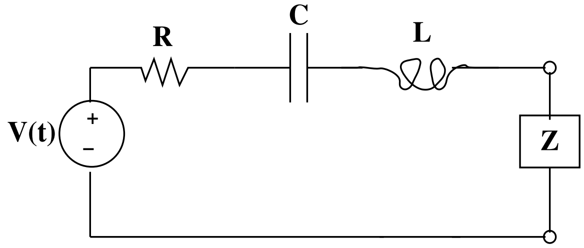
School of Engineering
Department of Electrical and Computer Engineering

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

Quizlette 11

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

1. **Basic Then ... Not Basic:**



Assume sinusoidal steady state operation at some frequency ω.

(a) *(2pts)* What value of Z maximizes the average power transfered to Z?

$Z = Z^*_{th} = R - Lj\omega - \frac{1}{Cj\omega}$

(b) *(3 pts)* Suppose we require $Z = R_L$ to be real (i.e., just a regular old resistor). What value of R_L maximizes power transfer into Z?

Let $Z = R_L$ ***and*** $Z_{th} = R + jX$

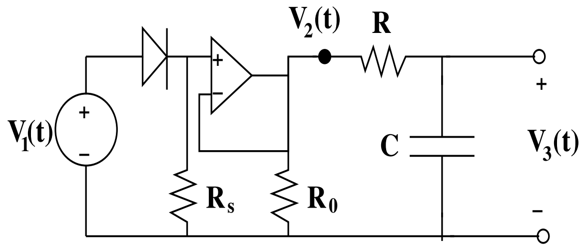
$$\overline{P} = \frac{1}{2}|V|^2 \frac{R_L}{(R_L + R)^2 + X^2}$$

Differentiating and setting equal to zero gives

$$R_L = |Z_{th}|$$

2. **Your Cute Future:** Consider the circuit shown in the figure.

(a) *(1 pt)* Assume the input voltage source amplitude is $\mathbf{V}_1 = V_1$ where $V_1 \in \Re$ and that the frequency of operation is ω. Please provide a labeled sketch of $V_2(t)$.



$V_2(t) = V_1 \frac{\textbf{sgn}\,(cos\omega t)+1}{2} \cos\omega t$

(b) *(1 pts)* Can you provide a transfer function from $\mathbf{V}_1$ to $\mathbf{V}_3$? Why?/Why not?

Nope. The circuit is nonlinear.

(c) *(1 pts)* If $\omega = 2\pi \cdot 60$ and $R = 10k\Omega$, provide (and argue for) a value of C that makes $V_3(t) \approx V_1$? **HINT:** Remember that RC is called the "time constant" and is a measure of how quickly charge bleeds from a capacitor C through a resistor R.

We need $RC \gg 1/60$ ***so say*** $RC = 1/6$ ***or*** $C = 1/60000$ ***whatever that is.***

(d) *(2 pts)* You are told that

$$V_2(t) = V_1 \sum_{k=-\infty}^{\infty} \frac{\cos\frac{k\pi}{2}}{\pi(1-k^2)} e^{jk\omega t}$$

is the analytic form of what you SHOULD have sketched in the previous part :) :) . What is the output $V_3(t)$.

Superposition holds to the right of $V_2(t)$ ***so***

$$V_3(t) = V_1 \sum_{k=-\infty}^{\infty} |H(jk\omega)| \frac{\cos\frac{k\pi}{2}}{\pi(1-k^2)} e^{jk\omega t + j\angle H(jk\omega)}$$

where $H(j\omega) = \frac{1}{RCj\omega+1}$