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 :	**PSpice 1** PC Pool	L1: in charge of the report
Date:		Assistant A2:
Professor:		Assistant A3:

Bridge Circuit with loaded Resistance – Simulation with the Program PSpice –

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. ....

Important

- Complete the cover page and attach it to your report.
- Please do not forget to include your group number (1, 2, 3) on the cover page.
- Leave a left-margin of at least 3 cm and prepare your report single-sided.
- Please staple your reports. Do not use binders or sheet protectors.
- Sort and number all pages prior to submission.
- Circuits must contain all quantities used for analysis, together with the corresponding ‘reference arrows’.
- All PSpice - plots (‘probe’ graphic) must have a title field and figure caption.

Objectives

- Gain experience with computer aided engineering for the development of electronic boards.
- Understand the Wheatstone bridge and the characteristics of the balanced and unbalanced bridge.

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.

Preparation for exercise 1: Bridge circuit with independent voltage source

Prepare the following calculations *w.r.t.* Figure 1:

1. Analytically derive equations for all elements of both the Norton and Thévenin equivalents of this circuit (*i.e.*, U_0 , I_0 and R_i).
2. Determine U_0, I_0 and R_i for $R_1 = R_2$, $R_3 = R_4$.
3. Determine U_L for $R_1 = R_2 = R_3 = 10\ k\Omega$, $R_4 = 40\ k\Omega$, $R_L = 13\ k\Omega$.

Preparation for Exercise 2: Bridge circuit with independent current source

Prepare the following calculations *w.r.t*. Figure 2:

1. Derive analytic equations for all elements of both the Norton and Thévenin equivalents of this circuit (*i.e.*, U_0 , I_0 and R_i).
2. Determine U_0, I_0 and R_i for $R_1 = R_2 = 10\ k\Omega$, $R_3 = 20\ k\Omega$, $R_4 = 40\ k\Omega$.

Preparation for Exercise 3: Sensivity analysis

Use the equation derived in the preparation for exercise 1 to determine the voltage of the voltage source of the equivalent circuit, and to verify the equation for the voltage sensitivity as stated in Exercise 3.

Exercise 1: Bridge circuit with independent voltage source

Figure 1 depicts a bridge circuit connected to a voltage source which is loaded with an ohmic resistance. We will use *PSpice* to analyse both the voltage across the load resistor and the current through the load as a function of the load resistance RL.

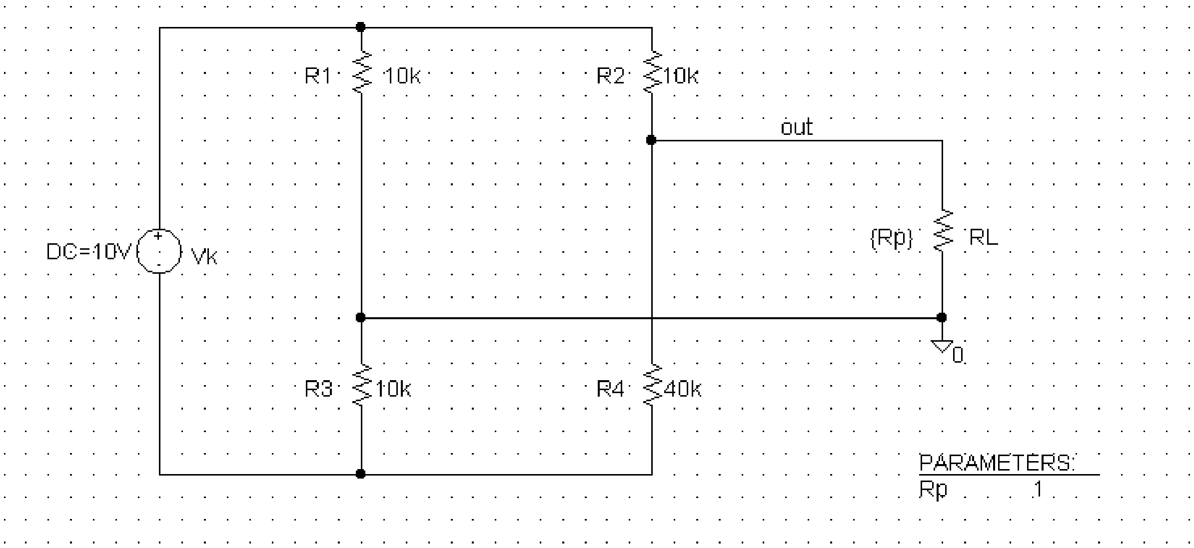

Fig. 1: Bridge circuit with independent voltage source

1. Open *schematics* and draw the circuit illustrated in Figure 1, including the label "*out*" of the load voltage and using the element *PARAM*. Save the corresponding file '*EEL_e1_1.sch'* in the directory *C:\Pspice*
2. Run the simulation with a variable load resistance.
3. Plot the bridge voltage U_L across R_L (U_L = f(Rp)) in *probe*. Create a second y-axis and additionally plot the power $P_L = U_L * I_L$ = f(Rp).
4. Determine the value of the maximum power P_{max} and the corresponding value of R_L.
5. Plot the load current $I_L = f(U_L)$.
6. Determine the values of the Norton and Thévenin equivalents of this circuit (U_0 , I_0 and R_i) based on the diagram $I_L = f(U_L)$.

Note:
The determination of U_0 and I_0 from the plots requires the selection of appropriate start and end values for *Rp.* It is therefore useful to repeat the simulation for different values of *Rp*.

Exercise 2: Bridge circuit with independent current source

Figure 2 depicts a bridge circuit that is connected to a current source and loaded with an ohmic resistance. We will use PSpice to analyse both the bridge voltage across the load resistor and the current through the load as a function of the load resistor R_L.

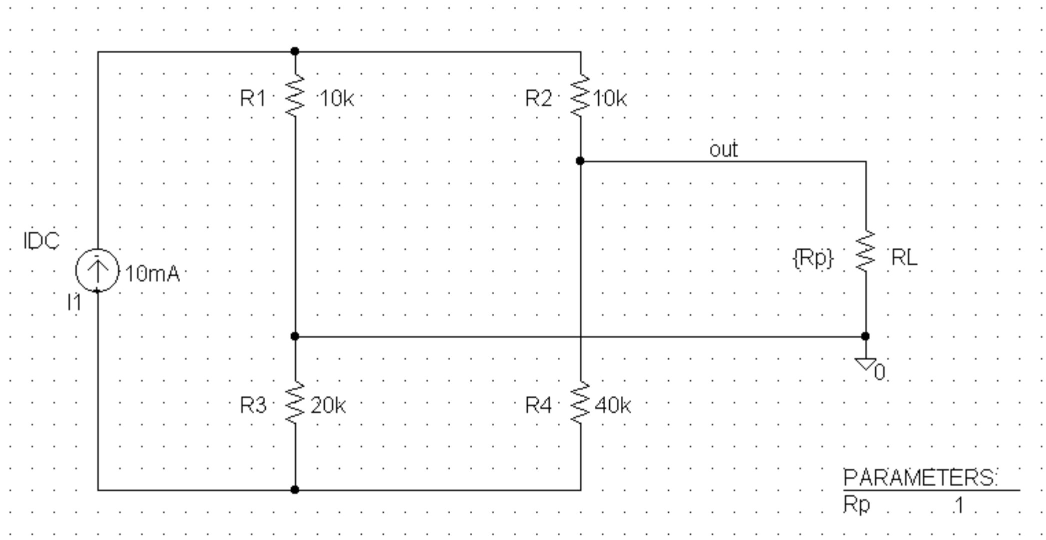

Fig. 2: Bridge circuit with independent current source

1. Open *schematics* and draw the circuit illustrated in Figure 2, including the label “*out*” of the load voltage. Save the corresponding file ‘*EEL_e1_2.sch’* in the directory *C:\Pspice*
2. Run the simulation with a variable load resistance. Try to find appropriate start and end values for Rp.
3. Plot the bridge voltage U_L across R_L (U_L = f(Rp)) in *probe*. Create a second y-axis and additionally plot the power $P_L = U_L \cdot I_L$ = f(Rp).
4. Determine the value of the maximum power P_{max} and the corresponding value of R_L .
5. Plot the load current I_L = f(U_L).
6. Determine the values of the Norton and Thévenin equivalents of this circuit (U_0, I_0 and R_i) based on the diagram I_L = f(U_L).

Experiment 3: Sensitivity Analysis

Figure 3 shows a general bridge similar to the bridge shown in Figure 1 using global parameters.

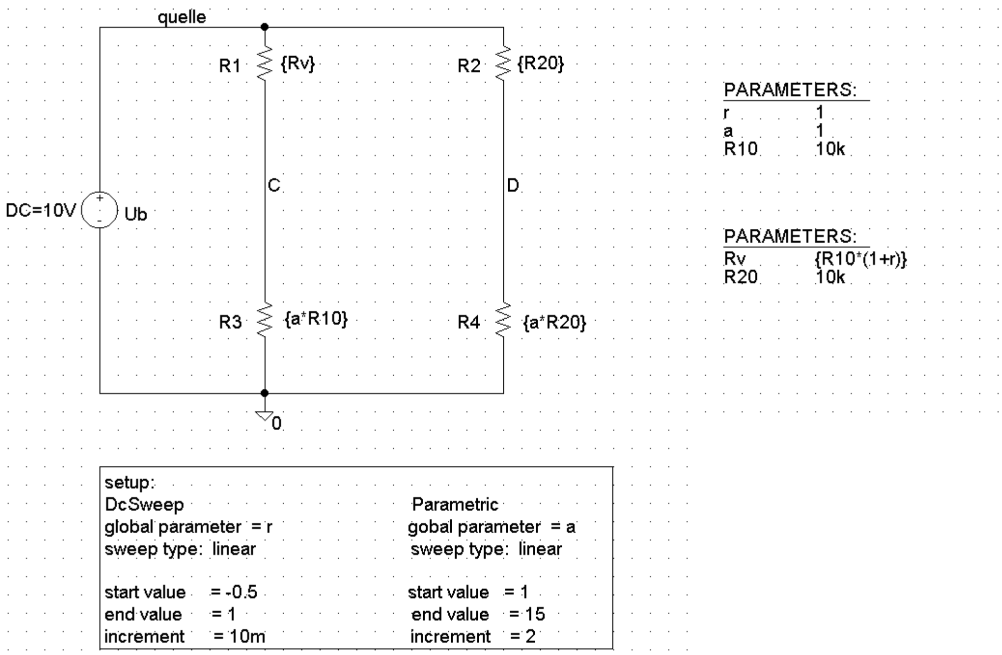

Fig. 3: Bridge circuit for sensitivity analysis

Definitions:

$R_1 = R_{10} \cdot (1 + r) \quad \Rightarrow \quad r = \dfrac{R_1 - R_{10}}{R_{10}}$ relative relation of resistances

$\dfrac{R_3}{R_{10}} = \dfrac{R_4}{R_2} = a$ condition for the relation of resistances

$\dfrac{U_{D-C}}{U_b} = \dfrac{a \cdot r}{(a+1) \cdot (a+1+r)}$ voltage sensitivity

1. Open *schematics* and draw the circuit illustrated in Figure 3 including the labels “C” and “D” of the bridge. Save the corresponding file ‘*EEL_e1_3.sch’* in the directory *C:\Pspice*.
2. Run the simulation after implementing the settings shown in the text block in Figure 3 above.
3. Plot the diagram $U_{D\text{-}C}/U_b = f(r)$ and label the values of the parameter *a* in this diagram.
4. Explain which bridge ratio should be theoretically chosen to achieve a high bridge sensitivity and how this is related to the diagram plotted in item 3.

Homework

For all circuits, compare the simulated values with the theoretically derived values.