

# uebung\_3.5.5

## Student Group

First Name	Surname	Matrikel Nr.

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### Exercise 3.5.5. Linear Voltage Regulator

In order to get a constant (lower) voltage from a 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  $5\text{ V}$  from the car battery voltage (between  $11\text{ V}$ ... $14\text{ V}$ ) 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 linear regulators 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 feedback from the output of the transistor back to the transistor controlling voltage. This feedback is given by  $R_1$ ,  $R_2$ , and the operational amplifier.

#### Tasks

- In both simulations there are two sliders on the right-hand side:
  - *Input Voltage*, which changes the ingoing voltage between  $5\text{ V}$ ... $20\text{ V}$
  - *Load Resistance*, which changes the load on the output between  $10\text{ }\Omega$ ... $1\text{ k}\Omega$
 Play with these sliders and look for the differences! What are these?
- The lower simulation with the operational amplifier is also called "**Low Dropout**" (**LDO**). The dropout is the minimum voltage difference on the transistor. How can the terminology low dropoff can be explained?
- To which primitive OpAmp circuit does the LDO circuit ( $R_1$ ,  $R_2$  and OpAmp) look similar to?
 

How can the controlling of the transistor input voltage  $U_{GS}$  be explained?
- Given a load resistor of  $R_L=1\text{ k}\Omega$ , an input voltage  $U_I=20\text{ V}$ , and an output voltage  $U_O=5\text{ V}$ , what is the dissipated power on the load and on the transistor?
- One LDO is the [TPS746](#).
  - What is the Pin  $FB$  for?
  - How does the [LM7805](#) differ regarding the set-up in a circuit?

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