**A green tree on a black background

Description automatically generated**

BIRZEIT UNIVERSITY

Physics Department

## 

## Physics 112

**Experiment No. 9**

**Resonance**

………………………………………………………………………………………

Student’s Name: **Mohammad Sheikh** Student’s No**.: 1221541**

Partner’s Name: **Mousa Suhaib** Partner’s No.:  **1210143**

Instructor: **Shayma’ Salama** Section No.: **6**

Date: 16-1-2024

**Abstract:**

* **The aim of the experiment is** :

to identify the natural frequency ( *f* 0 ) and the corresponding angular frequency (0) for an RLC circuit by plotting a graph of

I vs .

* **The method used is :** by connecting a circuit that contains a resistor(1&2 KΩ)and capacitor and inductor and a generator to a DCO and we obtained the values and graphs we wanted to see.
* **The main Result :**

*f0* = 5 \*103 kHz

W0  = 31.4 \*103 *rad/sec*

For R1 🡺 Qexp  = = = 0.31

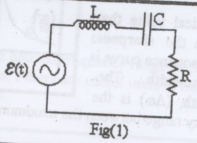
Qth = =

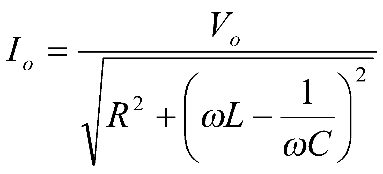
For R2 🡺 Qexp  = = = 0.15

Qth = =

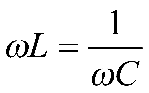
**Theory :**

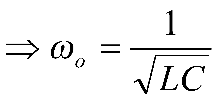
The amplitude of the current passing through the circuit shown

in  is given by, .



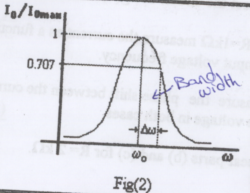
As we can see, we can get a maximum value of I0 when

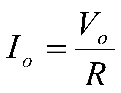


 under such a condition ω is the natural angular

frequency of the circuit.

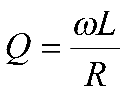
The resonance is that the current assumes its maximum value when the deriving voltage frequency equals the natural frequency of the RLC circuit.

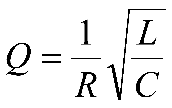


 Fig.2 shows a plot of the value of I0 as a function of ω.

At resonance and the value of the current is only limited by the resistance of the circuit.

**The quality factor:**

A measure of the sharpness of the resonance curve is a quantity

called the quality factor (Q), which is defined as

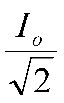
At resonance .

A diagram of a graph and a diagram of a graph

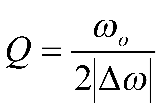
Description automatically generated

Fig.3 shows a plot of resonance curve for different combinations of R, L, and C.

The band width (∆ω) is a practical value that measures the sharpness of the resonance curve. The band width (∆ω) is the frequency range between the maximum value of and the value

, see fig.2.

The quality factor is related to the band width as follows:

.

**Data :**

L = 10 mH C = 0.05 F Vpp = 8 V

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *R = 1 K* Ω | | *R = 2 K* Ω | |
| *f (kHz )* | *V0 (volt)* | *I0 (mA)* | *V0 (volt)* | *I0 (mA)* |
| 0.2 | **1.84** | **1.84** | **3.30** | **1.65** |
| 0.5 | **4.24** | **4.24** | **4.85** | **2.425** |
| 1.0 | **7.28** | **7.28** | **7.12** | **3.56** |
| 3.0 | **11.4** | **11.4** | **12.9** | **6.45** |
| 4.0 | **11.9** | **11.9** | **13.0** | **6.5** |
| 4.5 | **11.9** | **11.9** | **13.0** | **6.5** |
| 5.0 | **11.9** | **11.9** | **13.0** | **6.5** |
| 5.5 | **11.9** | **11.9** | **13.0** | **6.5** |
| 10 | **10.9** | **10.9** | **12.6** | **6.3** |
| 20 | **8.24** | **8.24** | **11.4** | **5.7** |
| 50 | **4.16** | **4.16** | **7.28** | **3.64** |

**Calculations :**

**For R1 (from graph):**

*f0* = 5 \*103 kHz

W0  = 31.4 \*103 *rad/sec*

🡺 Imax = \* 11.9 = 8.41

Band width = w

w = w2 – w1 110 – 10 = 100

Qexp  = = = 0.31

Qth = =

**For R2 (from graph):**

*f0* = 5 \*103 kHz

W0  = 31.4 \*103 *rad/sec*

🡺 Imax = \* 6.5 = 4.59

Band width = w

w = w2 – w1 210 – 10 = 200

Qexp  = = = 0.15

Qth = =

**Analysis:**

By analyzing the graphs, data and the numerical results we can see that:

The results obtained experimentally for the natural frequency (![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAADAAAAAwCAMAAABg3Am1AAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAkUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAKZYAkcAAAALdFJOUwAEFD5plJzA1unqRZ0nggAAAAlwSFlzAAAh1QAAIdUBBJy0nQAAAJ9JREFUSEvtksEOgyAQRCm21Xb+/3+FdTQpsNU5ED34Di7oG0cSw821QYLLI5gsJOgfDrwXUywQ0I6b6F3wkAIx2UCMkXsj3+KywvwM9xnb/Cn9tenz2qQdCPjaqBkqnwGvwik4MfAsH+wFyoIeAS5WgJHTRklVsJmYbJS4AaegFVj+O8dvvwh4+b73xEH15cCnY4GdVvkg1WfFzUmEMAPoQwcpHFQGZgAAAABJRU5ErkJggg==)) and the corresponding angular frequency (![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAADAAAAAjCAMAAADlnnmAAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAhUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAG3RSMEAAAAKdFJOUwAIF1lxgsXP7/XMQjVJAAAACXBIWXMAACHVAAAh1QEEnLSdAAAAmElEQVQ4T+2O2w7CMAxDyx36/x9MlDieexviDaRZ2xynPtXKoR9UNamHmqDSA5nr3V7MjdqLmNxfE2JrwJDxHYj2RncfElsCAu4CfW8EOmIFPBeA5TmQkWvIMnvhnwFO6T7t/FJON3itl3DEh3tKgHQ21SgCG/glwMVpDtji7OaP9FEd+tG45pn0LeDtZaVYc0j1+dD/qZQ3X8QIkooDzqMAAAAASUVORK5CYII=)) closely matched what we predicted by theory.

As predicted, the graph of I vs. ![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAACUAAAAjCAMAAAAkGTMsAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAVUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAABIBAKQAAAAGdFJOUwABYHKAhZnEivgAAAAJcEhZcwAAIdUAACHVAQSctJ0AAAB1SURBVDhP7ZFJDoAwDAPLlv8/maRZWrUOAsERH4g1HqkHyp8XWYlILp96Yfot8waOtaB+kHU4bTbQ5hFYjJRFSawo9ywty2wxGa2GIr21e0HW5k2vIGuRhp5ZQBKoL9LlDzLIXx2hZLhOYiZS1WzJnT/fpZQTsgoDr60LuC0AAAAASUVORK5CYII=) has a maximum at![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAADAAAAAjCAMAAADlnnmAAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAhUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAG3RSMEAAAAKdFJOUwAIF1lxgsXP7/XMQjVJAAAACXBIWXMAACHVAAAh1QEEnLSdAAAAmElEQVQ4T+2O2w7CMAxDyx36/x9MlDieexviDaRZ2xynPtXKoR9UNamHmqDSA5nr3V7MjdqLmNxfE2JrwJDxHYj2RncfElsCAu4CfW8EOmIFPBeA5TmQkWvIMnvhnwFO6T7t/FJON3itl3DEh3tKgHQ21SgCG/glwMVpDtji7OaP9FEd+tG45pn0LeDtZaVYc0j1+dD/qZQ3X8QIkooDzqMAAAAASUVORK5CYII=).

The graph of I vs. ![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAACUAAAAjCAMAAAAkGTMsAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAVUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAABIBAKQAAAAGdFJOUwABYHKAhZnEivgAAAAJcEhZcwAAIdUAACHVAQSctJ0AAAB1SURBVDhP7ZFJDoAwDAPLlv8/maRZWrUOAsERH4g1HqkHyp8XWYlILp96Yfot8waOtaB+kHU4bTbQ5hFYjJRFSawo9ywty2wxGa2GIr21e0HW5k2vIGuRhp5ZQBKoL9LlDzLIXx2hZLhOYiZS1WzJnT/fpZQTsgoDr60LuC0AAAAASUVORK5CYII=) is symmetric about the line X=![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAADAAAAAjCAMAAADlnnmAAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAhUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAG3RSMEAAAAKdFJOUwAIF1lxgsXP7/XMQjVJAAAACXBIWXMAACHVAAAh1QEEnLSdAAAAmElEQVQ4T+2O2w7CMAxDyx36/x9MlDieexviDaRZ2xynPtXKoR9UNamHmqDSA5nr3V7MjdqLmNxfE2JrwJDxHYj2RncfElsCAu4CfW8EOmIFPBeA5TmQkWvIMnvhnwFO6T7t/FJON3itl3DEh3tKgHQ21SgCG/glwMVpDtji7OaP9FEd+tG45pn0LeDtZaVYc0j1+dD/qZQ3X8QIkooDzqMAAAAASUVORK5CYII=). (We used this fact to find ![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAD4AAAAmCAMAAACrmtiAAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAASUExURQAAAAAAAAAAAAAAAAAAAAAAAOArGaIAAAAFdFJOUwAhf93rhgZhJQAAAAlwSFlzAAAh1QAAIdUBBJy0nQAAAKFJREFUSEvt00sWgCAIBVCz3P+WQyN+oscTw3yDJODaqLSz01Lw/JgYLyXkYxx0xJcc4UADnz8Anh6nO6eXt1G/oRpjn9ug4+Z96LFvPL3x6XoxFnOh13idZyxrvca5yUSjOacvygUHuVz2YIGR5dySUS1nlwx0Liw5+kZSpKF8T736xLR6/ha+7rn28C+1c8DxpBgODyxc7UaMdLXz66R0AxPWBORw7ARhAAAAAElFTkSuQmCC) in a manner different than that described in the lab manual because the distance between any two points on the graph lying on the same horizontal line is double the distance between one of these two points and the line X=![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAADAAAAAjCAMAAADlnnmAAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAhUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAG3RSMEAAAAKdFJOUwAIF1lxgsXP7/XMQjVJAAAACXBIWXMAACHVAAAh1QEEnLSdAAAAmElEQVQ4T+2O2w7CMAxDyx36/x9MlDieexviDaRZ2xynPtXKoR9UNamHmqDSA5nr3V7MjdqLmNxfE2JrwJDxHYj2RncfElsCAu4CfW8EOmIFPBeA5TmQkWvIMnvhnwFO6T7t/FJON3itl3DEh3tKgHQ21SgCG/glwMVpDtji7OaP9FEd+tG45pn0LeDtZaVYc0j1+dD/qZQ3X8QIkooDzqMAAAAASUVORK5CYII=))

For each value of R, the value we got for the quality factor experimentally and by direct calculation closely matched.

The sharpness of the graph of I vs. ![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAACUAAAAjCAMAAAAkGTMsAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAVUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAABIBAKQAAAAGdFJOUwABYHKAhZnEivgAAAAJcEhZcwAAIdUAACHVAQSctJ0AAAB1SURBVDhP7ZFJDoAwDAPLlv8/maRZWrUOAsERH4g1HqkHyp8XWYlILp96Yfot8waOtaB+kHU4bTbQ5hFYjJRFSawo9ywty2wxGa2GIr21e0HW5k2vIGuRhp5ZQBKoL9LlDzLIXx2hZLhOYiZS1WzJnT/fpZQTsgoDr60LuC0AAAAASUVORK5CYII=) increases as the resistance deceases: where Q is inversely proportional to R. This is also confirmed by the graphs we obtained.

**Conclusion:**

We can conclude that current in an RLC circuit has reaches a maximum when the driving voltage frequency is equal to the resonant frequency. We can also conclude that the greater the resistance in an RLC circuit, the small the quality factor.

The results we obtained experimentally in this experiment closely matched those obtained by theory; the main factor that limited our precision, and therefore gave us a slight difference between practical and theoretical results, is the limitation imposed by the instruments and graphs when taking our data and measurements.

For example: when we wanted to find the quality factor using the I vs. ω graph, we had to determine the maximum and then take ω that corresponded to A black background with a black square

Description automatically generated with medium confidence… during all this much estimation had to be made, especially because we were dealing with a logarithmic scale. Additionally, for some values of ![A black background with a black square

Description automatically generated with medium confidence](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAACUAAAAwCAMAAAChW0MZAAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQUAAAAYUExURQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFY3HCoAAAAHdFJOUwAbJDlIeIDxwIpJAAAACXBIWXMAACHVAAAh1QEEnLSdAAAAaUlEQVRIS+2QOxKAMAhEUVTuf+Ng3FJgi0xS6KuWyRs+kZ9BmIMY0o1Kg5RbeK6kYlSHlDjrQEogWqk7Zqob6ne65KAMIRRnurVirQspYcVaCBnTB57jWrEXIgQ8t1Wdbmmvx3Ef9XVEGqz8Auas2hscAAAAAElFTkSuQmCC) we had to set the output frequency of the signal generator to a precision that is not given by the generator’s dial so it was only a matter of human judgment.