Problem 1. A communication channel receives a voltage waveform that consists of two frequencies: the audio signal at about 400 Hz and a noise signal at about 10 kHz. After amplification, the RMS magnitude of both of these waveforms is about 5 V. The speaker acts like a 3 Ohm resistor. In order to filter out the noise, a 0.1 mH inductor is placed in series with the speaker.

a. Draw two versions of this circuit, one for each of the frequencies. The input can be modeled as an AC voltage source. Assume the phase angle for both is 0°.
b. Calculate the impedances on each of the circuits at the different frequencies.
c. Calculate the RMS current phasor at each of the frequencies.
d. Calculate the voltage across the speaker (resistor) at each of the frequencies.
e. Calculate the power absorbed by the speaker at each of the frequencies.
f. What is the (1) unfiltered and (2) filtered signal-to-noise ratio, both in terms of voltage and power?
g. What are the trade-offs in choosing the size of the inductor? What's the theoretical maximum signal-to-noise ratio? If you need at least 0.25 W on the speaker to be able to hear it, what is the highest signal-to-noise ratio you can get?

Problem 2. A factory is acting like a 250 Ω resistor in parallel with a 500 mH inductor. A power distribution line supplying the factory from the substation can be modeled as a 65 mH inductor. At the substation, the voltage is $12\angle 6.5°$ kV.

a. Draw this circuit and find the impedance of the circuit elements. The substation can be modeled as a voltage source. The frequency is 60 Hz.
b. What is the voltage at the factory?
c. How much active and reactive power is the factory absorbing?
d. What is the factory's power factor?
e. If a 50 μF capacitor is installed in parallel with the factory, how do the voltage and power factor change?
f. What should the value of the capacitor be so that the power factor is 0.95 lagging?