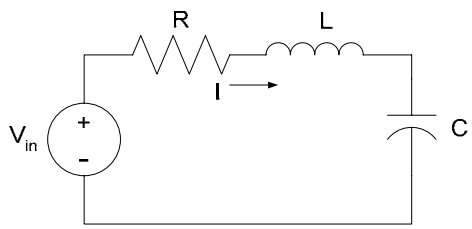
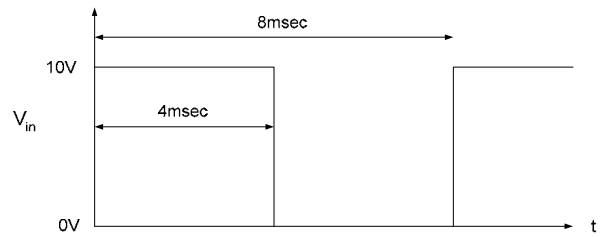
# LABORATORY EXPERIMENT #2

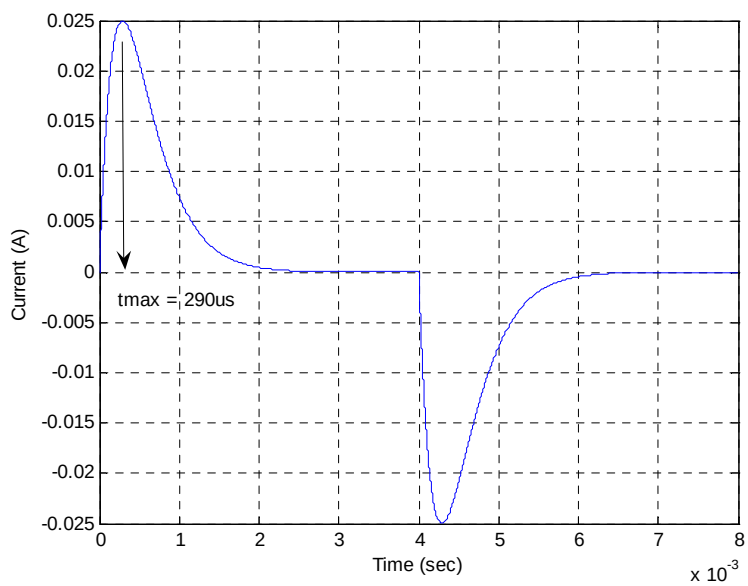
**DESIGN PROBLEM:** Our goal is to design the following series RLC circuit so that it cyclically charges and discharges the capacitor given the input voltage to the right.




**Specifications**:

- The current drawn from the source must have the attributes shown below (maximum value of 25mA occurring 290us following the pulse)
- The current response must have two real repeated poles (critically damped)




**Deliverables:**

- Values for R, L, and C
- Multisim validation
- Laboratory implementation
- Report documenting your findings

**Constraints:**

- Must use standard available lab parts for the implementation
- The function generator is used for the input
- The circuit resistance must include the $50\Omega$ output resistance of the function generator and the equivalent series resistance of the inductor

**HINTS:**

1. Place the circuit into the frequency domain with zero initial conditions. Model the input voltage as a step of 10V to solve for the current response (possible since the current reaches steady state before the input goes to zero). Keep all impedances in terms of the parameters.
2. Solve for the current and place it in the form (where $K_1$, $K_2$, and a depend on the circuit parameters R, L, and C).

$$I(s) = \frac{K_1}{(s+a)^2 + K_2}$$

3. To make the response critically damped, you will want to force $K_2 = 0$ (this is one constraint).
4. The inverse Laplace Transform of the current is then

$$i(t) = K_1 t e^{-at} u(t)$$

   Take the derivative of this expression and find when it is a maximum. Substitute this value to establish an expression for the maximum value. These are your two other constraint equations, from which you should be able to solve for R, L, and C.

$$100\Omega \le R \le 500\Omega \qquad 1mH \le L \le 150mH \qquad 0.1uF \le C \le 10uF$$

5. You may ask the instructor to OK your design values

6. Remember, the R must take into account the inductor resistance (so measure it) and the source output resistance ($50\Omega$).

7. To demonstrate the current waveform on the scope: measure the voltage on either side of the external resistance and then use the math function to find the difference (this will be the scaled current but should enable you to verify your design). Ask for help if necessary.

8. Bring a 3.5” disc so you can acquire the scope signal and report it in your findings.