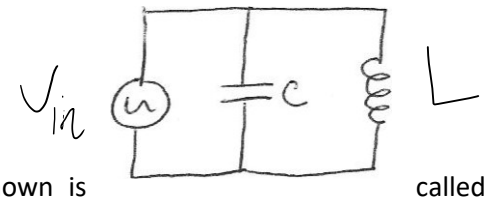
Problem Set 10 —AC

1. The generator in the circuit shown is given by $V_{in} = V_{max} \sin \omega t$.

(a) For each branch, what is the current amplitude at its phase relative to the applied voltage?

(b) What is the angular frequency ω such that the current in the generator vanishes?

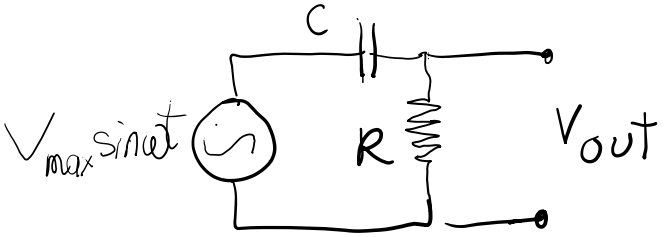
(c) at resonance, what is the current in the inductor? What is the current in the capacitor?



2. The circuit shown is called an RC high pass filter because high input frequencies are transmitted with greater amplitude than low input frequencies.

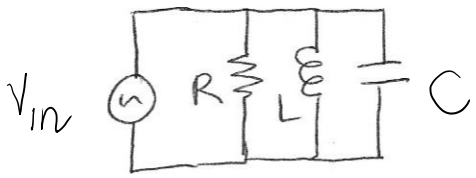
(a) if the input voltage is $V_{in} = V_o \sin \omega t$, show that the output voltage is $Vout = \frac{Vo \sin \omega t}{\sqrt{\frac{1}{(\omega RC)^2}+1}}$

(b) At what angular frequency is the output voltage half the input voltage?

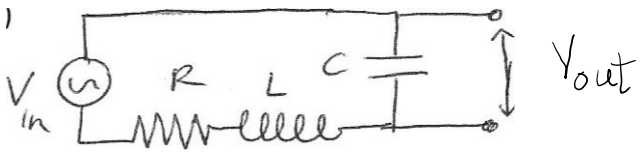


3. In a series LCR circuit $X_c = 16\Omega$ and 4Q at some frequency. The resonance frequency wo = 10^4 rads/s. (a) Find L and C. If R = 5Q and Vmax = 26V, find (b) the Q factor and the maximum current.

4. The circuit shows a resistor, *R*, capacitor, *C,* and an inductor, L, connected in parallel across an AC generator. The total current from the generator divides into three currents: the current I_R in the resistor branch, the current I_c in the capacitor branch, and the current I_L in the inductor branch. (a)Draw the phasor diagram for the currents. Let I_L be larger than Ic . (b) Find an expression for Z, the impedance of this circuit. (c) describe what happens when the generator frequency equals the natural frequency.



5. A resistor, *R*, inductor, *L* ,and capacitor, *C,* are in series with a generator, which has a voltage given by $V_{in} = V_o \sin \omega t$ as shown in the figure. Find the voltage across the capacitor as a function of frequency. (This is a low-pass filter)



6. An inductor, a capacitor, and a resistor are all connected in series across an AC source. If the resistance, inductance, and capacitance are all doubled, by what factor does each of the following quantities change? (a) the resonance angular frequency (b) the inductive reactance (c) the capacitive reactance (d) the impedance?

7. An LRC series circuit is connected to an AC source of variable frequency but constant amplitude, V_{max}. (a) Find the current amplitude as a function of ω (b) the average power dissipated by the resistor, (c) the amplitude V_L of the voltage across the inductor as a function of ω, (d) the amplitude V_c of the voltage across the capacitor as a function of ω?