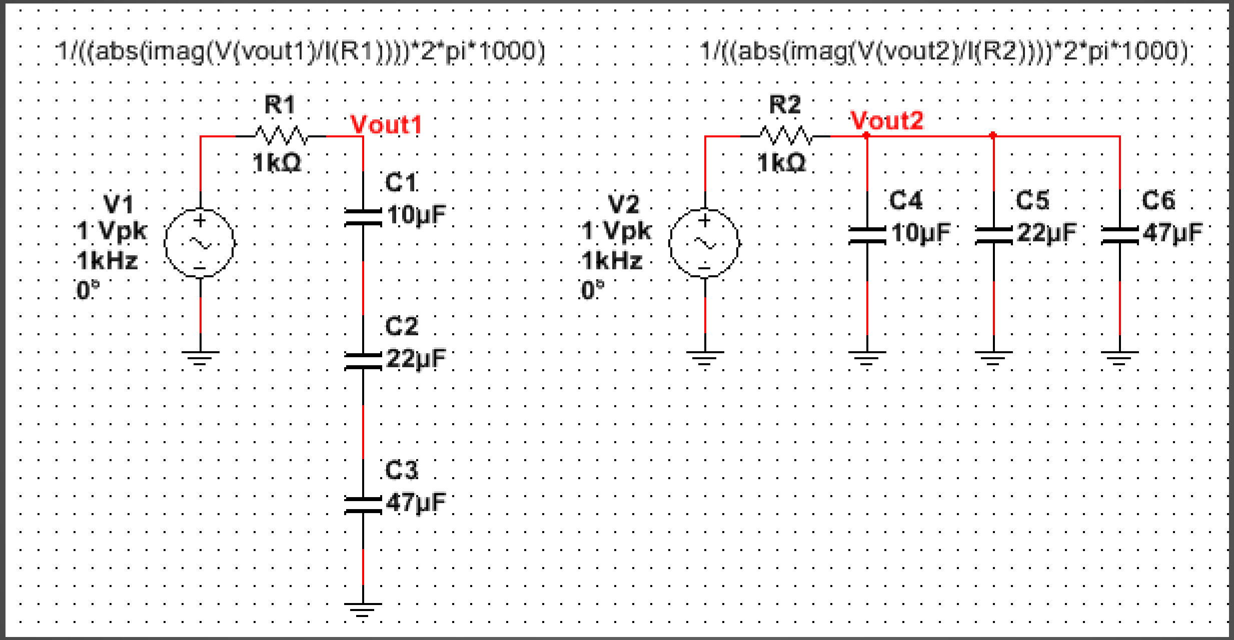
- For two series capacitors:
  - Product-over-the-sum

$$C_T = \frac{C_1 \times C_2}{C_1 + C_2}$$

C1=	10.0E-9	F
C1=	10.0E-9	F
Ct=	5.0E-9	F

Capacitance Reactance
Multisim verification of Series and Parallel

Series   Parallel



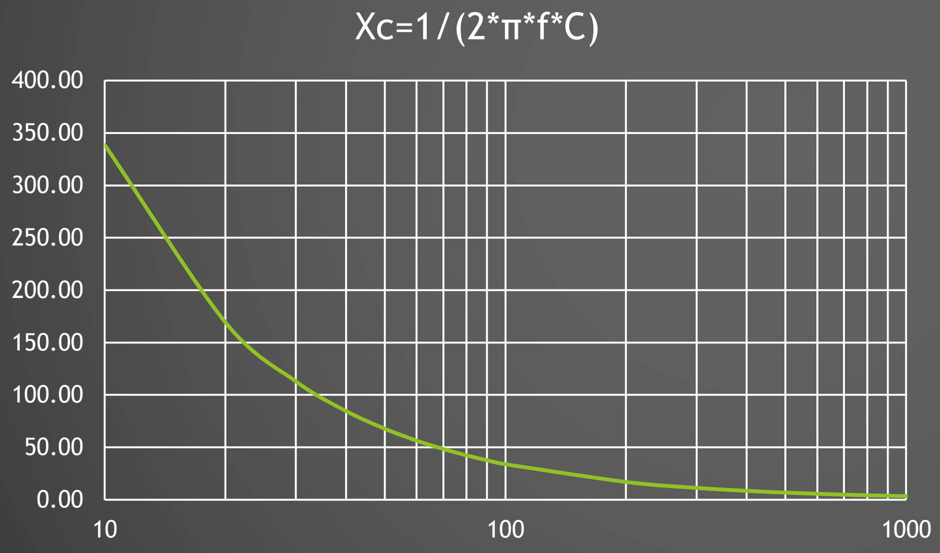
Capacitor
Single Frequency AC Analysis @ 1000 Hz

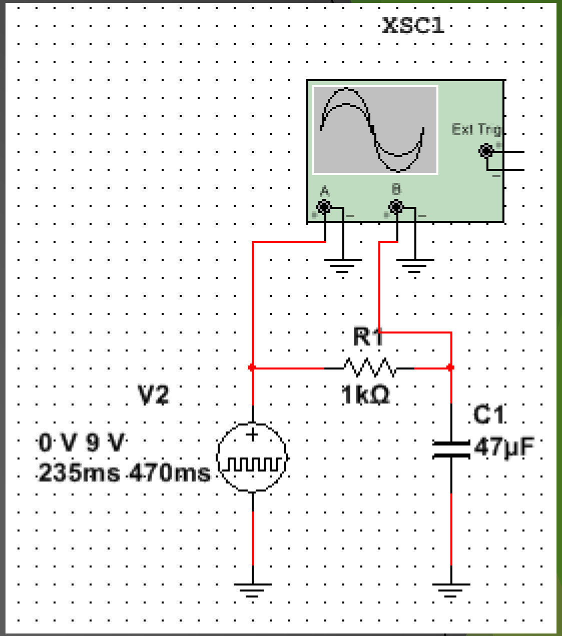
	AC Frequency Analysis	Real	Imaginary
1	1/((abs(imag(V(vout1)/I(R1))))*2*pi*1000)	5.99768 u	0.00000
2	1/((abs(imag(V(vout2)/I(R2))))*2*pi*1000)	79.00000 u	0.00000

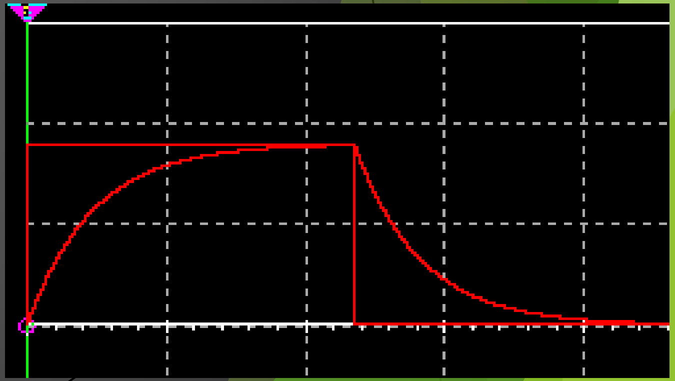
Using a simple RC circuit determine the

a. Time Constant
b. Create a graph that shows the RC time constant as a function of time
c. Determine XC at a fixed frequency
d. Create a graph that shows how XC changes as a function of frequency

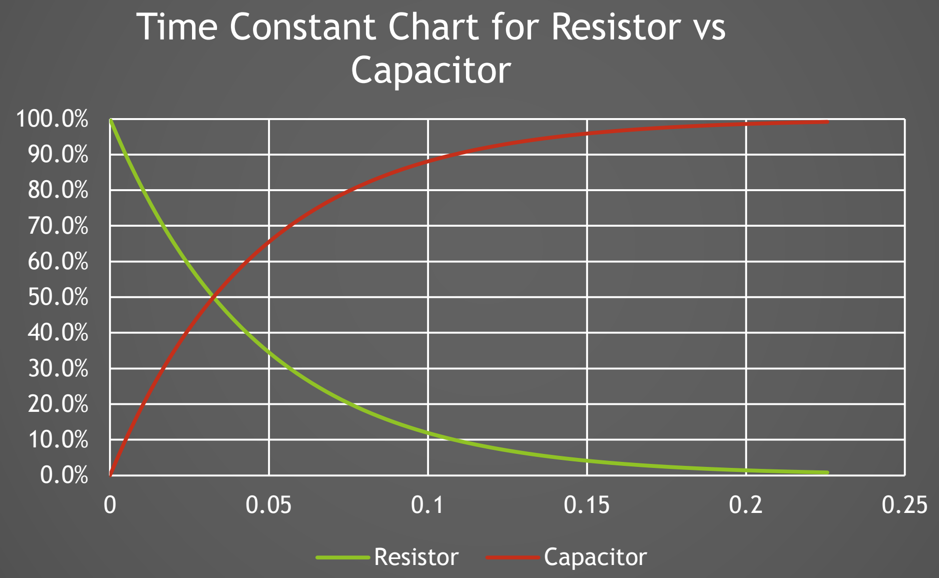
c=	47.0E-6	Farands
Freq	Xc	
10	338.63	
20	169.31	
30	112.88	
40	84.66	
50	67.73	
60	56.44	
70	48.38	
80	42.33	
90	37.63	
100	33.86	
200	16.93	
300	11.29	
400	8.47	
500	6.77	
600	5.64	
700	4.84	
800	4.23	
900	3.76	
1000	3.39	







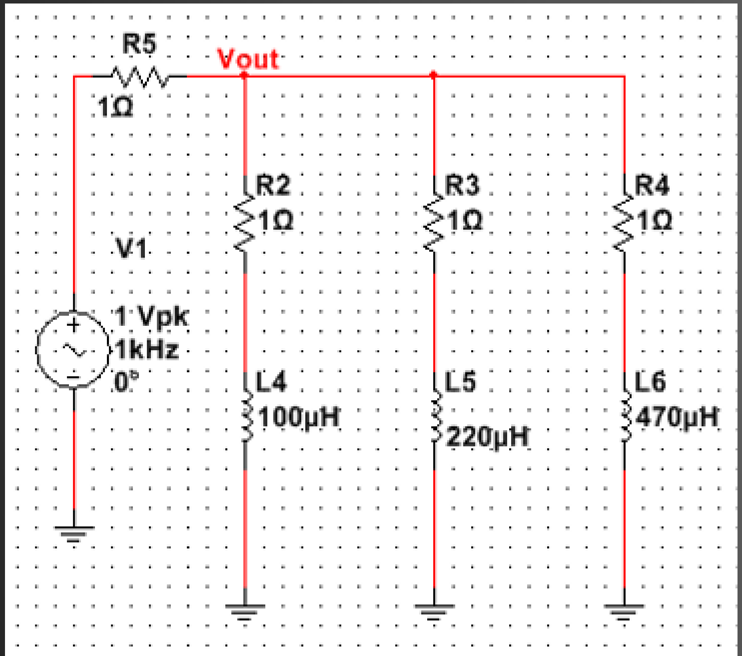
Time Constant chart



Multiple inductors combine in series and parallel

Parallel Inductor Combinations

Multisim Simulations



Excel verification

L1=	1.00E-04	H
L2=	2.20E-04	H
L3=	4.70E-04	H
Lt=	6.00E-05	H

Formula for Parallel inductors

Reciprocal method

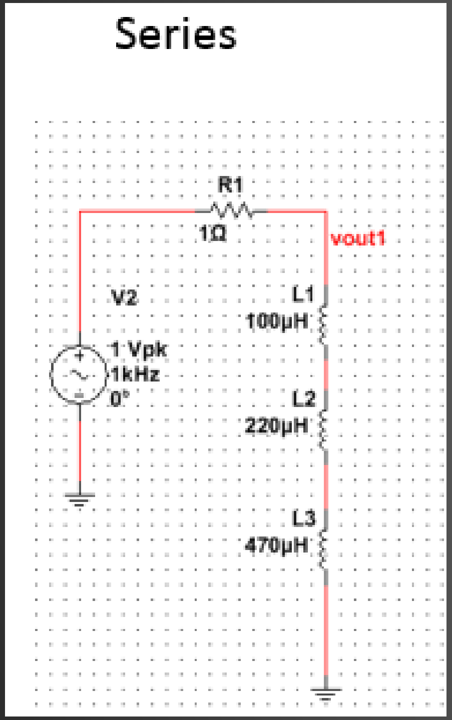
$$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} \cdots + \frac{1}{L_n}}$$

For two inductors by cross product method

$$L_T = \frac{L_1 \times L_2}{L_1 + L_2}$$

Inductors in Series Combination

Multisim Simulation



Excel calculations

L_1=	100.0E-6	H
L_2=	220.0E-6	H
L_3=	470.0E-6	H
L_T=	790.0E-6	H

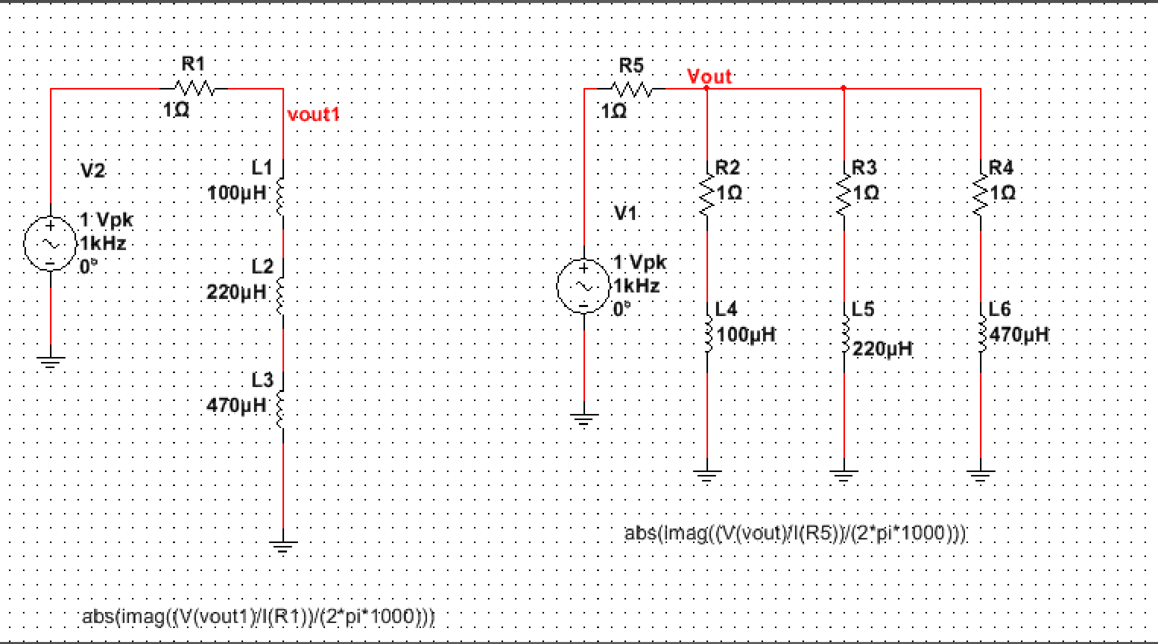
Calculation of series Inductors

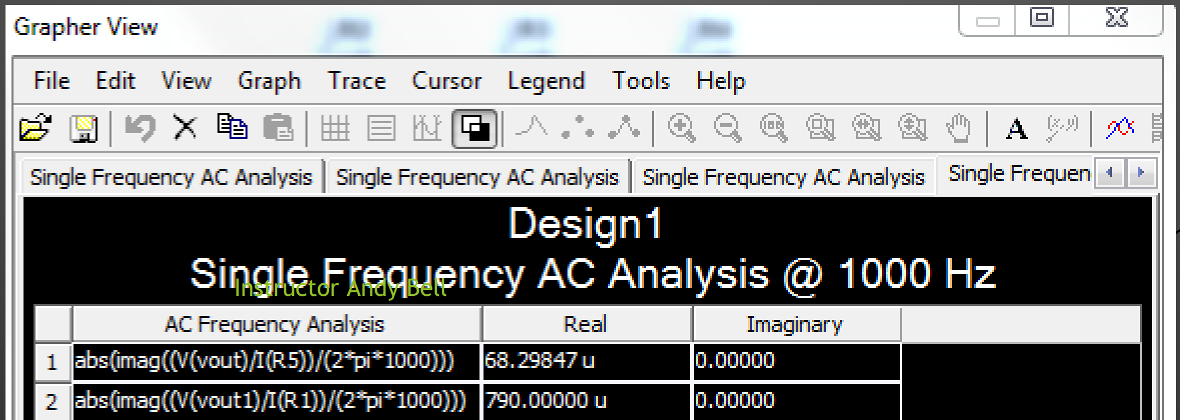
- All the inductance values add together to calculate total Inductance
- $L_T = L_1 + L_2 + L_3$....etc
- Example (Fig. 1-1)
- L_T = 100µH + 220 µH + 470 µH
- L_T = 790 µH

Inductance

Inductors In parallel and Series calculation verification

Series　　　　　　　　Parallel





Design1

Single Frequency AC Analysis @ 1000 Hz

	AC Frequency Analysis	Real	Imaginary
1	abs(imag((V(vout)/I(R5))/(2*pi*1000)))	68.29847 u	0.00000
2	abs(imag((V(vout1)/I(R1))/(2*pi*1000)))	790.00000 u	0.00000

Using a simple RL circuit determine the

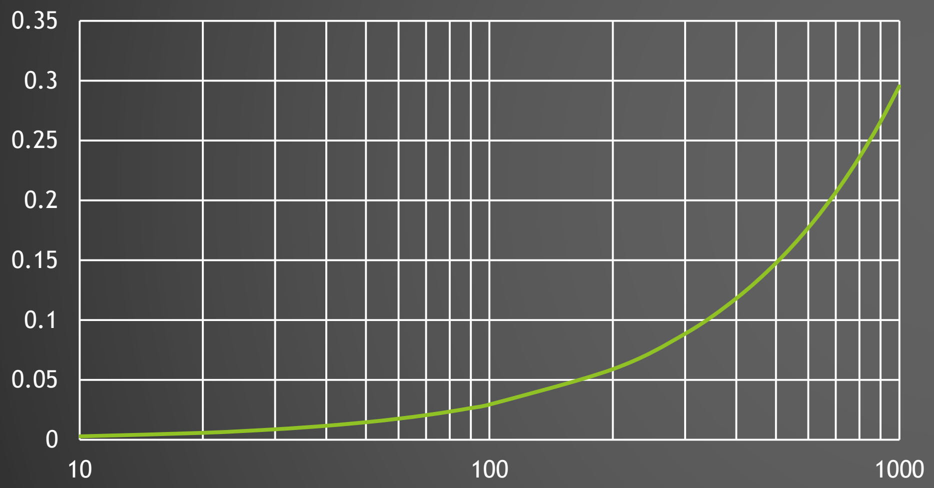
a.) Time Constant

b.) Create a graph that shows the RL time constant as a function of time

c.) Determine XL at a fixed frequency

d.) Create a graph that shows how XL changes as a function of frequency

$X_L=2\pi fL$



	47.0E-6
10	0.002953097
20	0.005906194
30	0.008859291
40	0.011812388
50	0.014765485
60	0.017718583
70	0.02067168
80	0.023624777
90	0.026577874
100	0.029530971
200	0.059061942
300	0.088592913
400	0.118123884
500	0.147654855
600	0.177185826
700	0.206716797
800	0.236247768
900	0.265778738
1000	0.295309709