Heriot-Watt University
Edinburgh **Electrical Electronic and Computer Engineering**

B38EB Circuits and Analysis
Series and Parallel a.c. Circuits Laboratory

Name	Signed	Date

You must hand in the completed laboratory experiment at the end of this session.

Part A: Series a.c. circuits

"For series circuits Kirchhoff's voltage law applies / all voltages are drawn as *phasors*"

Circuit A1: Series CR

Experimental results

a) Connect the circuit as shown in Figure A1.

b) Using the *bridge* measure the actual values of the 1 kΩ resistor and the 0.22 µF capacitor.

c) Set up the function generator to give a 5 volt rms sinewave. You are going to repeat the measurements **at three different frequencies**, namely 200 Hz, 500 Hz and 1 kHz.

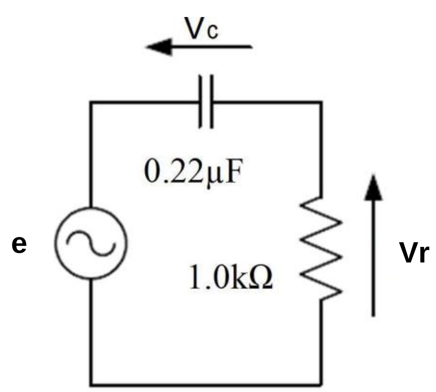


Figure A1 Series CR circuit

R = ____________ Ω

C = ____________ F

d) For each frequency measure and record the rms voltage across the resistor and the capacitor. Use the oscilloscope to measure and record the phase shift between the signal generator voltage (e) and the voltage across the resistor Vr.

Log your results in Table A1(a).

Frequency	signal generator voltage (e) (Volts rms.)	resistor voltage (V_r) (Volts rms.)	capacitor voltage (V_c) (Volts rms.)	phase shift between e and Vr (degrees)
200 Hz				
500 Hz				
1000 Hz				

Table A1(a)

Theoretical Calculations

The capacitive reactance of the 0.22 μF capacitor is different for each of the experimental frequencies. Calculate the respective reactance and insert into Table A1(b).

	f = 200 Hz	**f = 500 Hz**	**f = 1000 Hz**
capacitive reactance (Ω)			

Table A1(b)

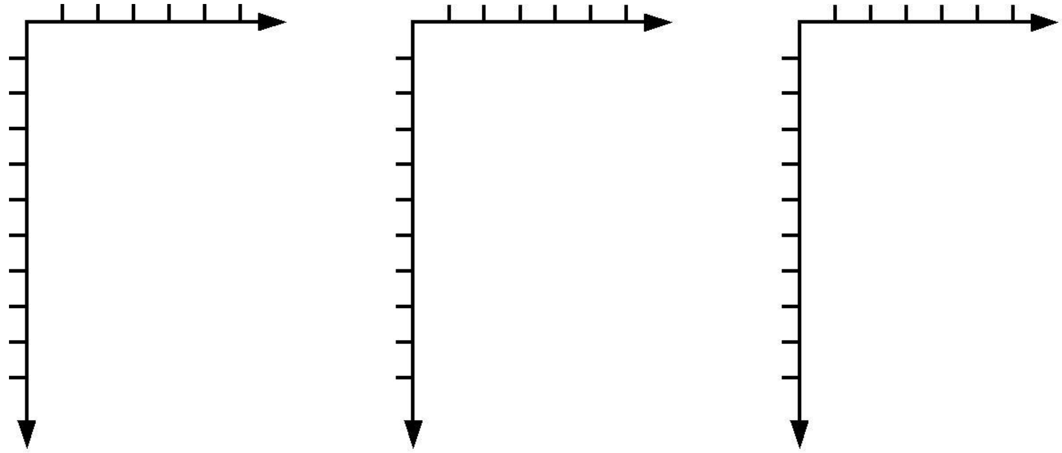
For each of the three frequencies

a) Draw an *impedance diagram* using the actual (measured) value of R and $|X_C|$. Calculate the phase angle and magnitude of the total impedance of the circuit, and show these on your diagram.

b) Draw a *phasor diagram* using the measured rms values for V_r and V_c. Calculate t h e magnitude and phase angle of the resultant voltage.

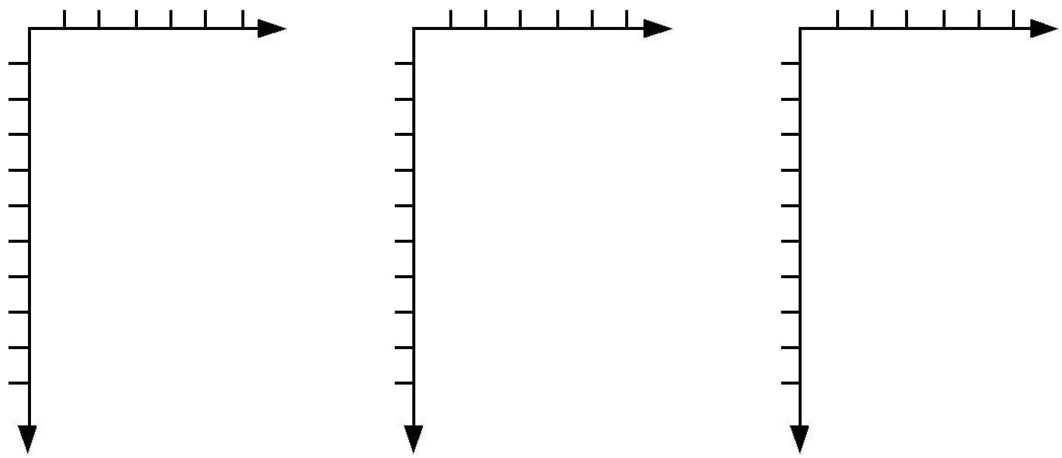
How do these values compare with the measured results?
How does the phase angle between the applied voltage *e* and the current *i* correspond to the phase angle of the impedance diagram?

Series CR circuit



(a) 200 Hz **(b) 500 Hz** **(c) 1000 Hz**

Experimental Results



(a) 200 Hz **(b) 500 Hz** **(c) 1000 Hz**

Z = **Z =** **Z =**

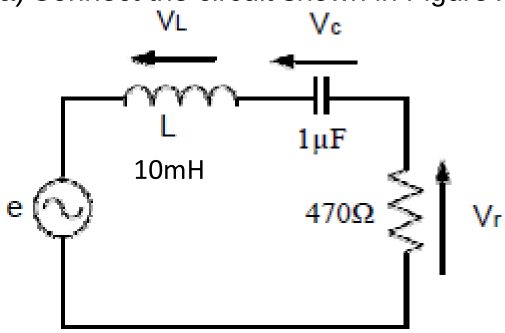
Theoretical Calculations

Comments:

Circuit A2: series connected R, L, and C

Experimental Results

a) Connect the circuit shown in Figure A2.



R =	____________	Ω
C =	____________	F
L =	_____________	mH

Figure A2 Series RLC

b) Using the *bridge* measure the actual values of the 470 Ω resistor, the 1.0 μF capacitor and the 10 mH inductor.

c) Set up the function generator to give a 5 volt rms sinewave.

d) Adjust the frequency of the signal generator in the range between 100 Hz and 2000 Hz. Adjust the frequency of the signal generator until you achieve the maximum voltage across the resistor (Vr). Record this maximum voltage and the frequency setting (fs)

V r (f s) = __________ volts rms. f s = __________ Hz

i) Now *reduce* the sinusoidal frequency until the voltage across the resistor is approximately 70 % of the maximum value found at frequency fs. Record the value of this frequency, f (low). Measure and record the rms signal generator voltage (*e*) and the voltages across the resistor, inductor and capacitor. Use the oscilloscope to measure and record the phase shift between the signal generator voltage and the resistor voltage. Log your results in Table A2a.

ii) Now *increase* the sinusoidal frequency until the voltage across the resistor is approximately 70 % of the maximum value found at frequency fs. Record the value of this frequency, f (high).
Repeat the same measurements as before and again log the results in Table A2(a).

Frequency	signal generator voltage (e) (Volts rms.)	resistor voltage (V_r) (Volts rms.)	capacitor voltage (V_c) (Volts rms.)	inductor voltage (V_l) (Volts rms.)	phase shift between e and Vr (degrees)
f (low) = Hz					
f (high) = Hz					

Table A2(a)

Theoretical calculations

Calculate the capacitive and inductive reactance for the three frequencies fs, f (low) and f (high), and insert into Table A2(b).

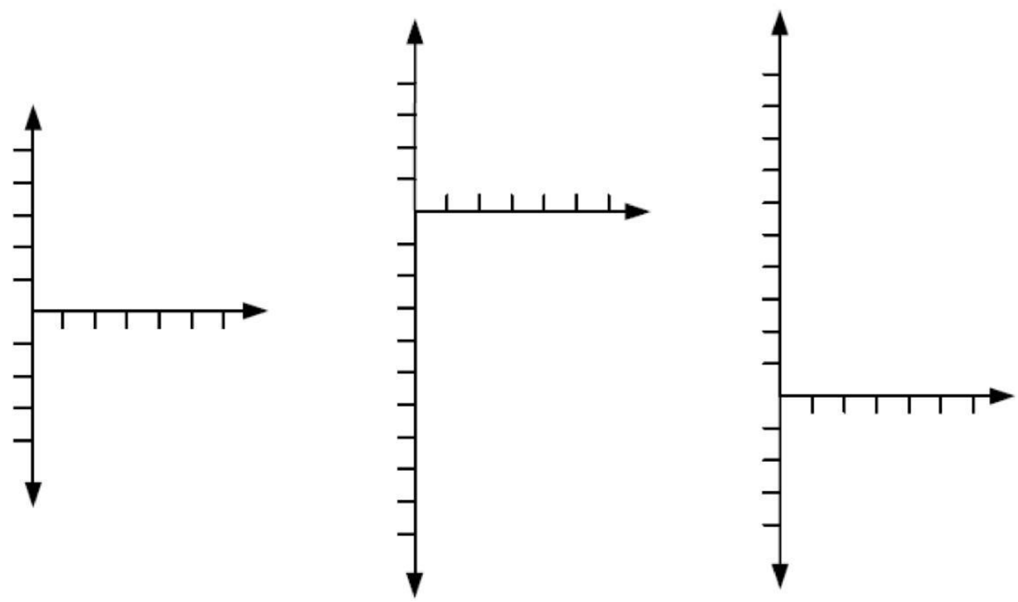
	fs =	f (low) =	f (high) =
Capacitive reactance (Ω)			
Inductive reactance (Ω)			

Table A2(b)

For each of the three frequencies, f_s, f (low) and f (high):

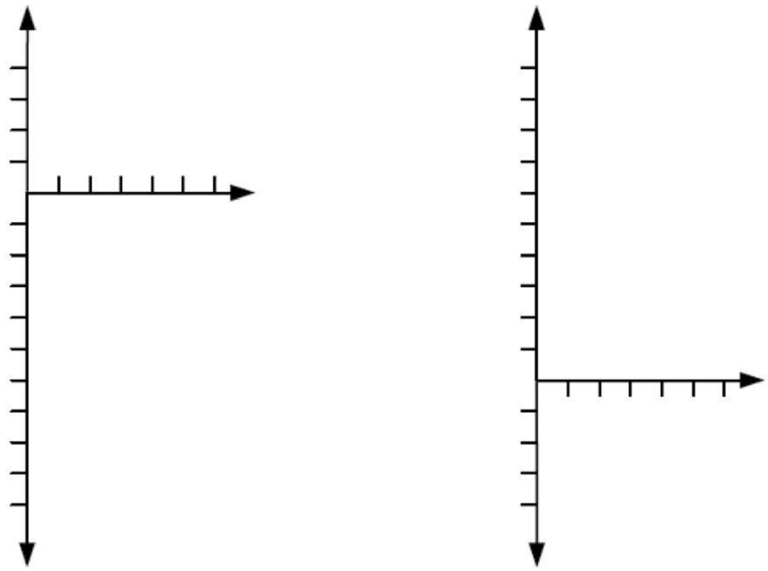
a) Draw an *impedance diagram* using the actual (measured) value of R and the capacitive and inductive reactance's.
Calculate the phase angle and magnitude of the total impedance of the circuit, and show these on your diagram.

b) Draw a *phasor diagram* using the measured rms values for V_r and V_c and V_L.
Calculate the magnitude and phase angle of the resultant voltage.



(a) f $_s$ **(b) f (low)** **(c) f (high)**

Impedance diagram



(a) f (low) **(b) f (high)**

Phasor diagram

Comments: