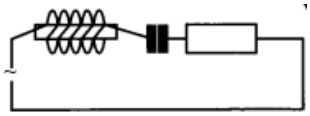
Sample: Electric Circuits - Electricity Assignment

1 Draw a sketch graph of frequency against current for this circuit.



The impedance of a series RLC circuit is given by: $Z=\sqrt{R^2+(X_L-X_C)^2}=\sqrt{R^2+\left(2\pi\cdot f\cdot L-\frac{1}{2\pi\cdot f\cdot C}\right)^2}$.

According to the Ohm's law, current in this circuit will be equal to: $I=\frac{U}{Z}=\frac{U}{\sqrt{R^2+\left(2\pi\cdot f\cdot L-\frac{1}{2\pi\cdot f\cdot C}\right)^2}}$.

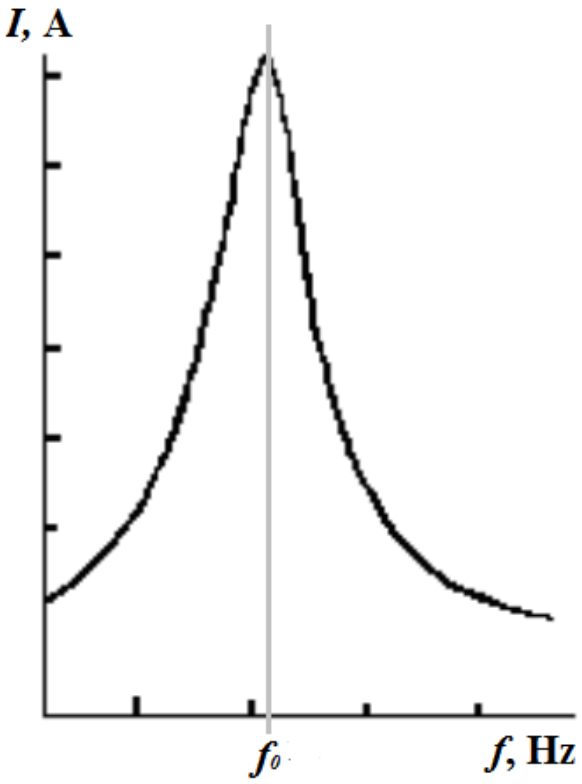
As you can see, values of $X_L=2\pi\cdot f\cdot L$ and $X_C=\frac{1}{2\pi\cdot f\cdot C}$ depend from frequency of the current f.

When the frequency is close to zero, $X_L << X_C$. When frequency increases, X_L increases and X_C decreases, value of $(X_L-X_C)^2$ decreases, total impedance decreases too and current will increase.

At certain frequency f_0, $X_L=X_C$, then $2\pi\cdot f_0\cdot L=\frac{1}{2\pi\cdot f_0\cdot C}\Rightarrow f_0=\frac{1}{2\pi\cdot\sqrt{L\cdot C}}$; also the value of $(X_L-X_C)^2$ will be equal to zero, impedance will become minimal and current will be maximal.

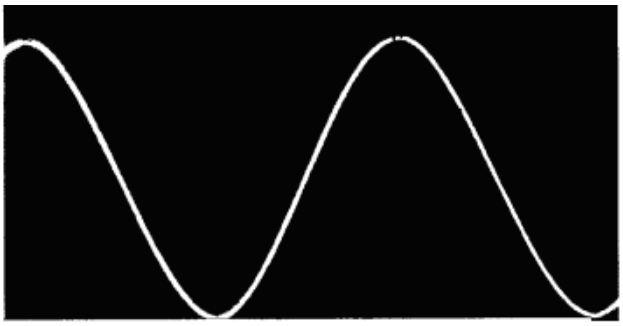
With the further increase of current frequency, value of $(X_L-X_C)^2$ will also get bigger than zero, impedance will increase and current will decrease.

We can show it on a sketch graph:



2 The picture shows a trace of an a.c. voltage on an oscilloscope. If the y axis is calibrated at 5V cm^{-1} and the time base is 1ms per cm. calculate :

a) the frequency.
b) the peek voltage
c) the r.m.s. voltage.



Total height of the trace is equal to 4.15 cm, and period of the trace (distance between two adjacent maxima or minima) is equal to 5.70 cm.

Thus, period of the a.c. is: $T = l_t \cdot 10^{-3} = 5.7 \cdot 10^{-3}$ s. Frequency is inversely proportional to the period, then: $f = \frac{1}{T} = \frac{1}{5.7 \cdot 10^{-3}} = 175$ Hz.

The peak voltage is equal to the half of total height: $V_P = \frac{h_V}{2} \cdot 5 = \frac{4.15}{2} \cdot 5 = 10.4$ V.

Then, r.m.s. voltage is: $V_{RMS} = \frac{V_P}{\sqrt{2}} = \frac{10.4}{\sqrt{2}} = 7.35$ V.