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CSE 4030
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Lab 7: Inductance and Thevenin equivalent circuit

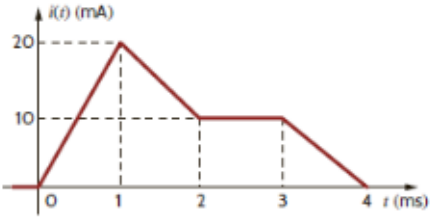
Introduction

In this lab, we had to find the voltage over time in an inductor and the energy stored. We alos had to find the missing resistor value in a circuit using thevenin's thereom and the power of the circuit. First, we show our work by hand then use Pspice simulation software to check. The purpose of this lab is to understand the circuit models for inductors and capacitors to calculate voltages, currents, and powers.

1-1

E6.6 The current in a 5-mH inductor has the waveform shown in Fig. E6.6. Compute the waveform for the inductor voltage.

ANSWER:



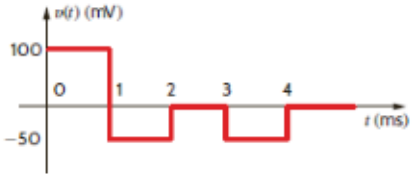


Figure E6.6

E6.7 Compute the energy stored in the magnetic field of the inductor in Learning Assessment E6.6 at $t = 1.5$ ms.

ANSWER:
$W = 562.5$ nJ.

Preparation

1. Find v(t) and the energy stored in the magnetic field of the inductor at t = 2ms (calculate by hand)
2. By using pspice simulation, find v(t)

1-2

E5.16 Given the circuit in Fig. E5.16, find R_L for maximum power transfer and the maximum power transferred.

ANSWER:
$R_L = 6\ \text{k}\Omega$;
$P_L = \frac{2}{3}\ \text{mW}$.

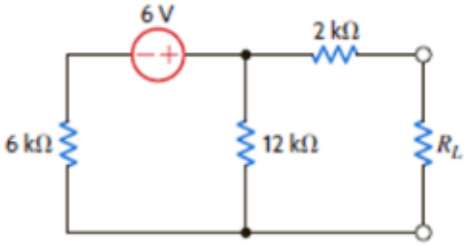


Figure E5.16

Preparation

1. Find Voc and Vth by the Thevenin theorem and draw the Thevenin equivalent circuit . Find RL for max. power transfer and the max. power transferred (calculate by hand).
2. By using pspice simulation, find V1, V2, and V3 in steady state.

Hand Written Work

Inductor:

$$V(t) = L\frac{di(t)}{dt}$$

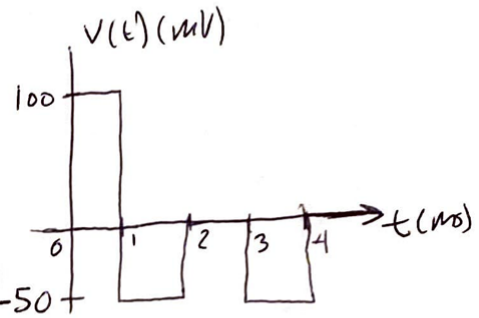
0ms to 1ms: $V(t) = (5m)\left(\frac{20mA}{1ms}\right) = 100mV$

1ms to 2ms: $V(t) = (5m)\left(\frac{-10mA}{1ms}\right) = -50mV$

2ms to 3ms: $V(t) = (5m)\left(\frac{0}{1ms}\right) = 0mV$

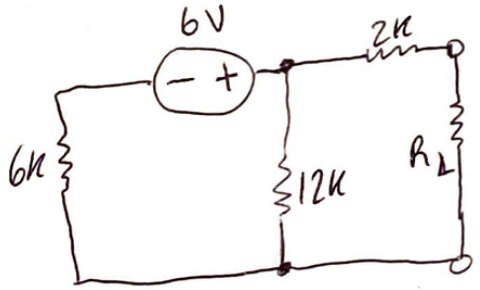
3ms to 4ms: $V(t) = (5m)\left(\frac{-10mA}{1ms}\right) = -50mV$

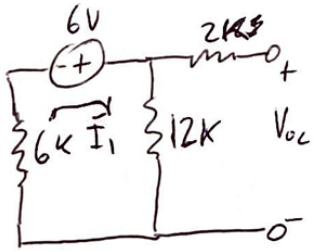
$t > 4ms: V(t) = 0mV$



$$W_L(t) = \frac{1}{2}Li^2(t) = \frac{1}{2}(5m)(15m)^2 = \boxed{562.5\,J \text{ at } t = 1.5ms}$$

Thevenin circuit:



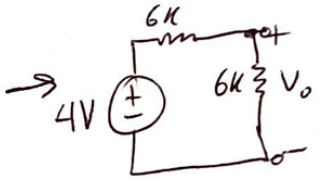


$I_1(6k+12k) + (-6) = 0$

$\Rightarrow I_1 = \frac{6}{18k} = 0.\overline{33}mA$

$V_{oc} = (0.\overline{33})(12K) = \underline{4V}$

$$R_{Th} = \left(\frac{1}{6K} + \frac{1}{12K}\right)^{-1} + 2K = \boxed{6K\Omega} = R_L$$

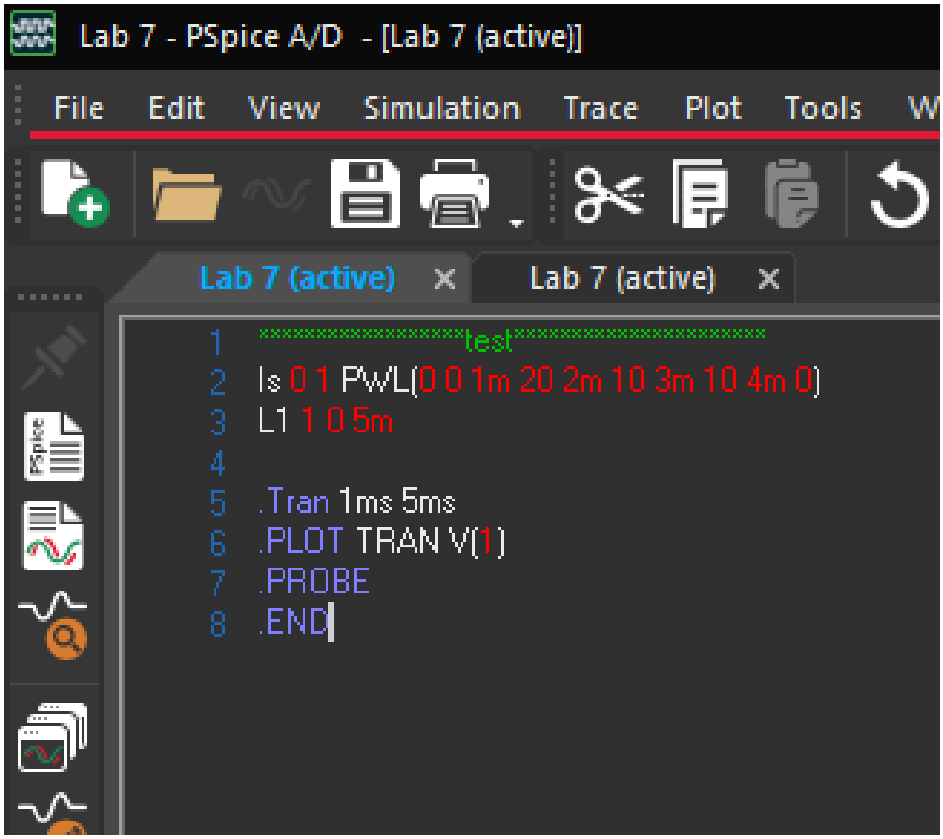


$$V_o = 4\left(\frac{6K}{6K+6K}\right) = 2V$$

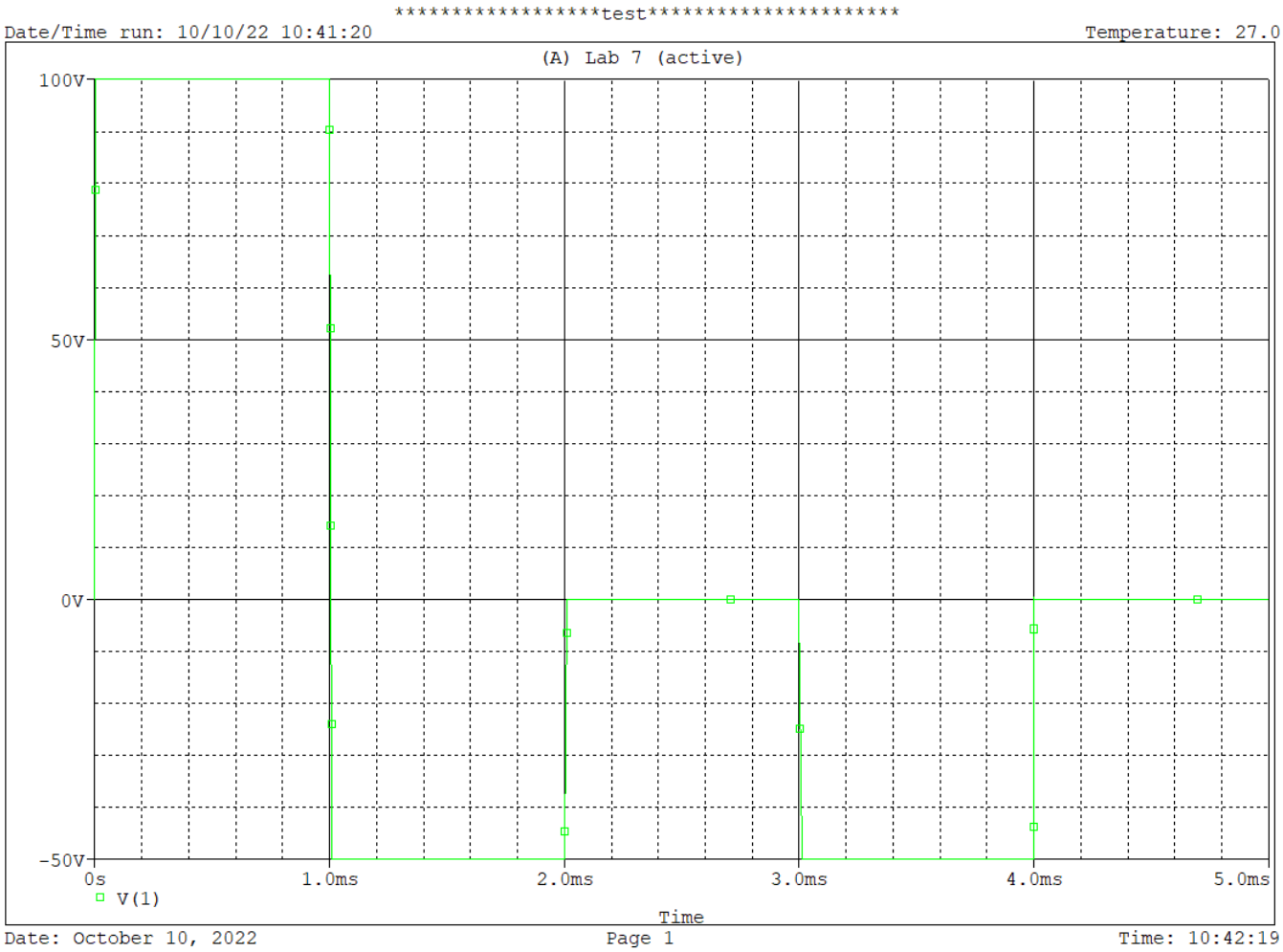
$$P_L = \frac{V^2}{R} = \frac{V_o^2}{R_L} = \frac{2^2}{6K} = \boxed{\frac{2}{3}mW}$$

Pspice simulation

Inductor:
Code used



Voltage trace



$0ms\ to\ 1ms\colon\ V = 100V$

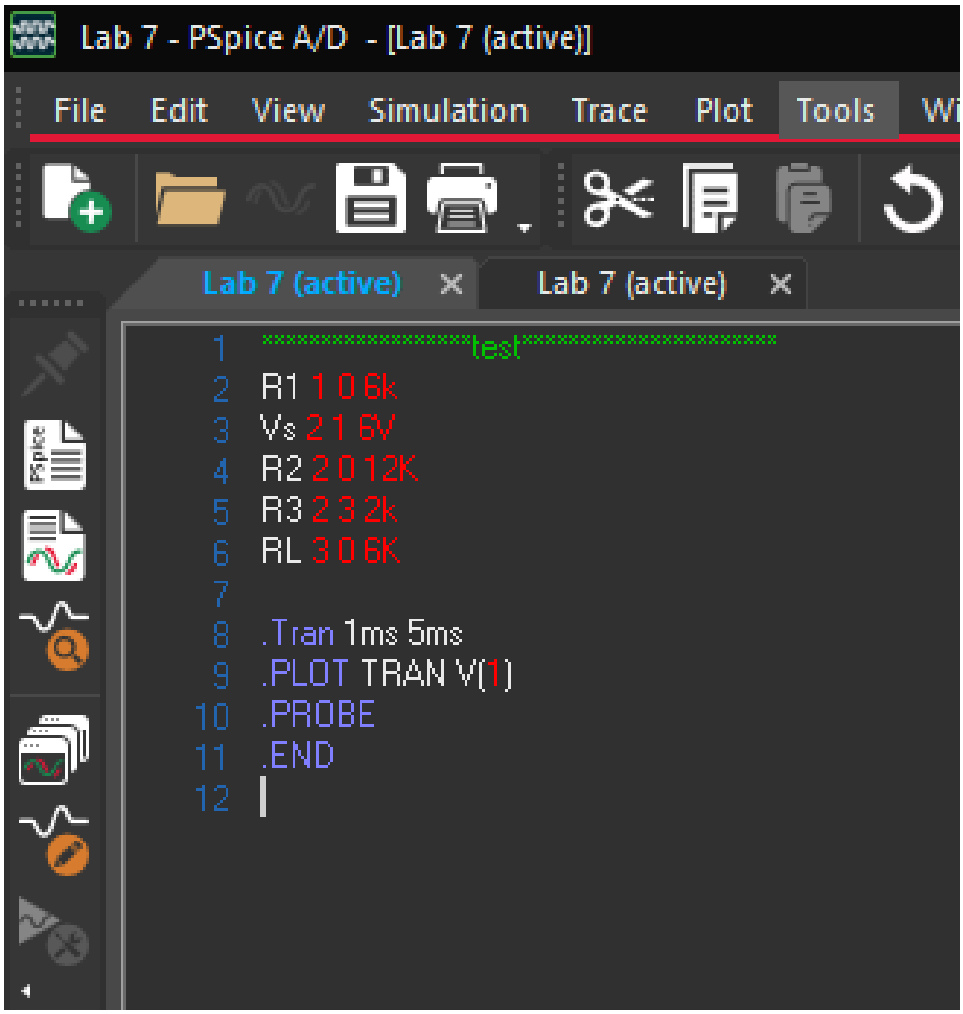
$1ms\ to\ 2ms\colon\ V = -50V$

$2ms\ to\ 3ms\colon\ V = 0V$

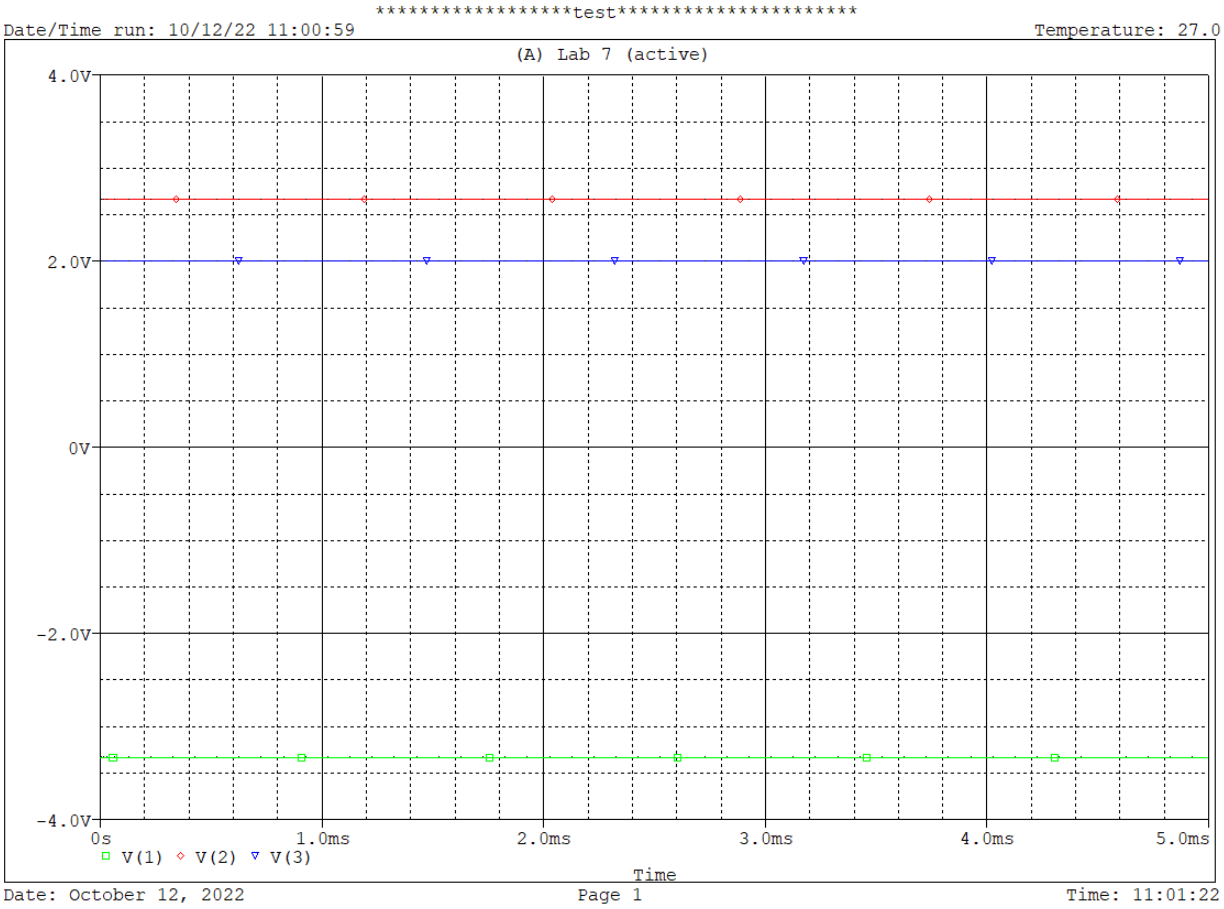
$3ms\ to\ 4ms\colon\ V = -50V$

$t > 4ms\colon\ V = 0V$

Thevenin circuit:
Code used



Voltage traces:

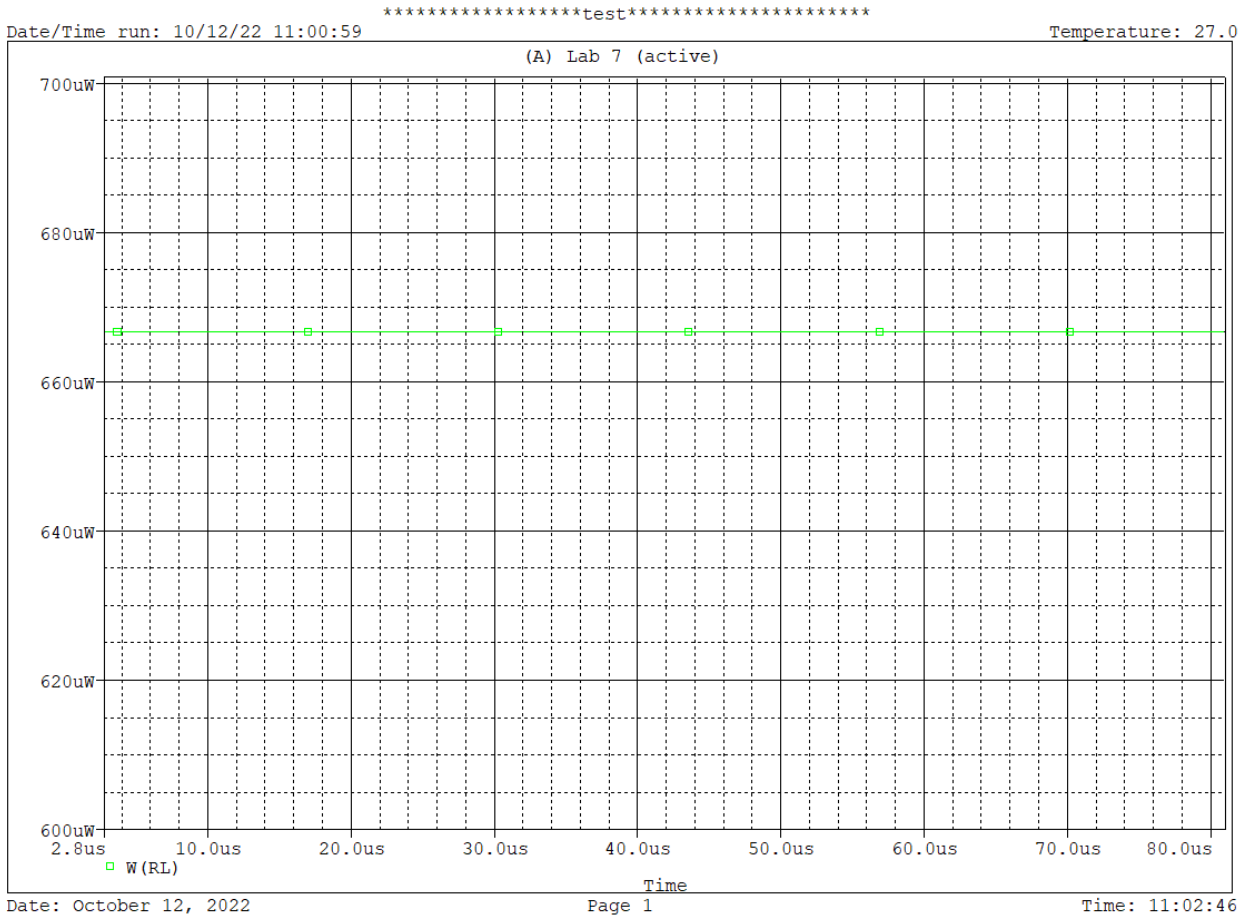


$V_1 = -3.33V$

$V_2 = 2V$

$V_3 = 2.67V$

Power trace:



$$P_L = 6.67mW$$

Conclusion

In this lab, I learned how to find the voltage across an inductor over a function of time and the energy stored at a given time. I also learned how to apply Thevenin Thereom to find the resistance of a circuit. After reviewing the answers obtained from handwritten work and pspice, I can conclude the answers concur and are correct.