

# Magnetoresistance and its Field Dependence

Experiment - 02 , Submission Date: 3rd Feb 2025

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```
In [1]: # import necessary libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from scipy.stats import linregress
```

```
In [2]: # set default params for matplotlib :
plt.rcParams['font.size'] = 14
plt.rcParams['lines.linewidth'] = 2
plt.rcParams["figure.figsize"] = (8,5)
```

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In [3]: # read all the data from the excel file :
data_dict = {f'data{i}': pd.read_excel('data.xlsx', sheet_name=i) for i in range(1, 10)}
data_dict['calibration'] = pd.read_excel('data.xlsx', sheet_name=0)
```

```
In [4]: print('-----Calibration Table -----')
data_dict['calibration']
```

-----Calibration Table -----

Out[4]:

	Magnet Voltage Supply (V)	Magnet Current Supply (A)	Magnetic Field (G)
0	0.0	0.0	0
1	1.3	0.1	154
2	1.8	0.2	204
3	2.3	0.3	261
4	2.8	0.4	322
5	3.4	0.5	384
6	3.9	0.6	466
7	4.5	0.7	525
8	5.0	0.8	581
9	5.5	0.9	640
10	6.1	1.0	701
11	6.6	1.1	764
12	7.2	1.2	827
13	7.8	1.3	895
14	8.4	1.4	966
15	8.9	1.5	1024

In [5]: *# define function to plot log – log graph of delta R vs Magnetic feild st*  
*# The function also returns the approximated slope of the log – log line*

```
def visualize( data_dict:dict , i:int ):
    """
        param data_dict : dictionary stroing the data.
        param i : index of the data sheet
        returns slope of the log log  graph between B vs dR
    """
    data = data_dict[f'data{i}']

    # get the data for dR and B
    x = np.log( data['Magnetic Field (G)'].to_numpy()[1:] )
    y = np.log( data['DR '].to_numpy()[1:] )

    # plot the curves :
    plt.plot( x , y , linewidth = 3 )
    plt.scatter( x , y , linewidths=2 )
    plt.ylabel(r'log of  $\Delta R$  ( $\Omega$ )')
    plt.xlabel(r'log of Magnetic Feild B (G)')
    plt.grid()
    plt.title(fr'Magetic Feild B$vs  $\Delta R$  at {5*i}$mA$ on log-log s

    # get the slope and intercept of the regression line
    slope , inter = linregress( x , y )[:2]
```

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xr = np.linspace( x[0] , x[-1] , 100 )
yr = slope*xr + inter

# plot the regression line :
plt.plot( xr , yr , 'r--' , label = 'Regression Line')
plt.legend()

# save and display the figure :
plt.savefig(f'Plots/plot{i}.jpeg')
plt.show()

# return the slope of the regression line
return slope

```

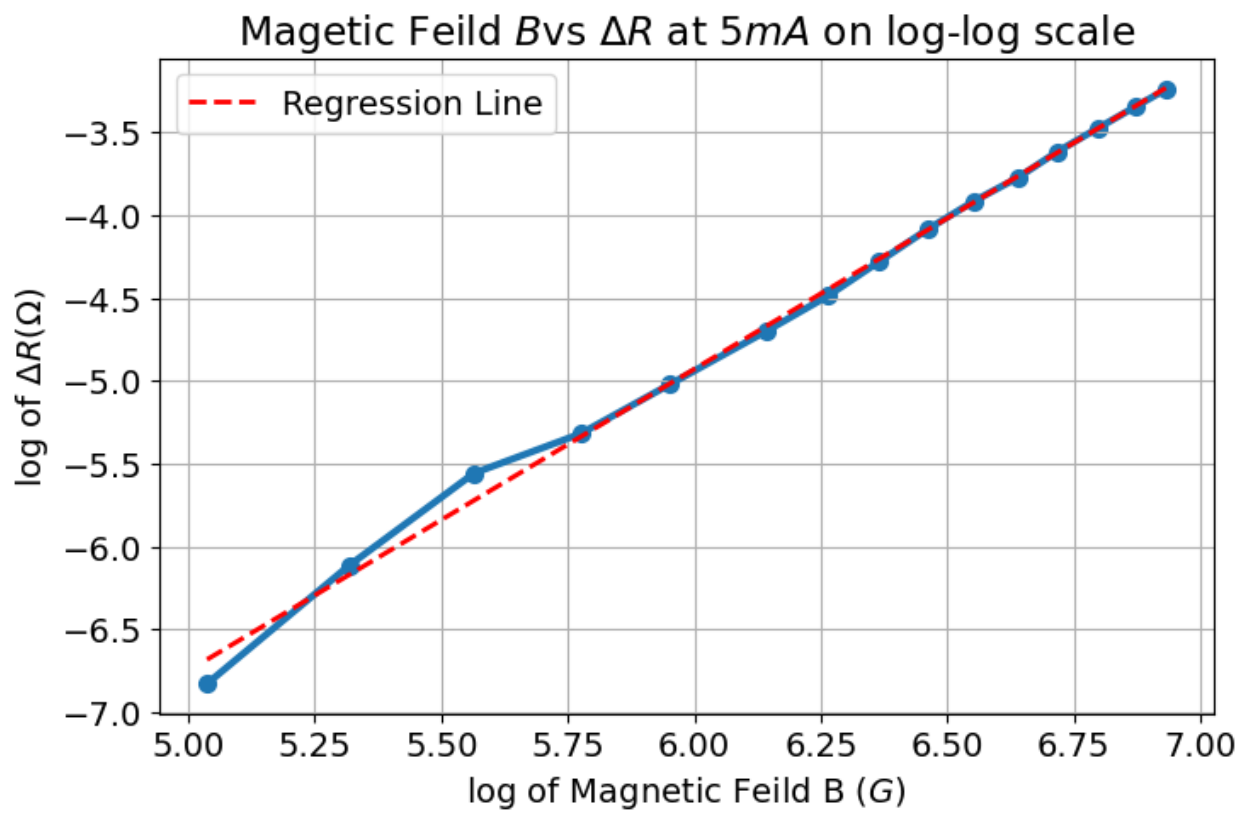
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In [6]: for i in range(1,5):
        print(f'----- Data Table for Probe Current at {i*5} mA -----')
        display( data_dict[f'data{i}'])
        slope = visualize( data_dict , i )
        print(f'Measured Slope of the Log – Log Graph : {slope}\n\n')

```

----- Data Table for Probe Current at 5 mA -----

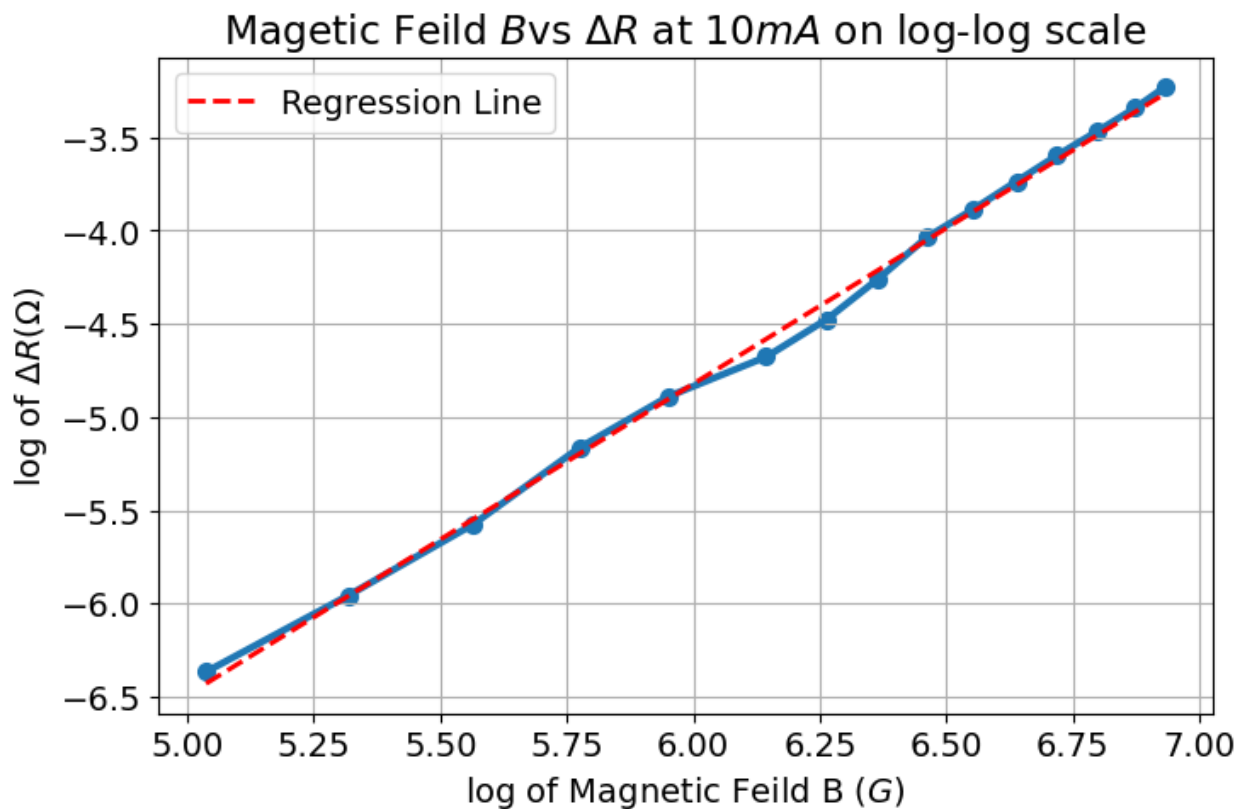
	Magnet Current Supply (A)	V+ (mV)	V- (mV)	Resistance (ohm)	DR	Magnetic Field (G)
0	0.0	10.633	-10.635	2.1268	0.000000	0
1	0.1	10.645	-10.646	2.1291	0.001081	154
2	0.2	10.661	-10.654	2.1315	0.002210	204
3	0.3	10.675	-10.675	2.1350	0.003856	261
4	0.4	10.687	-10.685	2.1372	0.004890	322
5	0.5	10.705	-10.703	2.1408	0.006583	384
6	0.6	10.731	-10.731	2.1462	0.009122	466
7	0.7	10.753	-10.754	2.1507	0.011238	525
8	0.8	10.781	-10.781	2.1562	0.013824	581
9	0.9	10.813	-10.813	2.1626	0.016833	640
10	1.0	10.847	-10.845	2.1692	0.019936	701
11	1.1	10.880	-10.876	2.1756	0.022945	764
12	1.2	10.922	-10.918	2.1840	0.026895	827
13	1.3	10.963	-10.963	2.1926	0.030938	895
14	1.4	11.012	-11.008	2.2020	0.035358	966
15	1.5	11.050	-11.050	2.2100	0.039120	1024



Measured Slope of the Log - Log Graph : 1.8216443363467985

----- Data Table for Probe Current at 10 mA -----

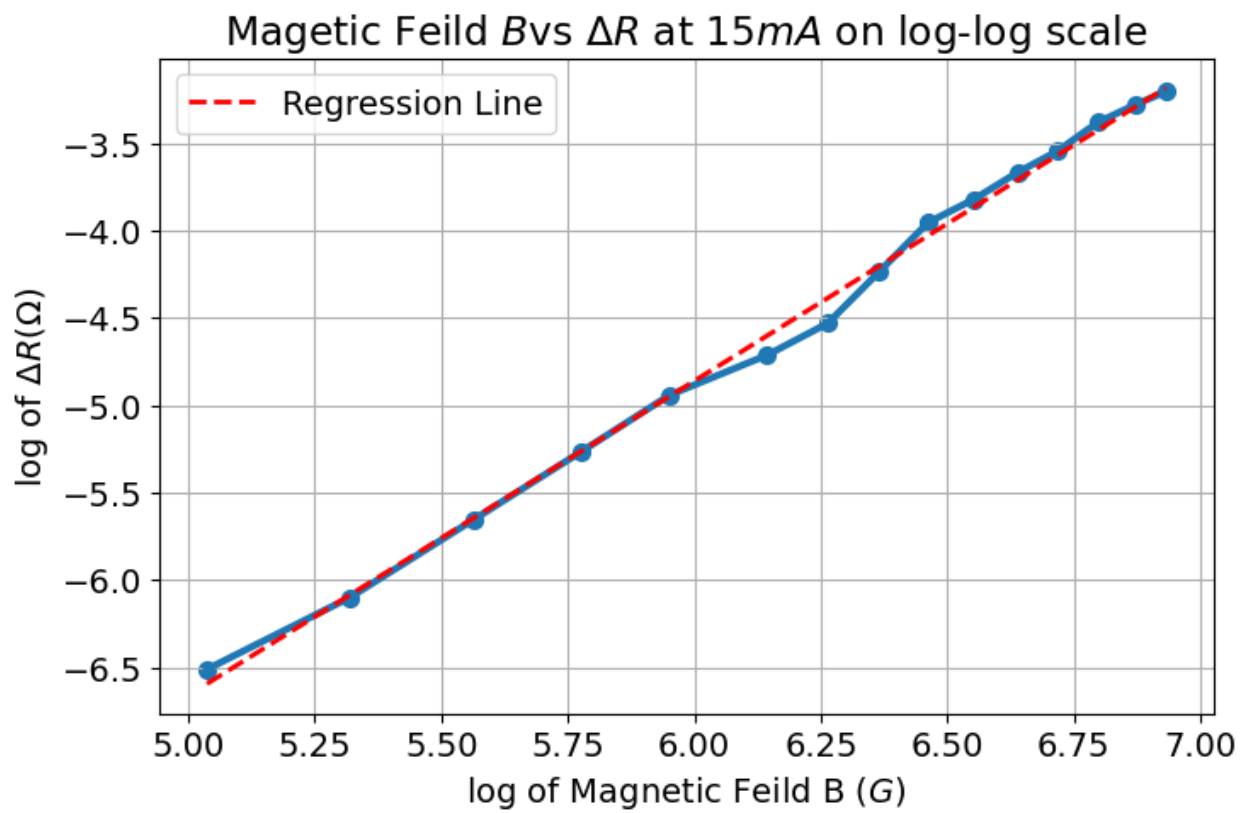
	Magnet Current Supply (A)	V+ (mV)	V- (mV)	Resistance (ohm)	DR	Magnetic Field (G)
0	0.0	21.256	-21.269	2.12625	0.000000	0
1	0.1	21.299	-21.299	2.12990	0.001717	154
2	0.2	21.320	-21.315	2.13175	0.002587	204
3	0.3	21.347	-21.339	2.13430	0.003786	261
4	0.4	21.388	-21.380	2.13840	0.005714	322
5	0.5	21.425	-21.420	2.14225	0.007525	384
6	0.6	21.461	-21.460	2.14605	0.009312	466
7	0.7	21.510	-21.499	2.15045	0.011382	525
8	0.8	21.565	-21.561	2.15630	0.014133	581
9	0.9	21.644	-21.633	2.16385	0.017684	640
10	1.0	21.699	-21.699	2.16990	0.020529	701
11	1.1	21.769	-21.771	2.17700	0.023868	764
12	1.2	21.851	-21.839	2.18450	0.027396	827
13	1.3	21.930	-21.920	2.19250	0.031158	895
14	1.4	22.015	-22.015	2.20150	0.035391	966
15	1.5	22.104	-22.104	2.21040	0.039577	1024



Measured Slope of the Log – Log Graph : 1.6703224305842537

----- Data Table for Probe Current at 15 mA -----

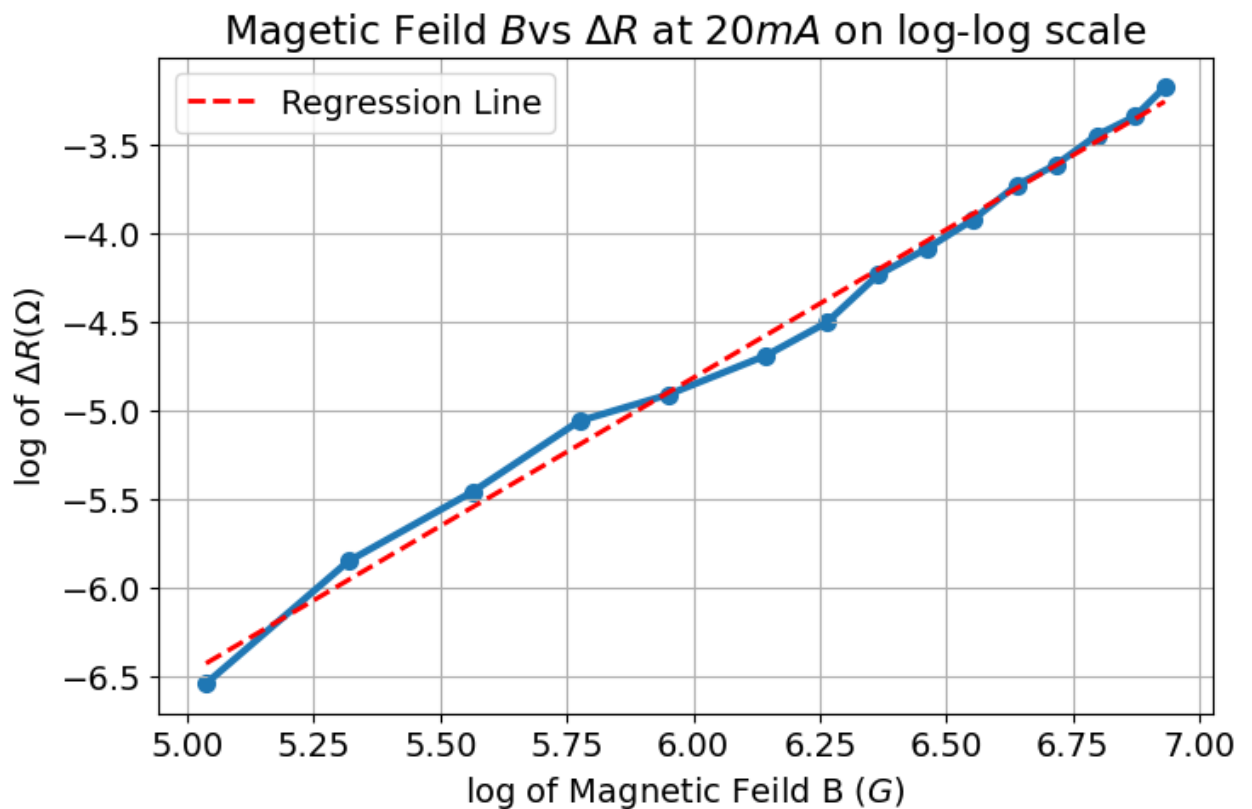
	Magnet Current Supply (A)	V+ (mV)	V- (mV)	Resistance (ohm)	DR	Magnetic Field (G)
0	0.0	31.934	-31.933	2.128900	0.000000	0
1	0.1	31.980	-31.982	2.132067	0.001487	154
2	0.2	32.006	-32.004	2.133667	0.002239	204
3	0.3	32.046	-32.045	2.136367	0.003507	261
4	0.4	32.098	-32.098	2.139867	0.005151	322
5	0.5	32.163	-32.160	2.144100	0.007140	384
6	0.6	32.211	-32.230	2.148033	0.008987	466
7	0.7	32.276	-32.279	2.151833	0.010772	525
8	0.8	32.391	-32.399	2.159667	0.014452	581
9	0.9	32.552	-32.539	2.169700	0.019165	640
10	1.0	32.634	-32.633	2.175567	0.021921	701
11	1.1	32.751	-32.748	2.183300	0.025553	764
12	1.2	32.852	-32.860	2.190400	0.028888	827
13	1.3	33.020	-33.020	2.201333	0.034024	895
14	1.4	33.141	-33.137	2.209267	0.037750	966
15	1.5	33.228	-33.230	2.215267	0.040569	1024



Measured Slope of the Log - Log Graph : 1.7997787783483026

----- Data Table for Probe Current at 20 mA -----

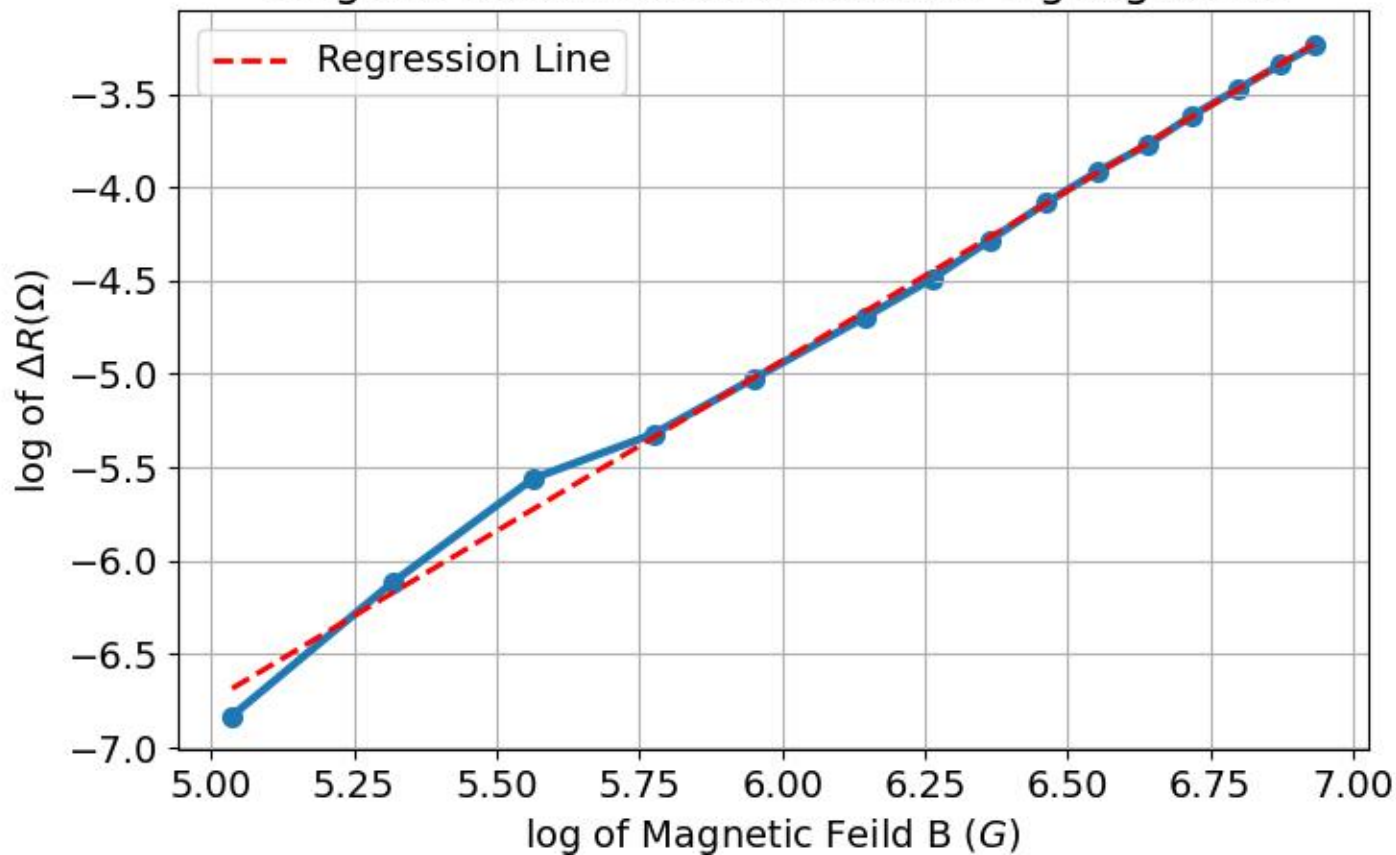
	Magnet Current Supply (A)	V+ (mV)	V- (mV)	Resistance (ohm)	DR	Magnetic Field (G)
0	0.0	42.555	-42.560	2.127875	0.000000	0
1	0.1	42.619	-42.619	2.130950	0.001445	154
2	0.2	42.680	-42.680	2.134000	0.002878	204
3	0.3	42.738	-42.740	2.136950	0.004265	261
4	0.4	42.835	-42.820	2.141375	0.006344	322
5	0.5	42.861	-42.881	2.143550	0.007367	384
6	0.6	42.960	-42.937	2.147425	0.009188	466
7	0.7	43.005	-43.051	2.151400	0.011056	525
8	0.8	43.160	-43.185	2.158625	0.014451	581
9	0.9	43.276	-43.267	2.163575	0.016777	640
10	1.0	43.405	-43.390	2.169875	0.019738	701
11	1.1	43.574	-43.582	2.178900	0.023979	764
12	1.2	43.719	-43.690	2.185225	0.026952	827
13	1.3	43.857	-43.960	2.195425	0.031745	895
14	1.4	44.060	-44.065	2.203125	0.035364	966
15	1.5	44.333	-44.328	2.216525	0.041661	1024



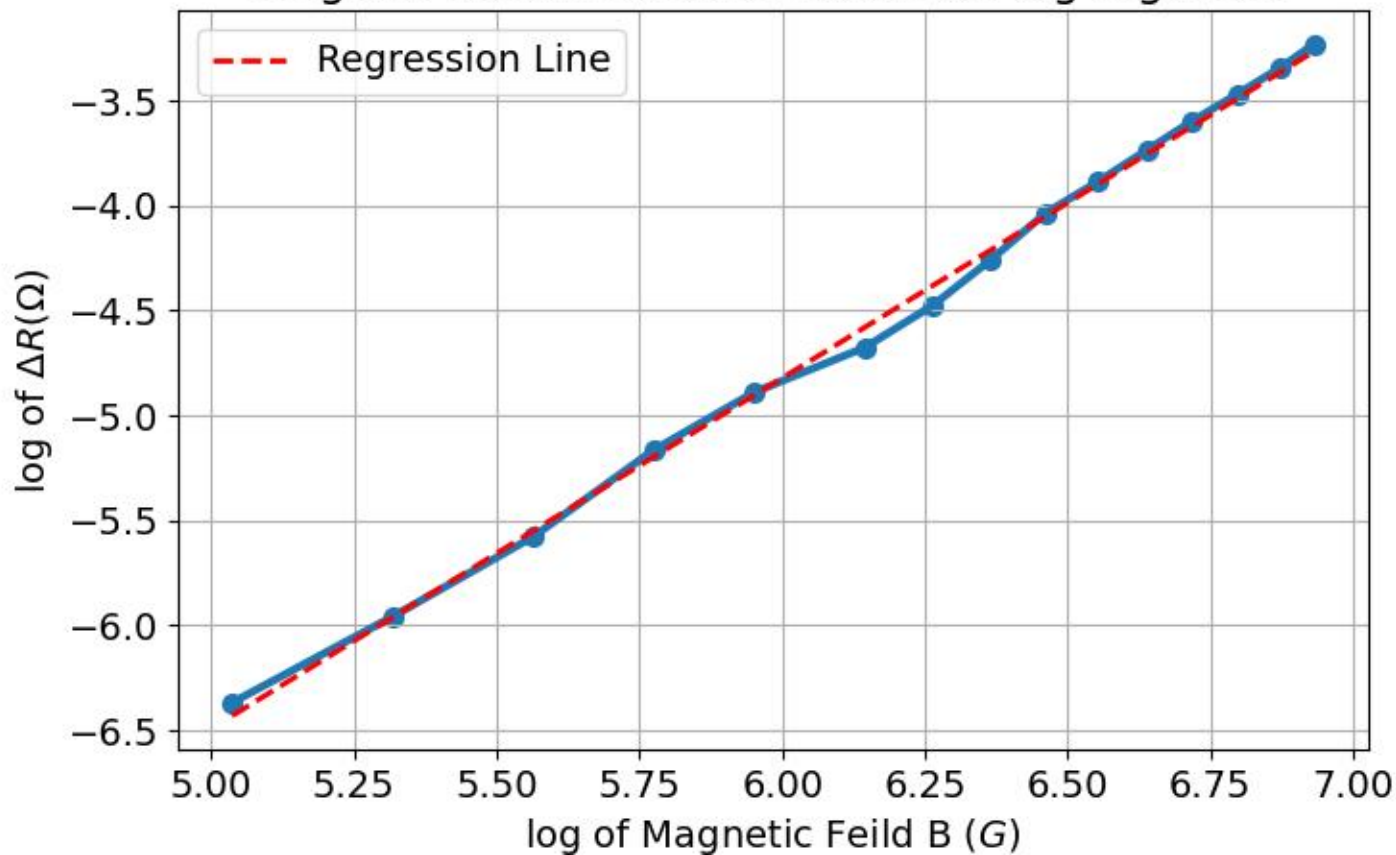
Measured Slope of the Log – Log Graph : 1.6715159939141642



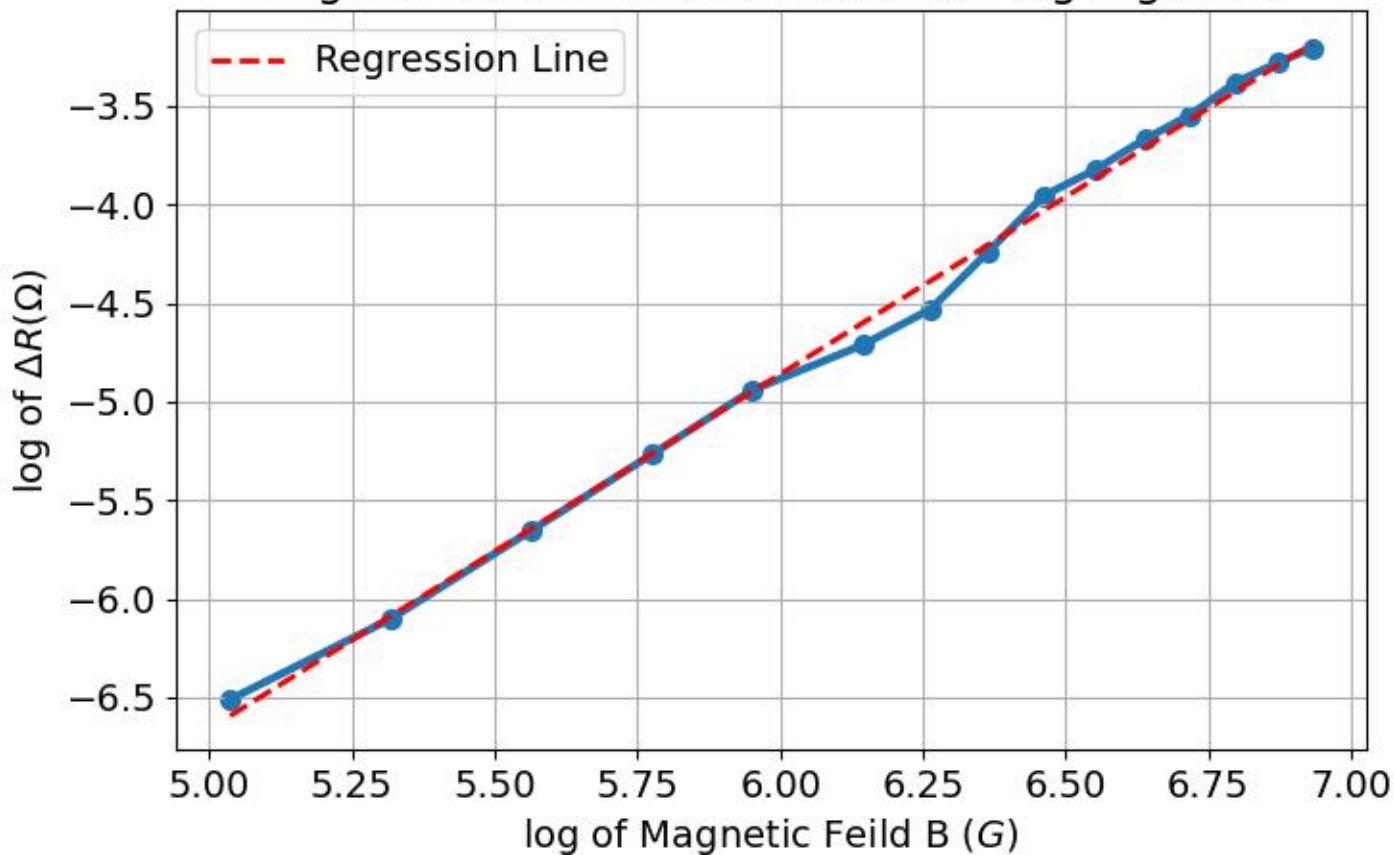
Magnetic Field  $B$  vs  $\Delta R$  at 5mA on log-log scale



Magnetic Field  $B$  vs  $\Delta R$  at 10mA on log-log scale



Magnetic Field  $B$  vs  $\Delta R$  at 15mA on log-log scale



Magnetic Field  $B$  vs  $\Delta R$  at 20mA on log-log scale

