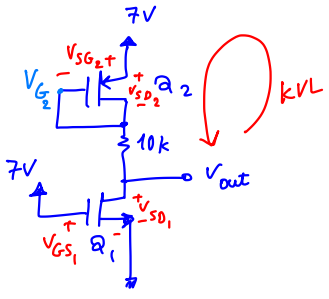
ECE 65 Spring 2021 midterm exam 2 solutions



Q_2 is in saturation because

$V_{GD_2}=0 \rightarrow V_{SG_2}=V_{SD_2} \rightarrow V_{SD_2} > V_{SG_2}-|V_{tp}|$

$I_{D_2} = \frac{1}{2} k_p V_{ov_2}^2 = \frac{1}{4}\left(\frac{mA}{V^2}\right) V_{ov_2}^2$: one equation with two unknowns

$V_{ov_2} = V_{SG_2} - |V_{tp}|$

KVL: $7V = V_{SD_2} + 10k\Omega \times I_{D_2} + V_{out}$

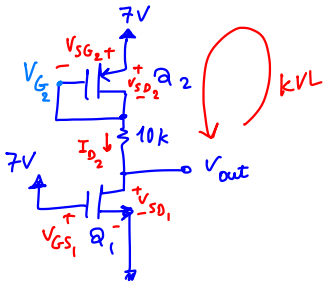
$7V = V_{SG_2} + 10k\Omega \times I_{D_2} + 0.3$

$7 - |V_{tp}| = V_{SG_2} - |V_{tp}| + 10k\Omega \times I_{D_2} + 0.3$

$5.7 = V_{ov_2} + 10k\Omega \times I_{D_2}$

$$\begin{cases} 5.7 = V_{ov_2} + 10k\Omega \times I_{D_2} \\ I_{D_2} = \frac{1}{4}\left(\frac{mA}{V^2}\right) V_{ov_2}^2 \end{cases} \Rightarrow V_{ov_2} + \frac{5}{2} V_{ov_2}^2 - 5.7 = 0$$

$V_{ov_2} = \begin{cases} -1.72 & < 0 \ \times \\ 1.32 & \checkmark \end{cases}$



$$V_{OV_2} = 1.32\,V \longrightarrow V_{SG_2} - |V_{tp}| = 1.32\,V \longrightarrow 7 - V_{G_2} - 1 = 1.32$$

$$\Rightarrow V_{G_2} = 4.68\,V$$

$$V_{OV_2} = 1.32\,V \longrightarrow I_{D_2} = I_{D_1} = \frac{1}{4}\left(\frac{mA}{V^2}\right) \times (1.32)^2 = 0.438\,mA$$

For Q_1 : $V_{GS_1} = 7V$

$$V_{OV_1} = V_{GS_1} - V_{t_n} = 6\,V$$

$$V_{DS_1} = V_0 = 0.3\,V$$

$V_{DS_1} < V_{OV_1} \Longrightarrow Q_1$ is in triode