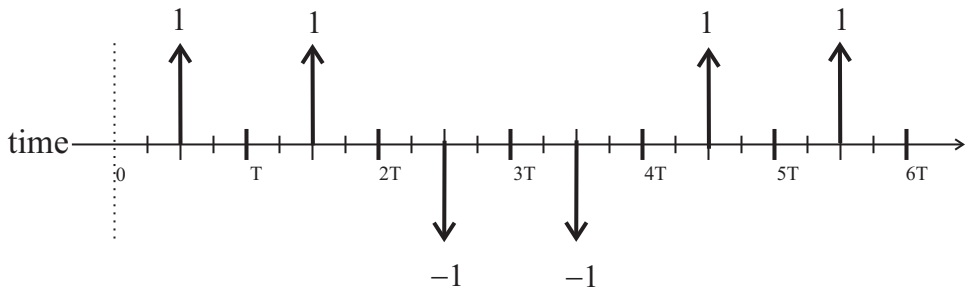
ECE 3025: Electromagnetics
Solutions to TEST 1 (Spring 2012)

1. **Nonlinear Loads on Transmission Lines:** The transit time on this line is $T = 1 \times 10^{-8}$ s. The chaotic oscillator requires a signal to propagate back and forth on the line twice to repeat its oscillation, for a total period of $4T$. The frequency would then be $1/4T$ or 25 MHz.

2. **Reflection Sketches:**



3. **Sinusoidal Lines:** (**20 points**) The following equations describe the phasor voltage and current on a transmission line:

$$\tilde{v}(z) = 6\exp(-j4\pi z) + 3\exp\left(-j\frac{\pi}{4}\right)\exp(j4\pi z)\,\text{Volts}$$

$$\tilde{i}(z) = 60\exp(-j4\pi z) - 30\exp\left(-j\frac{\pi}{4}\right)\exp(j4\pi z)\,\text{mA}$$

   (a) The largest possible voltage would be 6 + 3 = 9 V and the smallest possible voltage would be 6 - 3 = 3 V. Thus, the VSWR is equal to 3.

   (b) $\tilde{i}(0) = 60 - 30\exp\left(-j\frac{\pi}{4}\right)$ mA

   (c)

$$\tilde{Z}_L = \frac{\tilde{v}(1/16)}{\tilde{i}(1/16)} = \frac{6\exp(-j\pi/4) + 3}{.060\exp(-j\pi/4) - .030}$$

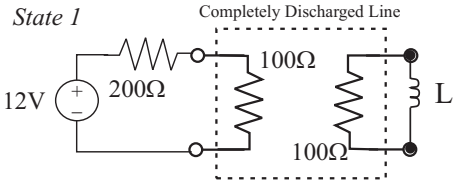
4. **T-line Sequence Problem:**

	V_A	V_B	V^+	V^-
State 0	0	0	0	0
State 1	4	0	4	0
State 2	0	0	3	-3
State 3	0	6	3	3
State 4	36/5	36/5	24/5	12/5
State 5	24/5	36/5	12/5	12/5
State 6	0	0	-6	6
State 7	0	-12	-6	-6

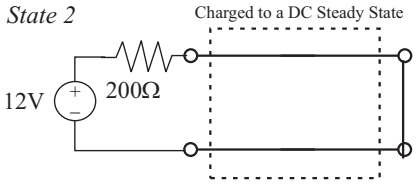
Below are notes and equivalent circuits used for each state:

- State 0: *Both switches are connected to the inductors and both lines are uncharged.*
- State 1: *Immediately after switch A is closed onto the DC source.* We use the dead line model for this transition. Only V^+ and V_A change.
- State 2: *Switch A has been closed (connected to the source) for a while.* The right-side inductor has become a short circuit and the transmission line becomes two conductive connections.
- State 3: *Immediately after switch B is closed onto the DC source.* The transmission line has charge on it already, so we must use the general equivalent model, with dependent sources using V^+ and V^- from the previous state (right before the switch change). Note: the savvy student will also recognize that there will be a nasty spark when the inductor is suddenly open-circuited at this step.
- State 4: *Switch B has been closed (connected to the source) for a while.* The transmission line connects the two sources in the steady state.
- State 5: *Immediately after switch A closes onto the stand-alone inductor.* The inductor will behave initially as an open circuit across the terminals of the left-hand side of the line.
- State 6: *Switch A has been connected to the inductor for a while.* Both inductor and transmission line become shorts in the steady DC state.
- State 7: *Immediately after switch B closes onto the stand-alone inductor.* The right-side inductor looks like an open circuit when first connected.

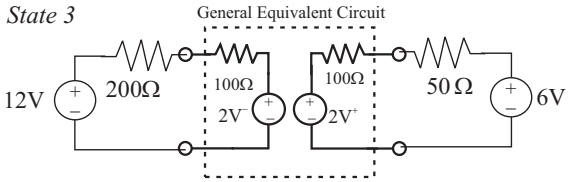
State 1



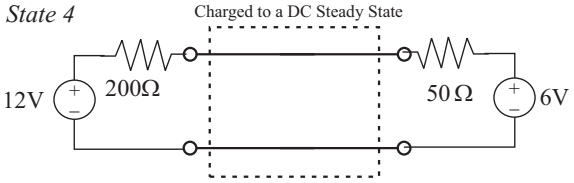
State 2



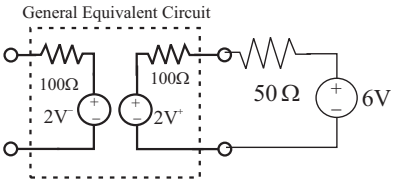
State 3



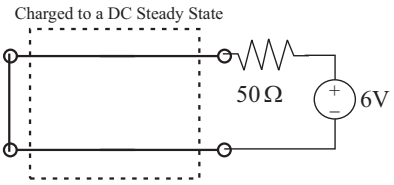
State 4



State 5



State 6



State 7