Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

University of Applied Sciences Hamburg	DEPARTMENT OF ELECTRICAL ENGINEERING	**Laboratory for Instrumentation and Measurement**
Group No :	**HW Lab 2** Room 501	L1: in charge of the report
Date:		Assistant A2:
Professor:		Assistant A3:
Nonlinear characteristics and Wheatstone Bridge		

Report History

Report 1		Date		Remarks
	received			
	checked			
	result	o.k.		
		n.g.	➔ *1. Correction* ➔ Term.....	
1. Correction		Date		Remarks
	received			
	checked			
	result	o.k.		
		n.g.	➔ 2. *Correction* ➔ Term.....	Last chance!!
2. Correction		Date		Remarks
	received			
	checked			
	result	o.k.		
		n.g.	➔ ***not passed*** ➔ back to L1.....	

Final decision:

☐ o.k.

☐ not passed Prof. .....

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Objectives

- Understand the characteristics of non-linear resistances, especially the differential resistance at the operating point.
- Become familiar with the presentation of measured data using linear and logarithmic scaling.
- Apply the Wheatstone bridge and gain a solid understanding of the balanced and unbalanced bridge equations, as well as sensitivity and linearity.
- Learn to critically analyse measured data and to compare it against theoretically derived values.

Preparation

Note:
This homework is to be prepared as group work before the lab session starts and to be presented at the beginning of the lab session by the team leader.

1. Non-linear current characteristic

   Let: $$\frac{I}{mA} = a\left(\frac{U}{V}\right)^b$$
   where a = 14,7 and b = 0.54

   Calculate the current for the following voltages: 0.1 V, 0.2 V, 0.5 V, 1 V, 2 V, 5 V and 10 V.

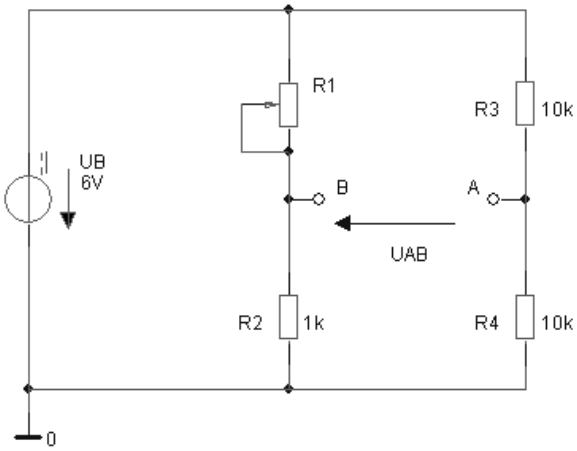
2. Unbalanced bridge

   Let R_2 = 1 kΩ; R_3 = R_4 =10 kΩ and U_B = 6 V.

   Calculate the bridge voltage $U_{AB}(R_1)$ where R_1 is to be incremented from 500Ω to 1800Ω in steps of 100Ω.

   Present the calculated values on graph paper using the following scales:

   U_{AB} (ordinate): 100 mV/cm,
   R_1 (abscissa): 100 Ω/cm.



Experiment 1: Measuring the characteristic diagram of non-linear components

Both current and voltage are simultaneously measured in incremental steps to obtain the characteristic diagram of an electrical component. The data is to be graphically presented. In order to fully exploit the range of the variable voltage source, the circuit is to be set up with a voltage divider. The specific setup has to be highlighted in the (prepared) circuit diagram.

Light bulb

Nominal values of the light bulb: 15 V / 82 mA

a) Measure the resistance of the cold light bulb and document both the measured value and the measurement device being used.

b) Measure the voltage across the light bulb and the current flowing through it within the range 0.1 V to 10 V. List the data in a table and consider that each decade should have at least 3 measurement points. Use the adjustable power supply to adjust the voltage.

c) Plot the characteristic function I = f(U) using lin-lin scaling, and graphically determine both the DC resistance R and the incremental resistance r at the operating points U = 0.1 V, 1.0 V and 10.0 V. Enter the results into the following table.

U/V	**I /mA**	**R /Ω**	**r /Ω**
0.1			
1.0			
10.0			

d) Plot the I = f(U) diagram using log-log scaling.

e) Within the voltage range 0.5V < U < 10V, the characteristic function is to be approximated by the expression in Equation 1. Present the pre-calculated values in a log-log diagram.

$$\frac{I}{mA} = a\left(\frac{U}{V}\right)^{b} \qquad \text{(Equation 1)}$$

f) Use a regression line (‘best linear fit’) to approximate the measured data in the log-log diagram within the range 0.5V < U < 10V.

g) Graphically determine the parameters a and b in Equation 1 from the regression line.

h) Prove the results obtained in g) by superimposing the graph of the calculated values on both the linear and the logarithmic diagram.

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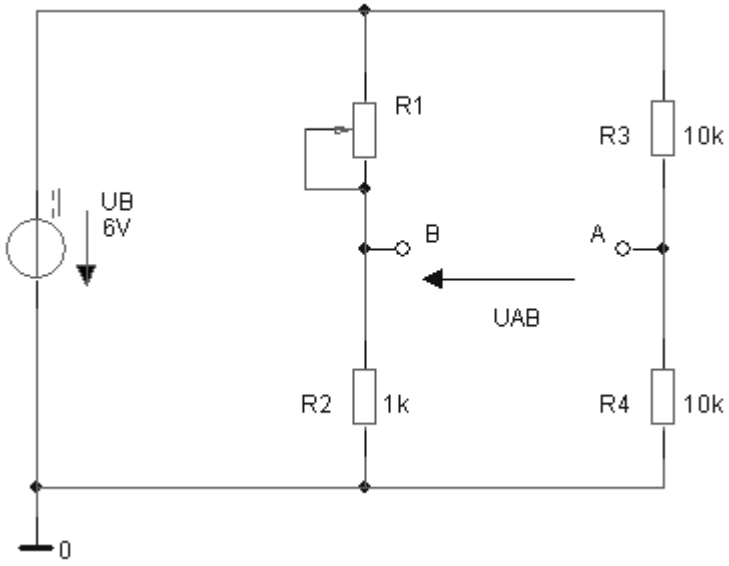
Experiment 2: Wheatstone bridge

a) Set up the circuit shown below. R_1 is a 10 kΩ potentiometer.
Let: R2 = 1 kΩ; R3 = R4 = 10 kΩ and U_B = 6 V.

Attention: The resistance of the potentiometer can only be measured if it is disconnected from the circuit. Otherwise you risk damaging the measurement device.
You have to disconnect the potentiometer before each measurement.



b) Determine the value of R_1 for which the bridge is balanced.
Let this value be $R_{1,0}$.

c) Measure the voltage U_{AB} as a function of R_1 for the following values:
R_1 = 550 Ω, 750 Ω, 1.0 kΩ, 1.25 kΩ, 1.4 kΩ , 1.7 kΩ and 2.0 kΩ.

d) Put all values into a table together with the relative unbalance $r = \Delta R/R_{1,0}$ where $\Delta R = R_1 - R_{1,0}$.

e) Draw the graph $U_{AB} = f(R_1)$ and highlight the pre-calculated values in this diagram.

f) Draw the tangent of $U_{AB} = f(R_1)$ in the balance point. Determine the bridge sensitivity E_0 at this point and compare it against the theoretical value.