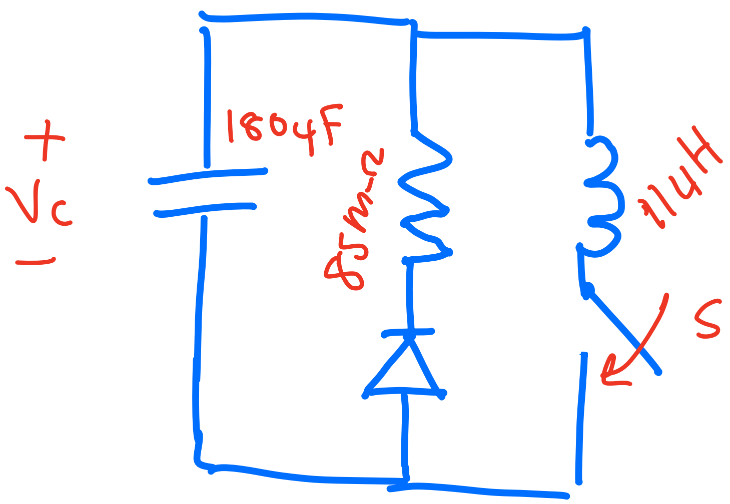
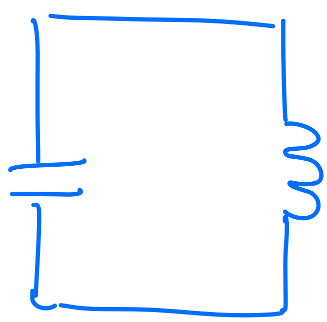


After the switch closes at $t=0$, our circuit will assume 2 states:

State 1: Diode is OFF, so the middle branch has an open.

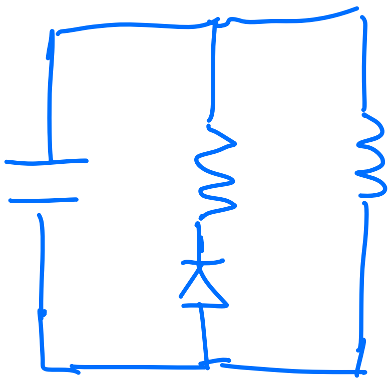


Initial conditions:

V_c @ $t(0)_- = t(0_+) = V_x = 1000V$

$I_L = 0A$

State 2: Diode turns on when Vx hits 0V... RLC circuit.



Initial conditions:

$V_x = 0V$

$I_L = 4045.2A$

I_L is @ MAX bc C has fully discharged into L...

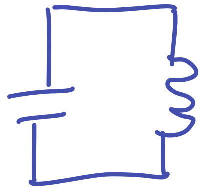
$\frac{1}{2} C V_x^2 = \frac{1}{2} L I_m^2$

180μF 1000 11μH

$180 = L I_m^2 \rightarrow 4045.2A$

Will have a piecewise fn to represent circuit behavior after t=0.

State 1 diffeq.



$I_L(0) = 0\,A$

$V_c(0) = 1000V$

$$L\frac{di}{dt} + \frac{1}{C}\int i\,dt = 0$$

$$\hookrightarrow \frac{di^2}{dt^2}L + \frac{1}{C}i(t) = 0$$

$$\hookrightarrow \frac{di^2}{dt^2} + \frac{1}{LC}i(t) = 0$$

$$\hookrightarrow s^2ke^{st} + \frac{1}{LC}ke^{st} = 0$$

$$\hookrightarrow s^2 + \frac{1}{LC} = 0$$

$$\hookrightarrow i(t) = k_1e^{j\omega_0 t} + k_2e^{-j\omega_0 t}$$

$$\hookrightarrow i(t) = A_1\cos\omega_0 t + A_2\sin\omega_0 t$$

$$v = L\frac{di}{dt} \rightarrow \frac{V(0)}{L} = \frac{di}{dt}$$

$$i(t) = A_1 \cos \omega_0 t + \cancel{A_2 \sin \omega_0 t}$$

$$i(0) = 0A \qquad 0 \qquad 0$$

$$i(t) = A_1 \rightarrow A_1 = 0$$

$$i(t) = A_2 \sin(\omega_0 t)$$

$$\frac{di}{dt} = \frac{d}{dt}\left(A_2 \sin(\omega_0 t)\right)$$

$$= A_2 \omega_0 \cos(\omega_0 t) \quad @\ t = 0$$

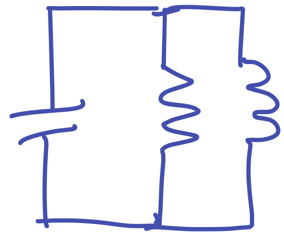
$$\frac{di}{dt} = A_2 \omega_0$$

$$\frac{V_0}{L} = A_2 \omega_0$$

$$\frac{1000V}{114H \sqrt{\frac{114H}{1804F}}} = A_2 = 4045.2$$

$$\underline{i(t) = 4045.2 \sin(22473 \cdot t)}$$

State 2 Diff Eq:



Initial conditions:

$V_c(t_x) = 0V$

$i_L(t_x) = 4045.2A$

$\hookrightarrow \quad s^2 + \frac{s}{RC} + \frac{1}{LC} = 0$

$\hookrightarrow \quad i(t) = A_1 e^{s_1 t} + A_2 e^{s_1 t}$

$\alpha = \frac{1}{2RC} = 32,679$

$\alpha > \omega_0$

$\omega_0 = \frac{1}{\sqrt{LC}} = 22473$

$\rightarrow$ overdamped

$\hookrightarrow \quad i(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$

$i'(t) = A_1 s_1 e^{s_1 t} + A_2 s_2 e^{s_2 t}$

$s_1, s_2 = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$

$s_1 = -8953 \quad s_2 = -56404$

$$i(t) = A_1 e^{-8953t} + A_2 e^{-56404t}$$

$$i(t_x) = A_1 + A_2 = 4045.2$$

$$\frac{di}{dt} = A_1 s_1 + A_2 s_2$$

$$\frac{di}{dt} = A_1(-8953) + A_2(-56404)$$

$$\frac{0}{L}$$

$$A_1 + A_2 = 4045.2$$

$$-8953A_1 - 56404A_2 = 0$$

$$A_1 = 4808.4 \qquad A_2 = -763.2$$

Equation 2:

$$i(t) = 4808.4e^{-8953t} - 763.2e^{-56404t}$$

1)

$$i(t) = \begin{cases} 0 \leq t \leq t_1 & 4045.2\sin(22473t) \\ t_1 < t & 4808.4e^{-8953t} - 763.2e^{-564046} \end{cases}$$

2) $\frac{1}{2}CV_x^2 = \frac{1}{2}LI_m^2$ $\underline{I_m = 4045.2\,A}$

180µF 1000 11µH

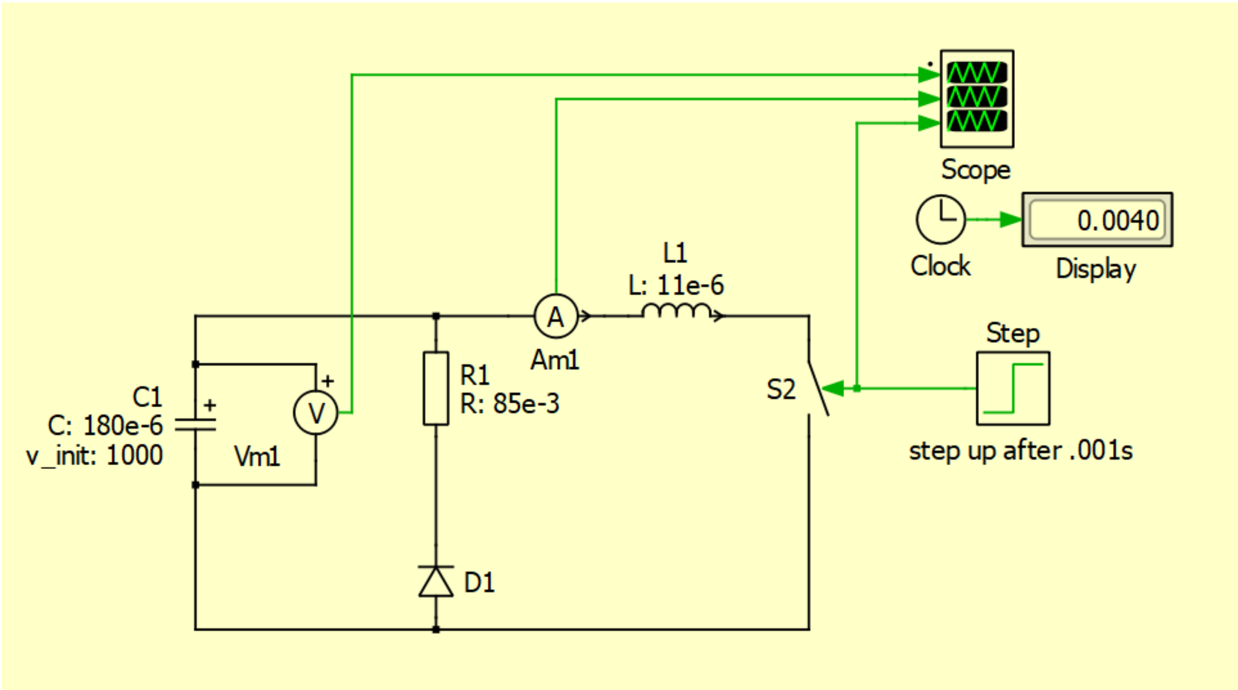
$180 = LI_m^2 \rightarrow 4045.2A$

3) $1 = \sin(22473 \cdot t) \rightarrow t_x = \underline{6.99 \times 10^{-5} \text{ seconds}}$

$\frac{\pi}{2}$

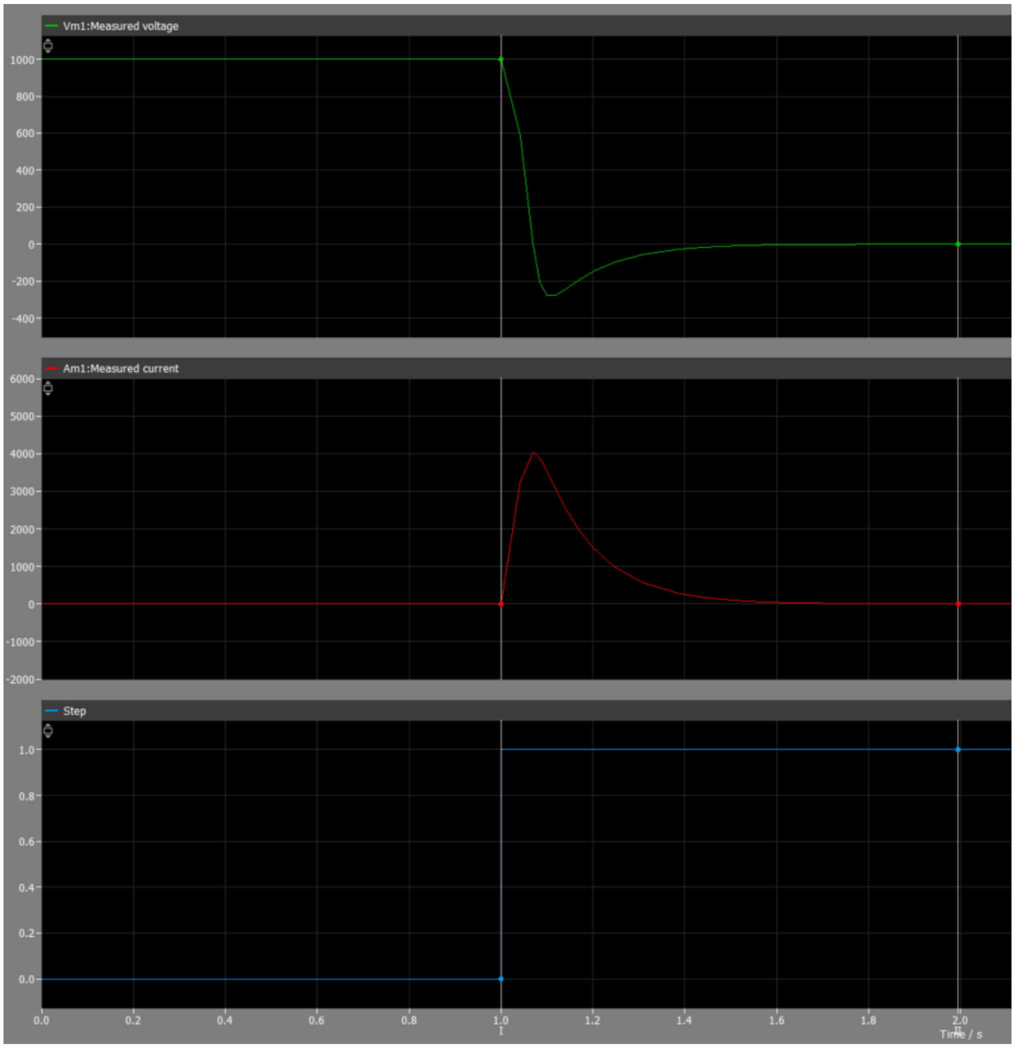
4) $\frac{1}{2}CV_x^2 = \underline{90W}$

PLECS SIM:

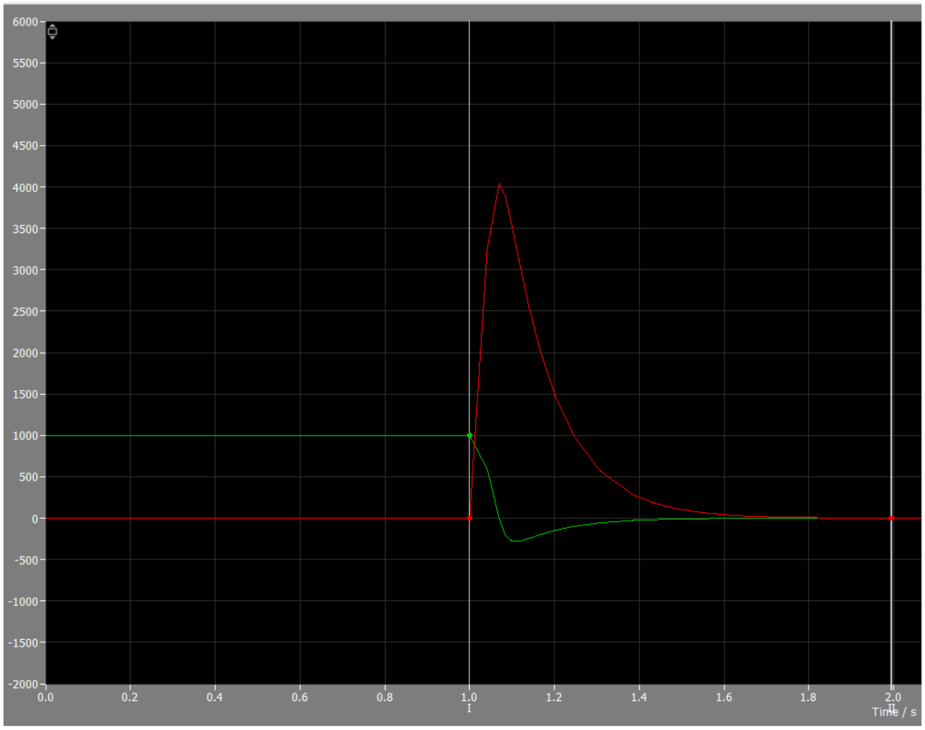


Scope
Clock
0.0040
Display
L1
L: 11e-6
A
Am1
C1
C: 180e-6
v_init: 1000
+
V
+
Vm1
R1
R: 85e-3
S2
Step
step up after .001s
D1

b) V_c_init = 1000V



Green: Capacitor Voltage
Red: Inductor Current
Blue: My switch (activated via step function)

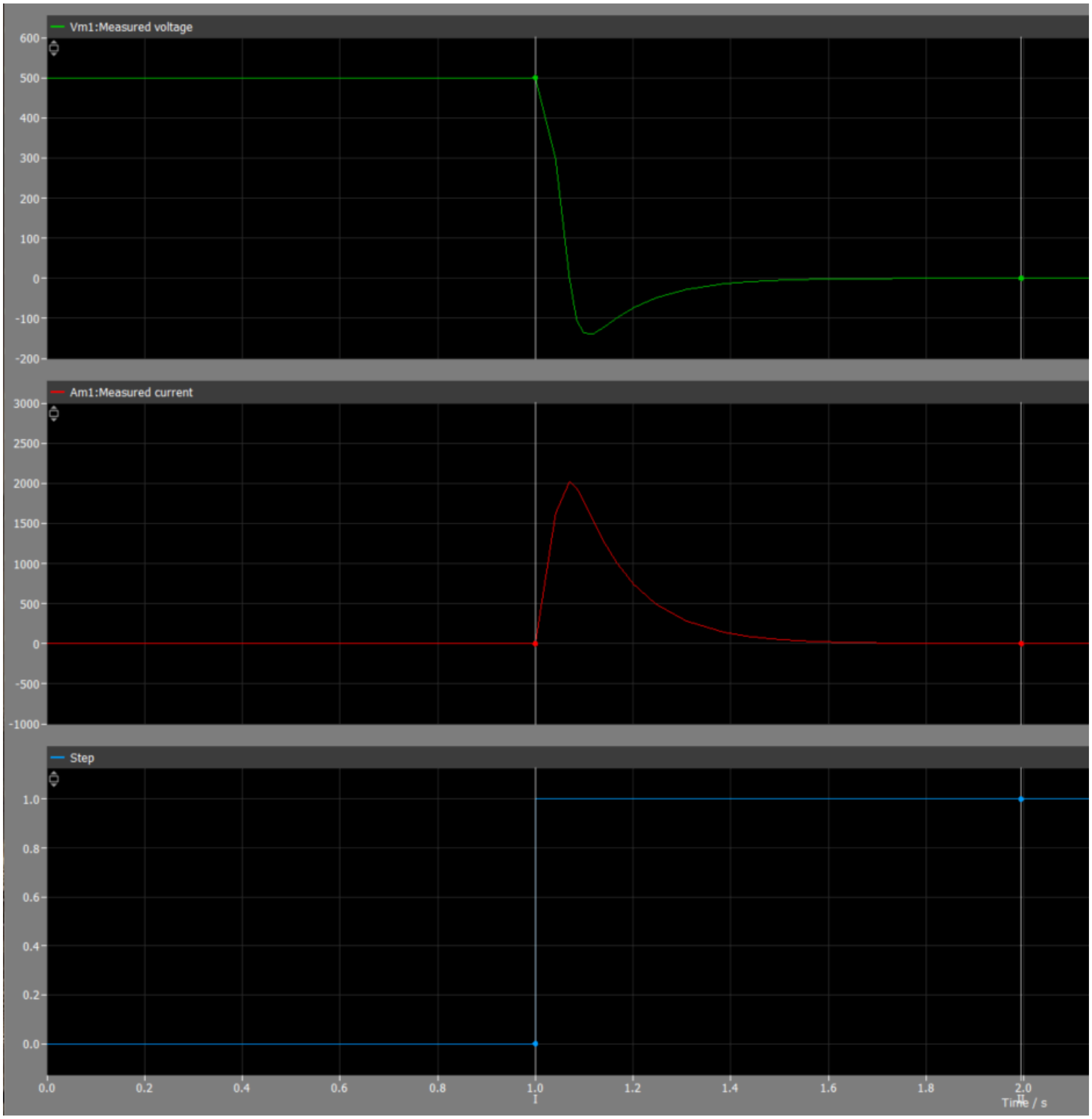


V_C, I_L plotted together

c)

Less current. In simulating various V_c_init, I found no change to t

V_c_init = 500V



Green: Capacitor Voltage
Red: Inductor Current
Blue: My switch (activated via step function)