WS 2019/20

Tutorial for Microelectronics III

2. Basic Principles of Transistor

Task 1:

a) Which type of circuitry does the circuit in Figure 1 belong to?

b) Please sketch the transfer characteristic of $V_{out}$ in dependence of $V_{in}$ (from 0 to $V_{DD}$) and mark the important points. In which range do the transistors $T_1$ and $T_2$ work?

c) Please dimension the transistors $T_1$ (top) and $T_2$ (bottom) so that the following specifications are fulfilled:

\[ I_d = 0.5 \text{mA} \]
\[ \beta_{0n} = 100 \mu\text{A/V}^2 \]
\[ V_{th1,2} = 0.7V \]
\[ V_B = 1.5V \]
\[ r_{out} = 2k\Omega \]
d) The bulk of $T_1$ is now connected to ground (as shown in figure 2). Which parameter of the transistor is affected?

This is given:

$V_{th0} = 0.7V$
$V_{DD} = 5V$
$I_d = 0.5mA$
$\gamma = 0.45 V^{1/2}$
$2\phi_D = 1.2$
$\beta_{on} = 100\mu A/V^2$

Please dimension $T_1$ for achieving the maximum output voltage $V_{out} = 3.5V$. 