

# uebung\_3.5.5

## Student Group

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## Table of Contents

Exercise 3.5.5. linear ..... 3



### Exercise 3.5.5. linear

In order to get a constant (lower) voltage from an higher voltage input or a source with a broader spread of the voltage (e.g. a battery) often linear regulators are used. One example could be to get 5V from the car battery voltage (between 11V...14V) for a microcontroller in a control unit e.g. the brake control unit. Linear regulator here means that a transistor as a variable resistor is used to drop the unwanted voltage.

Below, two types of such a linear regulator are shown

1. The first simulation shows a simple series regulator with a FET. "Series" here marks the fact that the transistor is in series to the load resistor  $R_L$ . The zener diode  $D$  has a current limiting series resistors  $R_D$  ahead. By the voltage divider of  $R_D$  and  $D$ , a relatively constant voltage will be created.
2. The second simulation shows a more sophisticated circuit. Here there is a feedback from the output of the transistor back to the transistor controlling voltage is given by  $R_1$ ,  $R_2$  and the operational amplifier.

You work in the company "HHN Mechatronics & Robotics" and are supposed to generate a bipolar signal (-10V ... + 10V) from a unipolar signal of a digital-to-analog converter (0...5V) in a project. A colleague recommended the circuit shown on the right.

1. First, analyze what change is made by pressing the switch  $S$ . How does the output signal change?
2. Try to determine mathematically the relationship of  $U_O$  and  $U_I$  as  $U_O(U_I)$  by superposition.
3. The circuit still has the problem that for an positive half-wave the output is still negative. Which additional circuit must be provided so that this problem can be solved?

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