# Workshop Tutorials for Physics
ER11: **AC Circuits**

A. Qualitative Questions:

1. An inductor is connected to an AC power supply. If the frequency of the power supply is doubled:
a.   What will happen to the inductance of the inductor?
b.   What will happen to the inductive reactance of the inductor?
c.   If it was a capacitor that was connected to this power supply what would happen to the capacitive reactance when the frequency was doubled?
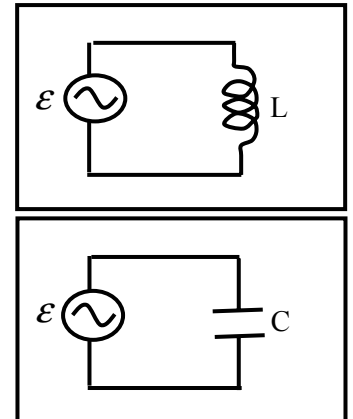
2. When a resistor is connected to any power supply the voltage across the resistor and the current through the resistor are always in phase. This is not the case for capacitors and inductors. Consider an LC series circuit that is connected to an AC power supply, for example the mains power from a typical wall socket.
a.   Do you think the current and the voltage across the capacitor are in or out of phase? Why? If there is a phase difference, what would it be?
b.   Do you think the current and the voltage across the inductor are in or out of phase? Why? If there is a phase difference, what would it be?

B. Activity Questions:

1. Series RLC circuit
Connect the AC power supply to the RLC circuit.
Use the oscilloscope to view the potential difference across the inductor and the capacitor.
Sketch a graph of what you see. What do you notice about the two curves?
As you vary the frequency of the input voltage what happens to the globe? Explain this effect.
As you vary the inductance of the inductor what happens to the globe? Explain this effect.

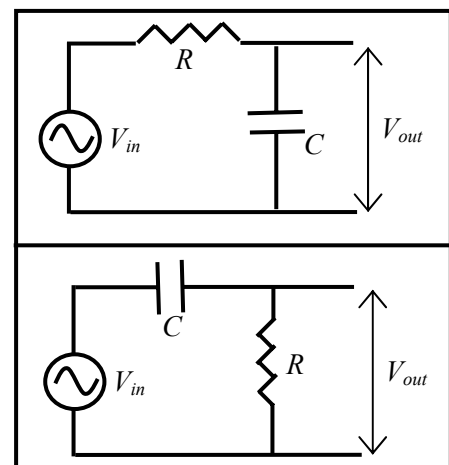### 2. High pass and low pass filters
Vary the frequency of the input voltage while observing the output on the oscilloscope.
What sort of filter is this?
How does it work?
Repeat your observations with the second filter.
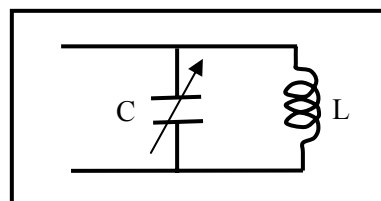What sort of filter is this one and how does it work?

3. Tuning circuit
Examine the circuit and identify the main components.
How is this circuit tuned?

C. Quantitative Question:

1. A variable capacitor, C, with a range from 10 pF to 365 pF is used in the tuning circuit of a car radio. The capacitor is part of a variable frequency LC circuit as shown opposite.

**a.** What is the ratio of maximum to minimum frequencies that can be tuned with this capacitor?

A second capacitor, C_1, is in parallel with the variable capacitor.
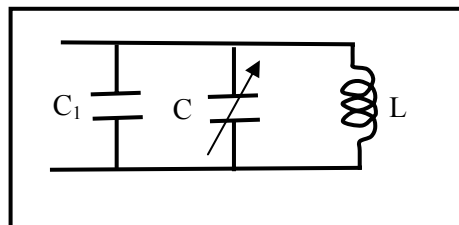
b. What value capacitor, C_1, must be added in parallel to this circuit to reduce this ratio by a factor of 2?

c. With this value of C_1, what inductance should the inductor, L, be for be the circuit to tune in to the AM radio band, with frequency range 540 kHz to 1600 kHz?

2. RLC circuits have many uses, for example they are used as the tuning circuit in radios, and as frequency generators to produce musical tones for doorbells. A mains powered RLC circuit is shown below. The power supply, $\mathcal{E}$, is 240 V (RMS) with a frequency of 50 Hz. The resistor has a resistance of 50 Ω, the capacitor has a capacitance of 50 μF and the inductor has an inductance of 0.05H.
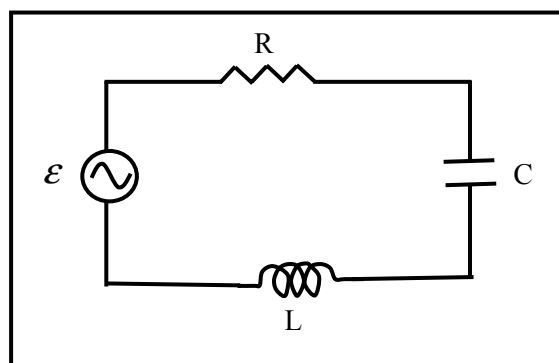
a. Calculate the total impedance, Z, of the circuit.

b. Sketch and label a phase amplitude diagram showing the potential difference across each component, and use this to find the phase angle between the current and the applied *emf, $\mathcal{E}$*.

c. Calculate the resonant frequency, ω_o, for this circuit. How does this compare to the frequency of the *emf* source?

d. Calculate the quality factor, Q, for this circuit. What does this tell you about the circuit?