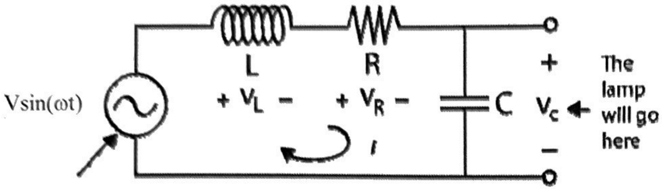
Ballast circuit with NO lamp, but some parasitic R from wiring resistances, etc.:



This is a square wave in our circuit. We'll "approximate" the square wave by its fundamental for now.

Question: What's V_c, the capacitor (& lamp) voltage?

A little 8.02:

$$V\sin\omega t = V_L + V_R + V_C$$

or

$$V\sin\omega t = L\frac{di}{dt} + Ri + V_C \qquad \text{but } i = C\frac{dV_C}{dt}$$

so

$$V\sin\omega t = LC\frac{d^2V_C}{dt^2} + RC\frac{dV_c}{dt} + V_C$$

What's V_c? Guess a particular solution

Try:

$$V_C = A\sin(\omega t - \phi)$$

Substitute it in and see what happens:

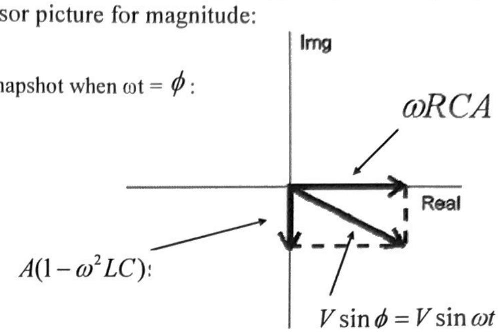
$$V\sin\omega t = -\omega^2 LCA\sin(\omega t - \phi) + \omega RCA\cos(\omega t - \phi) + A\sin(\omega t - \phi)$$

or

$$V\sin\omega t = \omega RCA\cos(\omega t - \phi) + A(1 - \omega^2 LC)\sin(\omega t - \phi)$$

Phasor picture for magnitude:

Snapshot when $\omega t = \phi$:



so, for magnitude:

$$V = A\sqrt{(\omega RC)^2 + (1 - \omega^2 LC)^2}$$

or

$$A = \frac{V}{\sqrt{(\omega RC)^2 + (1 - \omega^2 LC)^2}}$$

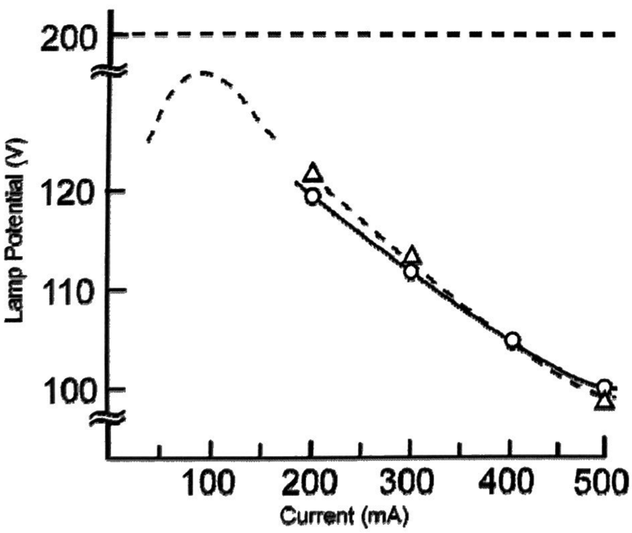
(explore what happens at $\omega = \frac{1}{\sqrt{LC}}$)

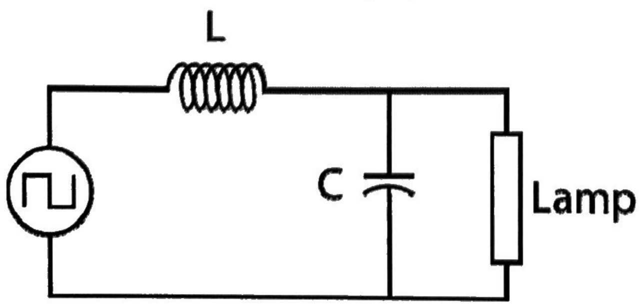
For completeness, evaluate at $\omega t = 0$ to eliminate ϕ:

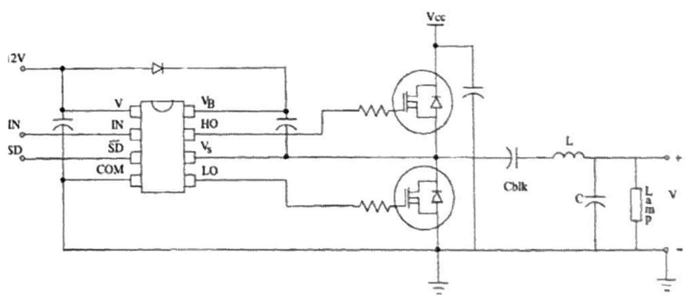
$$[-\sin(-\phi)]A(1-\omega^2 LC) = \omega RCA\cos\phi$$

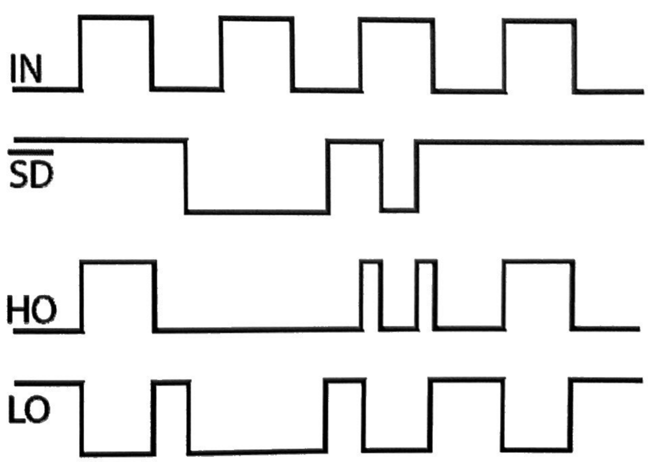
$$\tan\phi = \frac{\omega RC}{(1-\omega^2 LC)}$$

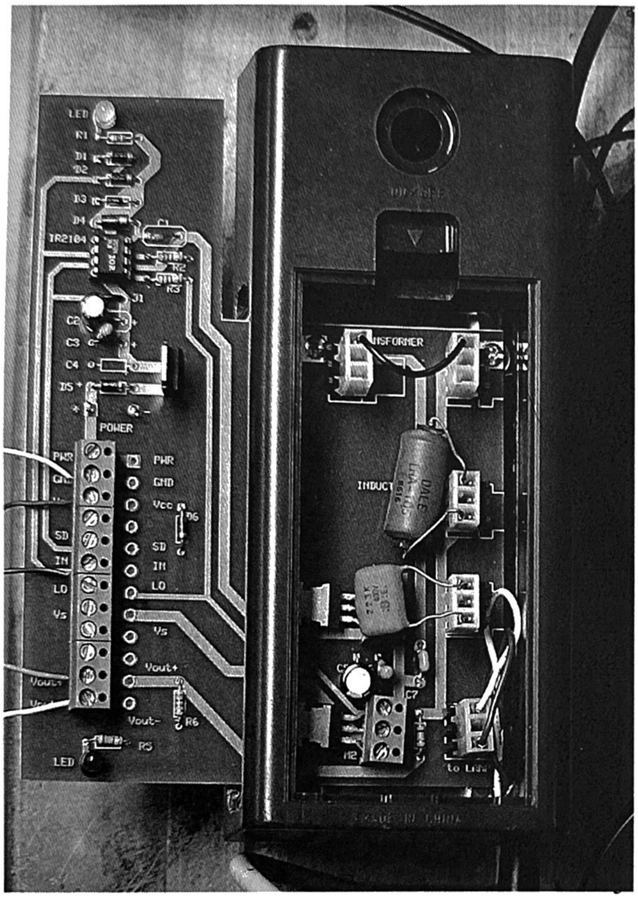
$$\phi = \tan^{-1}\frac{\omega RC}{(1-\omega^2 LC)}$$



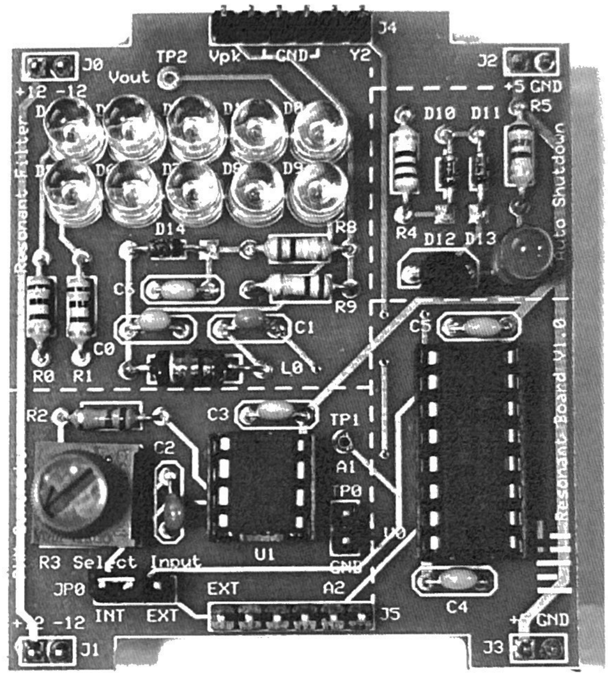




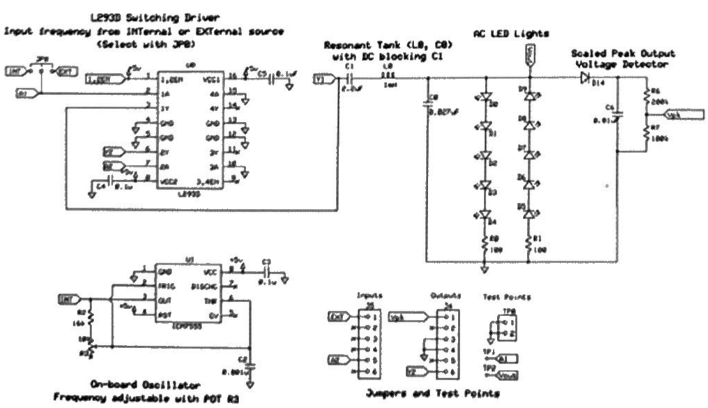




Resonant converter with LED lamp:

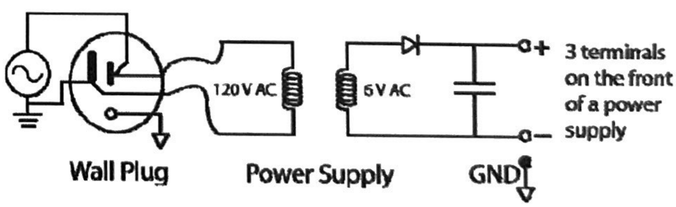


Schematic of Resonant Converter with LED lamp:

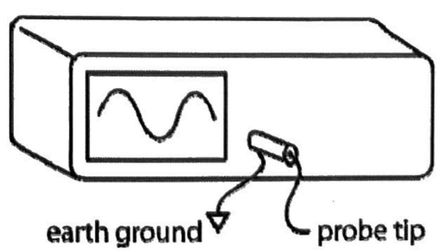


Electrical test equipment:

Example: Power supply, internal construction. Very simplified ☺:



Oscilloscope:



With our lab power supplies, it is your choice whether to ground the output or leave it floating.

Remember, however, an oscilloscope ground alligator clip is always corrected to earth ground on a healthy scope.