mos_voltage_pump.sqproj

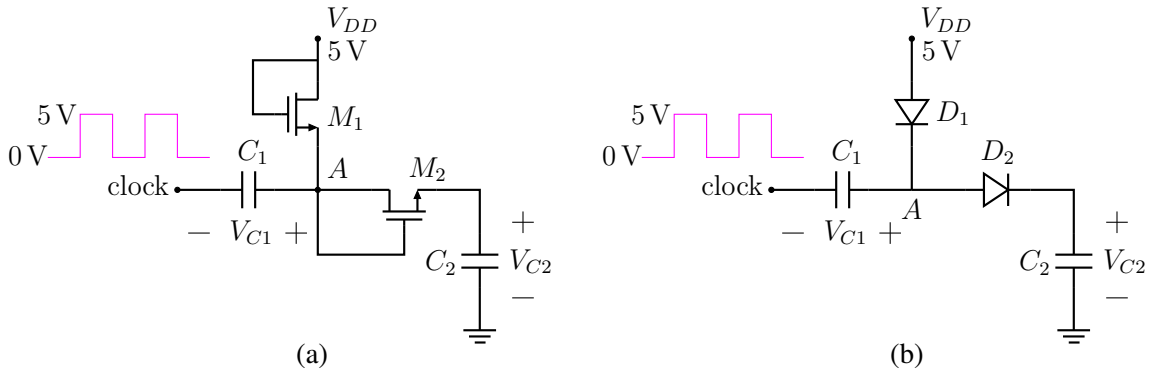

Figure 1: (a) Voltage pump with MOS transistors, (b) Voltage pump with diodes.

Fig. 1 (a) shows a voltage pump circuit with n-type MOS transistors. The functioning of this circuit is similar to the voltage pump circuit with diodes which is shown in Fig. 1 (b) and described in `ee101_voltage_doubler_1.sqproj`. The transistors M_1 and M_2 are "diode-connected," with $V_{DS} = V_{GS}$. The condition for the transistor to turn on is therefore $V_{DS} > V_T$ (the threshold voltage of the transistor) which is similar to $V_D > V_{\text{on}}$ in the diode case. In that sense, the two circuits are similar.

Note also that the condition for saturation for a diode-connected transistor is $V_{DS} > V_{GS} - V_T$, i.e., $0 > -V_T$ which is always true since V_T would be generally positive for an n-type transistor. M_1 and M_2 operate therefore in the saturation region when they conduct.

The circuit file consists of two solve blocks. The first block is used to perform transient simulation. The results of this block are useful to understand how the output voltage builds up with time. The second solve block is used to perform steady-state waveform analysis and gives the various voltages in the steady state.

Exercise Set

1. Run the simulation, and plot $V_{C1}(t)$, $V_{C2}(t)$, $V_A(t)$. Compare qualitatively these plots with those obtained in `ee101_voltage_doubler_1.sqproj`. Why are they different?

2. As seen in `ee101_voltage_doubler_1.sqproj`, the ratio C_1/C_2 decides how V_{C1} and V_{C2} will evolve, starting with $V_{C1} = V_{C2} = 0\,\text{V}$. Simulate three cases:

(a) $C_1 = 1\,\text{pF}$, $C_2 = 1\,\text{pF}$.

(b) $C_1 = 1\,\text{pF}$, $C_2 = 0.5\,\text{pF}$.

(c) $C_1 = 2\,\text{pF}$, $C_2 = 1\,\text{pF}$.

Compare the plots for $V_{C1}(t)$ and $V_{C2}(t)$ in the above cases. Explain why (b) and (c) are different.

References

1. R. J. Baker, H. W. Li, and D. E. Boyce, *CMOS Circuit Design, Layout, and Simulation*, Prentice-Hall India, 1998.

2. `http://en.wikipedia.org/wiki/Voltage_doubler`