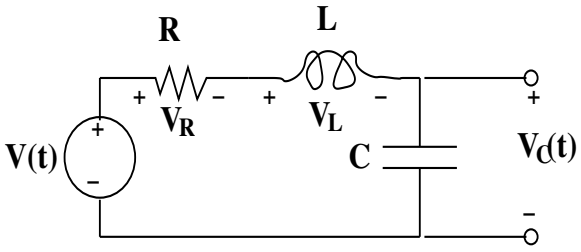
School of Engineering
Department of Electrical and Computer Engineering

332:221 **Principles of Electrical Engineering I** **Fall 2012**

Quizlette 9

USING A CALCULATOR WILL SLOW YOU DOWN! Final answers must appear in the appropriate box. Show your work outside the box.

1. **Basic Stuff:**



(a) *(1 pts)* What is the Thevenin impedance at frequency ω for the circuit shown?

$$Z_{th} = \frac{(R+Lj\omega)\frac{1}{Cj\omega}}{R+Lj\omega+\frac{1}{Cj\omega}} = \frac{R+Lj\omega}{RCj\omega+LC(j\omega)^2+1}$$

(b) *(2 pts)* Use impedance methods to derive the transfer function $H(j\omega)$ between input $V(t)$ and output $V_L(t)$, the voltage across the inductor as labeled .

$$H(j\omega) = \frac{Lj\omega}{R+Lj\omega+\frac{1}{Cj\omega}} = \frac{LC(j\omega)^2}{RCj\omega+LC(j\omega)^2+1}$$

(c) *(2 pts)* The transfer function between the input voltage and the current through the capacitor, $I_C(t)$, is

$$H(j\omega) = \frac{Cj\omega}{1+RCj\omega+LC(j\omega)^2}$$

Please write down the differential equation that relates $V(t)$ to $I_C(t)$.

$$C\frac{dV}{dt} = I_C + RC\frac{dI_C}{dt} + LC\frac{d^2I_C}{dt^2}$$

2. **Getting Cute:**

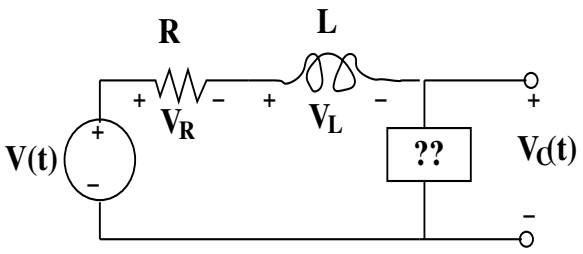


Figure 1:

(a) *(3 pt)* The transfer function between input $V(t)$ and output $V_C(t)$ is

$$H(j\omega) = \frac{LC(j\omega)^2 + RCj\omega + 1}{2LC(j\omega)^2 + 2RCj\omega + 1}$$

Please find $Z_{??}$.

$$Z_{??} = Lj\omega + R + \frac{1}{Cj\omega}$$

(b) *(2 pts)* You are told that the mystery box ***??*** contains ideal resistors, capacitors and inductors and that for input $V(t) = 10\cos\omega t$ we have $V_C(t) = 2cos(\omega t - \phi_1) + 3\sin(\omega t + \phi_2) - 4\sin(\alpha\omega t)$ where ϕ_1 and ϕ_2 are known constant phase offsets and α is a real constant.

What values for α are possible? Why?

$\alpha = \pm 1, 0$. ***Otherwise, a sinusoidal input at frequency*** ω ***would not elicit a sinusoidal output at the same frequency. To get frequency in the output different than the drive, the circuit must be nonlinear and you can't build a nonlinear circuit with ideal resistors, inductors and capacitors.***