Physics RLC in AC

We are going to examine the many parameters that describe RLC circuits that are driven by an AC Source. We want to pick certain R, L, and C values and fix them for the rest of the lab. We will be doing 3 'data runs', one with a relatively low frequency that gives us a 'capacitive' circuit (where the current leads the voltage), a run with a relatively higher frequency that will be 'inductive' (where the voltage peaks before the current). The third and final data run will be at the frequency closest to what we calculate to be the resonant frequency for the circuit. The following calculations will give us the resonant frequency. The angular resonant frequency is given by:ωr=1L⋅C√ ,where L is the inductance and C is the capacitance. Note that the angular frequency will be in units of radians per second. We now use:fr=ωr2⋅π to get the resonant frequency in hertz. On the third data run, set the driving frequency (of the source) as close as possible to this resonant frequency. On all three data runs, we need to obtain the following data: From the circuit picture we will obtain f, the frequency of the ac source, R, the resistance, L, the inductance, C, the capacitance and, Vtotrms, irms, VRrms, VCrms and VLrms. The last five variables are the rms values for the total voltage, the current (which is the same throughout the circuit), the voltage drop across the resistor, the voltage drop across the capacitor, and the voltage drop across the inductor, respectively. You may use the pictures of the circuit during each data run to record this data instead of putting all of it in a table.From the graph below the circuit, we need to also obtain VRm, VLm, VCm, Vtotm. These are the amplitudes of the voltage drops over the resistor, inductor, capacitor and all components, respectively. Furthermore, we need to read from the graph, im, the amplitude of the current throughout the circuit and ϕ. The way we obtain phi is to first find tVRPeak and tVtotPeak. which are the time when the resistor voltage first peaks (remember that the voltage curve peaks the same time as the current peaks) and the first time when the total voltage peaks. To get the phase angle, note that:ΔtT=ϕexp360o=Δt⋅fwhere T is the period of oscillations, ϕexp is (the experimental value of) the phase angle between the total voltage and the total current, f is the frequency of oscillations and:Δt=tVRPeak−tVtotPeakwhere tVRPeak is the time when the resistance voltage peaks and tVtotPeak is the time when the total voltage peaks. Note that this will be positive if the total voltage peaks before the current and it will be negative if the total voltage peaks after the current. We can now find the experimental value of the phase difference using: ϕexp=f⋅Δt⋅360oWe should obtain a ϕexp for all three data runs. Even though we had to do a calculation to find it, we treat this as the experimentally measured phase value.The following computations are to be done for every data run.We first check to see whether our experimentally obtained amplitudes correspond with their respective rms values:VRmth=2–√⋅VRrmsDoes this agree with VRm, the amplitude for the resistor voltage that was read from the graph?We now repeat this comparison for VLmth, VCmth, Vtotmth, and imth, where the 'th' stands for the theoretical value. In each of these cases, we obtain the theoretical value by multiplying all of the corresponding rms values by 2–√ . We then compare these theoretical values with VLm, VCm, Vtotm and im, the amplitudes of these voltages and current as they were read from the graph. If the theoretical and experimental values agree, then we can assure ourselves that we are indeed working working with rms values for the voltages and current as they appear in the circuit diagram.Next, let's check to see if our rms values are consistent with Ohm's Law (for the resistor, the reactances, and for the impedance).VRrmsth=irmsR.Does our theoretical rms value for the voltage drop across the resistor agree with the VRrms given on the circuit diagram?Compute the reactances:XL=ω⋅L,XC=1ω⋅C ,and the impedance,Z=R2+(XL−XC)2−−−−−−−−−−−−−−√ .