This problem can add up to 6 points to your score on Test #2. You are to receive no help from another person with this work. You are allowed to use any text and any other form of literature. By submitting the work you are stating that you have not received help from another person.

Do your work on engineering paper. Use only one side of the paper. Do neat work.

You are given the following circuit. The circuit is initially at rest, that is, \(i(0^-) = v(0^-) = 0\).

(a) Develop the differential equation that can be solved directly to find \(v(t)\). Leave your equation in general form (use parameters \(R\), \(L\), \(C\), \(V_S\)).

(b) Assume the general form for the characteristic equation of

\[s^2 + 2\xi \omega_n s + \omega_n^2 = 0\]

You are to design the circuit for \(V_S\), \(R\), \(L\), and \(C\) so that

- after the switch is closed, the final value of \(v(t) = 10 \text{ volts}\)
- \(\xi\) is selected as 0.4
- the response is to be in the band of \(10(1 \pm 0.01)\) by \(t = 0.1 \text{ seconds}\) but cannot reach this band prior to 0.09 seconds and must remain in this band after \(t = 0.1 \text{ seconds}\).

Constraints: \(C\) must be selected from \(1 \mu F, 10 \mu F, 100 \mu F\)

\(L\) must be in the range \(0.3H \leq L \leq 4H\)
The deliverables of this problem are (submit with your work)

- show your development of the differential equation
- show how you determined $\omega_n$
- show how you determined $V_S$, $R$, $L$, and $C$
- explicitly give your differential equations with numerical values
- give your hand determined solution for $v(t)$
- verify your solution for $v(t)$ using the MATLAB Symbolic Tool kit, ie dsolve( ........
- Use MATLAB to plot $v(t)$
- Use MATLAB to give your numerical values of $t$ vs $v(t)$ (a statement of $[t;v]$ will do this include evidence that you met the design requirement on reaching steady state