(Attending online)

ELECTRONIC WORKSHOP – 1

LAB 2 – MEASUREMENT OF RC, RL AND RLC CIRCUITS

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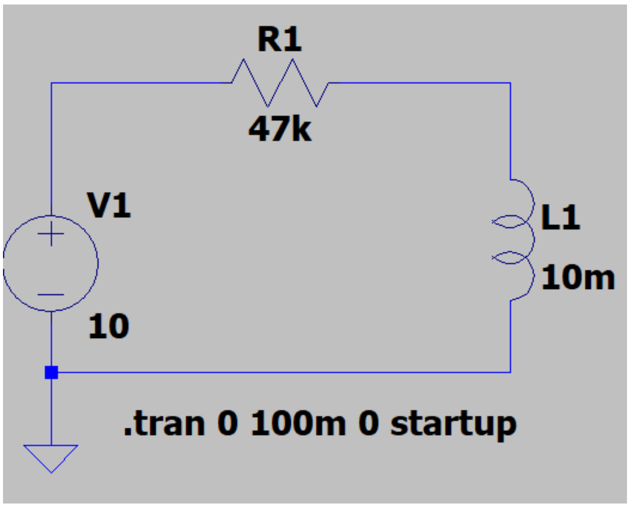
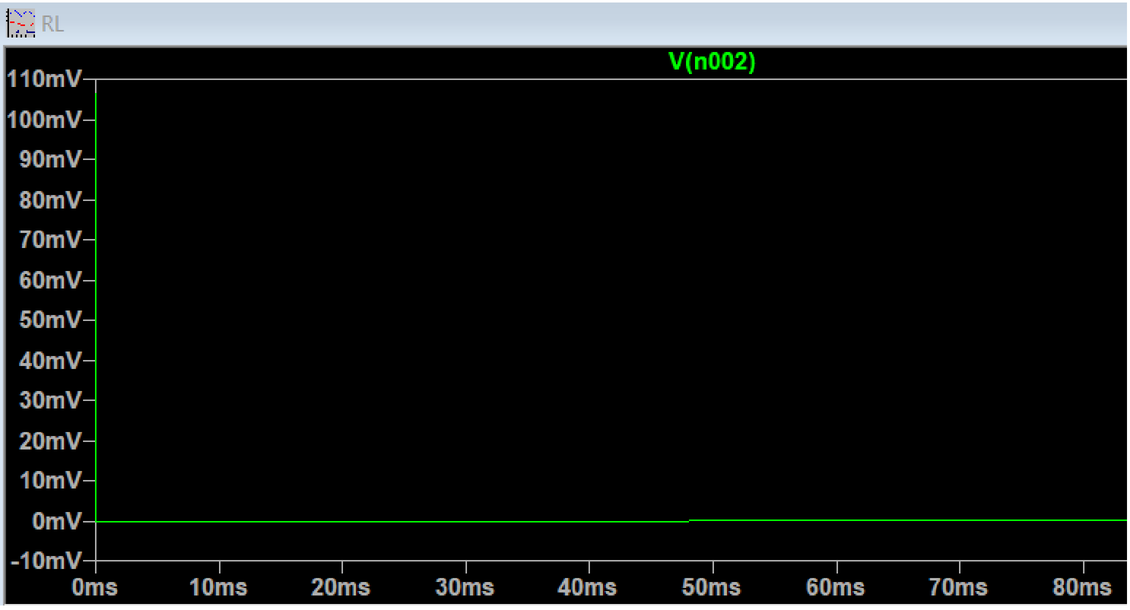
1) Introduction to RL and RC circuits

RL circuit

1) Time constant for the given LR circuit is T = L/R = 10 mH / 47 Kohms = 2.13 X exp(-7)

Expected steady state inductor voltage = 0 (here and for the rest of this doc, exp is in powers of '10' not 'e').



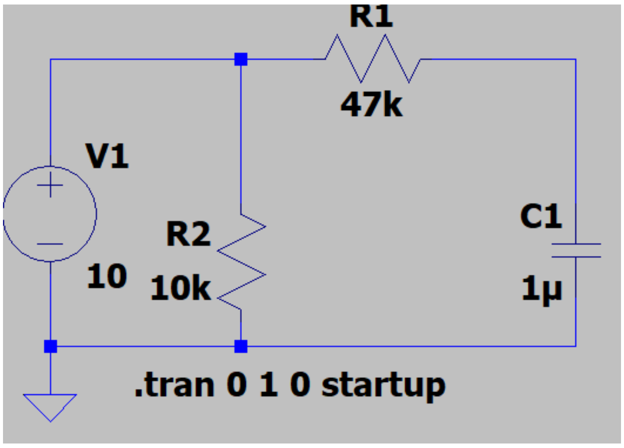


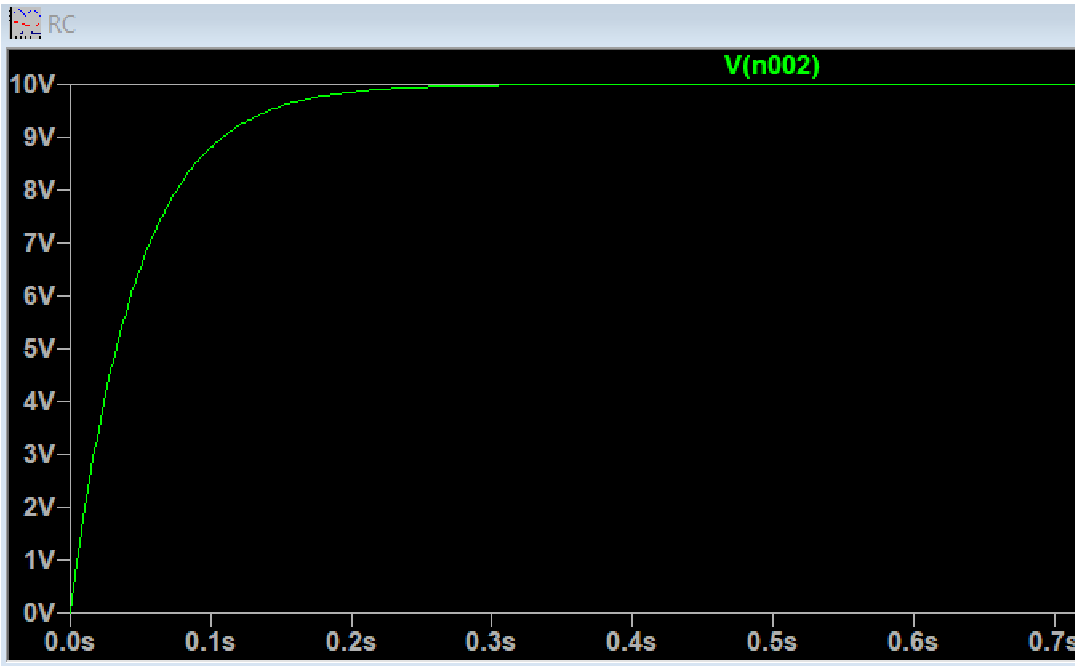
Voltage in steady state = 0.

RC circuit

1) Time constant of circuit = CR. From Thevenin's theorem, R = 47k ohms and C = 1u.

Thus, time constant = 47k X 1u = 4.7 X exp(-2). Expected steady state voltage of capacitor = E = 10V.





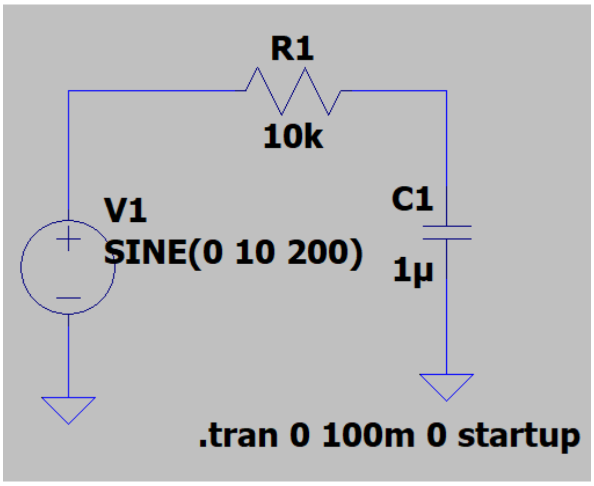
Voltage in steady state = 10.

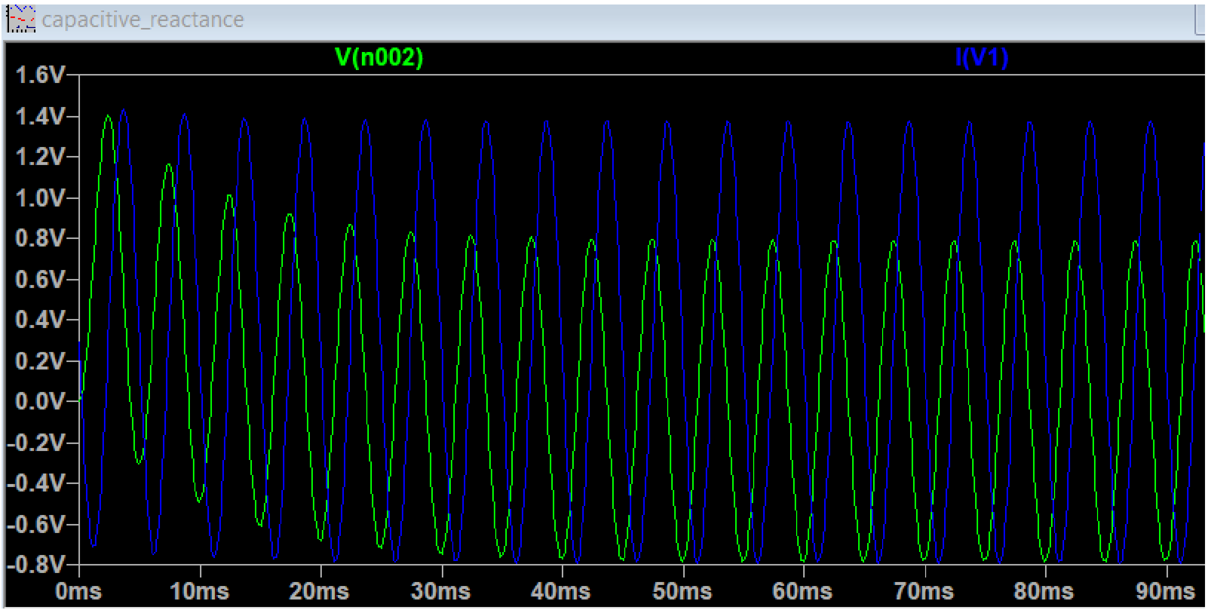
Questions:

1) Approximation of inductor at DC steady state would be a wire ie. it conducts perfectly.
2) Approximation of capacitor at DC steady state would be capacitor would be an open switch ie it does not conduct at all. Does not allow current to pass through.
3) After 5 time constants, RC circuits usually reach steady state.
4) They are usually in the form of a parabola or an inverse parabola and saturate at one point.

2) Capacitive Reactance

1) Circulating current is: Vin / R = 10 V p-p / 10 k ohms = 1 X exp(-3) A p-p
2) Theoretical value of Xc = -j *(1/2piFC) = -j * (1/2*3.14*200*exp(-6)) = 796.2 ohms
3) Peak capacitor voltage = exp(-3)A X 796.2 ohms = 0.8 V
4) For 2.2 uF
    a. Theoretical value of voltage Xc = -j * (1/2piFC) = -j *(1/2*3.14*200*2.2*exp(-6)) = 362 ohms
    b. Peak capacitor voltage = exp(-3)A X 362 ohms = 0.36 V
5) Capacitive reactance should decrease with increase in frequency.





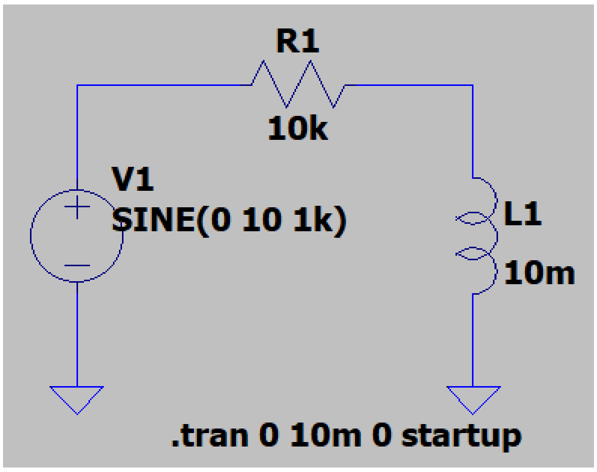
Current leads

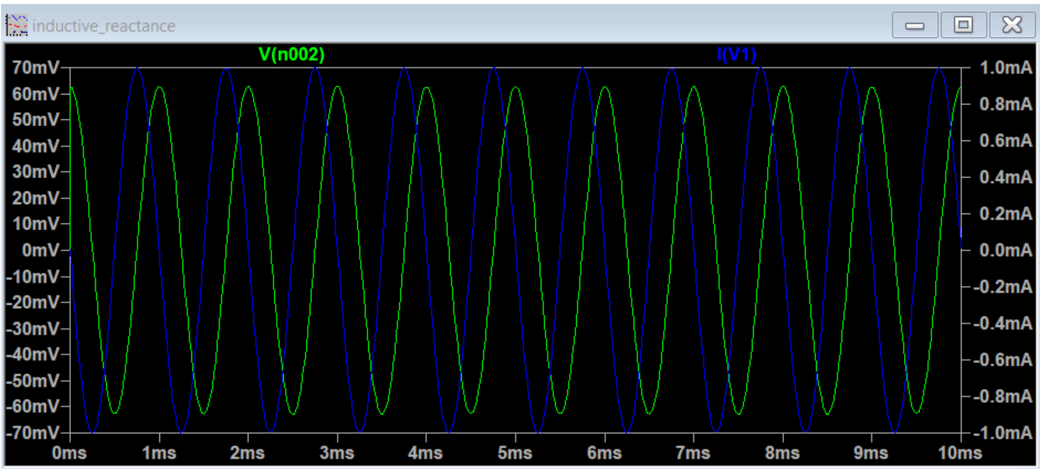
Questions:

1) Capacitive reactance and frequency have an inverse relationship
2) Capacitive reactance and capacitance have an inverse relationship too.
3) The resulting plots would still be of the same shape because its an inverse relationship
4) Capacitive reactance would be 10 times higher if the frequencies are 10 times lower. In this case we might not approximate capacitive reactance as 0 while calculating circulating frequency.

3) Inductive Reactance

1) Circulating current is : V / R = 10V / 10k ohms = 1 mA.
2) Theoretical value of Xl = j2*pi*F*L = j * 2 * 3.14 * 1000* exp(-2) = j * 62.8 ohms.
3) Peak – Peak inductor voltage = 1mA * 62.8 ohms = 62.8 mV
4) For 1mH:
    a. Circulating current = 1mA
    b. Xl = 6.28 ohms
    c. Inductor voltage = 6.28 mA p-p





Voltage leads.

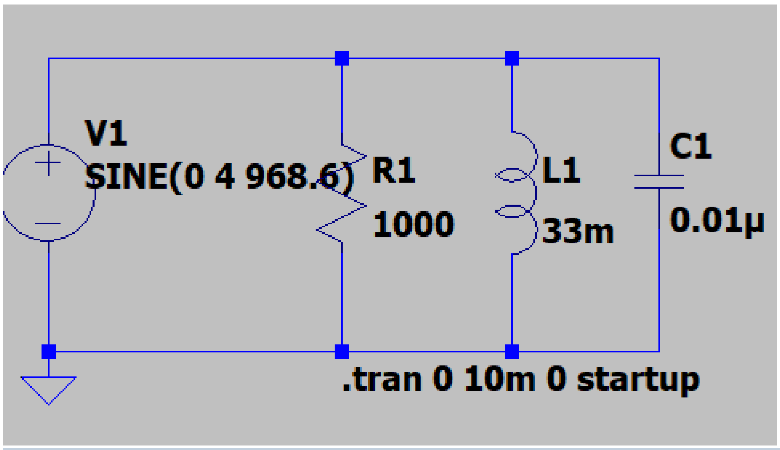
Questions

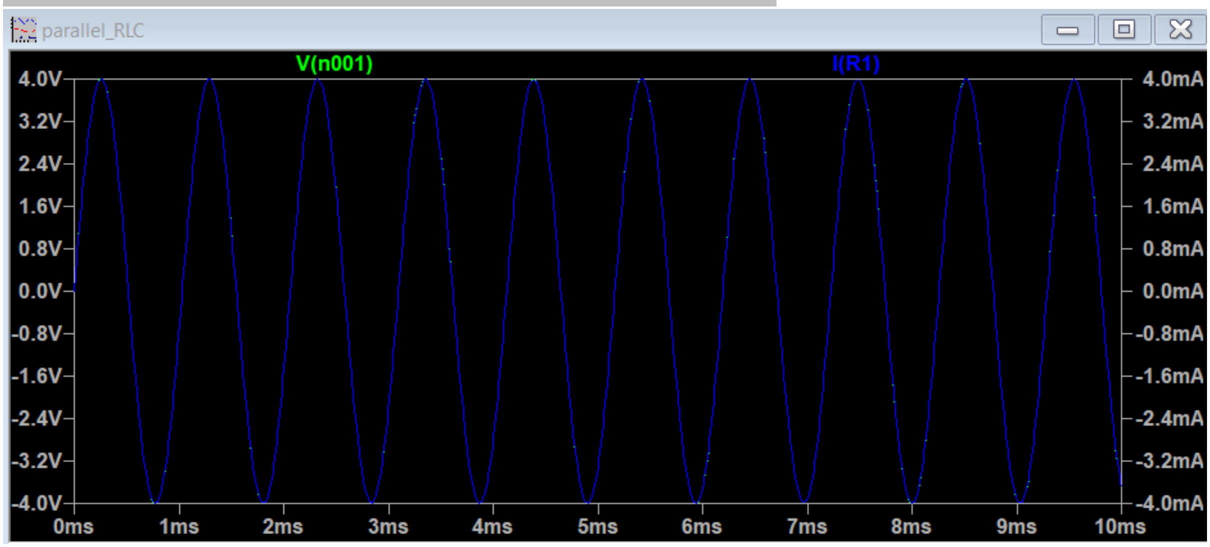
1) Inductive reactance increases with frequency. It is directly proportional.
2) Inductive reactance increases with inductance. It is directly proportional.
3) The reactance would have increased 10 times.

4) Resonance in RLC circuits

1) Parallel RLC
   Resonance is achieved in RLC circuits if f = 1/(2*pi* sqrt(LC)); thus resonance frequency for the given circuit is 968.6 Hz.
2) Series RLC
   Resonance in series RLC circuit is also given by the same formula:
   f = 1/(2*pi*sqrt(LC));
   Frequency of the given circuit is: 8761.2 Hz

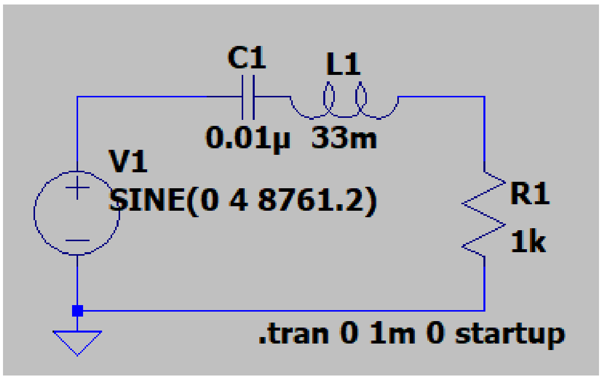
PARALLEL RLC

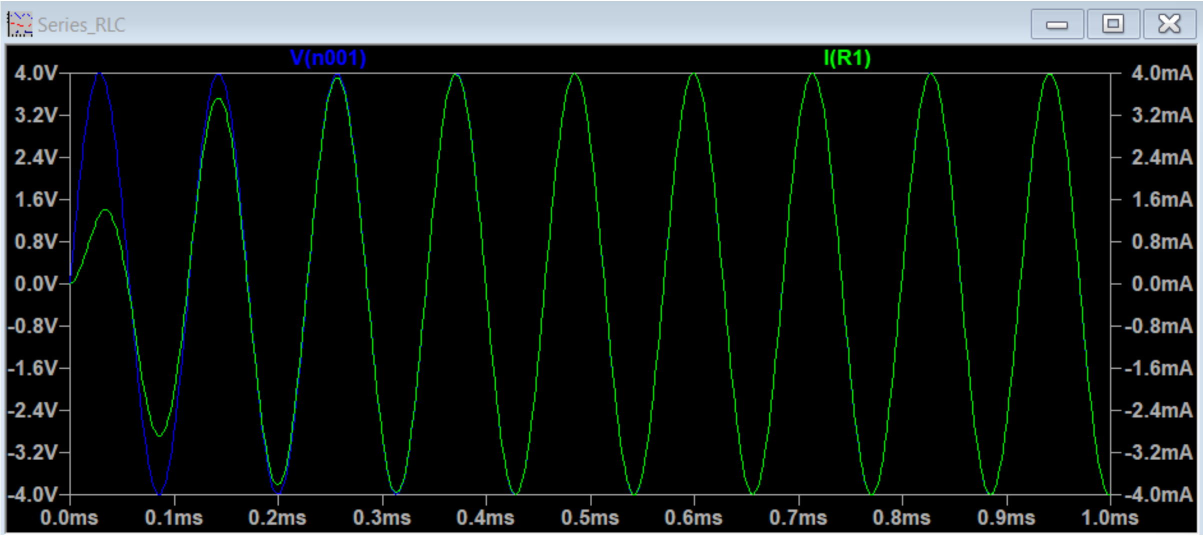




In resonant frequency of 968.6, there is no phase difference between current through R and source voltage.

SERIES RLC





No phase difference in current through resistance and source voltage in resonant frequency.