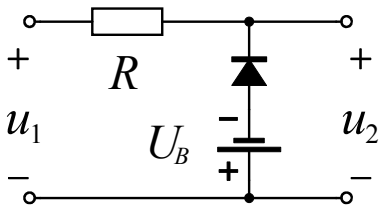
Written exam at the course

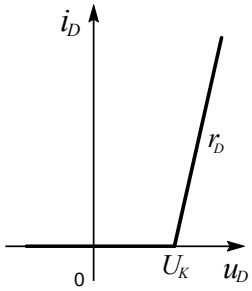
# NONLINEAR ELECTRONIC CIRCUITS

II. degree – 1. class / APS, 14. 2. 2023

1. Calculate and draw the transfer function $u_2(u_1)$ for the drawn circuit! What is the peak-to-peak value of output voltage $U_{2pp}$, if input equals $u_1(t) = 5\ \text{V}\cdot\sin(\omega t)$?

$U_B = 2{,}5$ V
$R = 100\ \Omega$
$r_D = 10\ \Omega$
$U_K = 0{,}7$ V

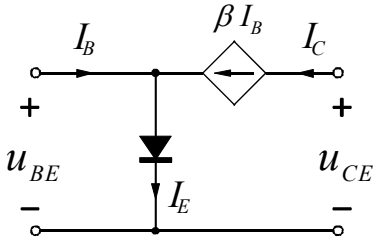



(Solution: $\boldsymbol{u_2 = u_1}$; $\boldsymbol{u_1 \geq -3{,}2}$ V, $\boldsymbol{u_2 = 1/11 \cdot u_1 + 32/11}$ V ; $\boldsymbol{u_1 < -3{,}2}$ V; $\boldsymbol{U_{2pp} = 8{,}36}$ V)

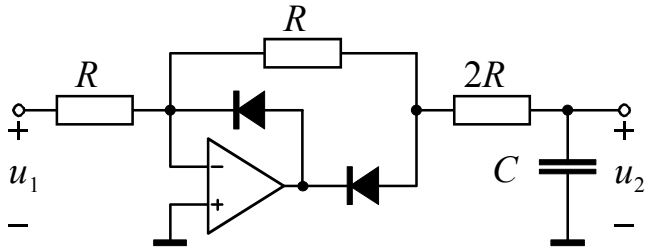
2. Draw a circuit of a simple voltage stabilizer consisting of an *npn* transistor, a breakdown diode and a resistor with the parameters given. Consider the specified transistor model for the active region. Replace the diode in the model with a battery $U_{BE} = 0{,}6$ V and a series resistance $R_E = 0{,}1\ \Omega$. The stabilizer operates in the input voltage range 12 – 24 V. Determine the output voltage at the input voltage of 24 V, maximum power on the transistor and output resistance at output current of 0,5 A.

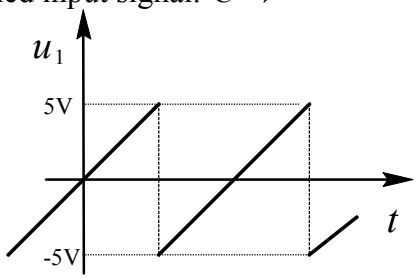
$U_{z0} = 5{,}6$ V
$r_z = 10\ \Omega$
$R = 470\ \Omega$
$\beta = 50$




(S.: $\boldsymbol{U_{izh=out} = 5{,}23}$ V, $\boldsymbol{R_{izh=out} = 0{,}292\ \Omega}$, $\boldsymbol{P_T \approx 9{,}39}$ W, $\boldsymbol{P_T = 9{,}21}$ W)

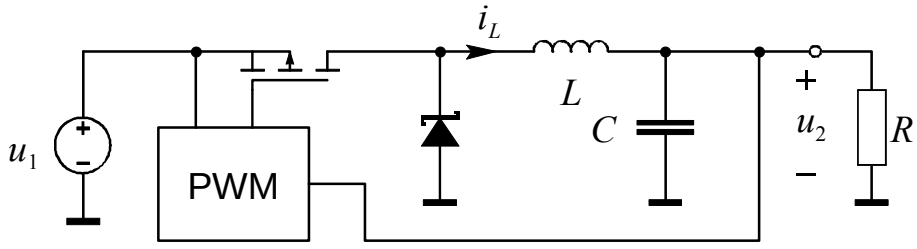
3. Calculate the output voltage $u_2$ at the given input signal $u_1$. Simplify the calculation by assuming that the polarization of the diodes depends only on the input signal. Complement the circuit to get the true mean voltage detector of half-wave rectified input signal. $C \to \infty$




(Solution: $\boldsymbol{U_2 = -1{,}5}$ V, **diode anti-parallel to the right diode)**

4. The switch regulator in the schematics below is designed for output voltage $U_2 = 5$ V. The input voltage $U_1$ changes in the range of 10 – 15 V. Determine the inductance, so that the regulator already operates in continuous current mode at load current of 1 A. Assume the transistor to be ideal, for the diode use knee voltage of $U_K = 0{,}3$ V. What will be the maximum losses on the diode at the load current 2 A? $f = 130$ kHz




(Solution: $U_1 = 15$ V: $D = 0{,}346$, $\Delta I_L = 2$ A, $\boldsymbol{L_{min} = 9{,}89\ \mu}$**H**, $\boldsymbol{P_D = 0{,}392}$ W)

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You have 75 minutes, the use of a sheet with basic equations is allowed.
The results are expected to be published tomorrow in STUDIS.