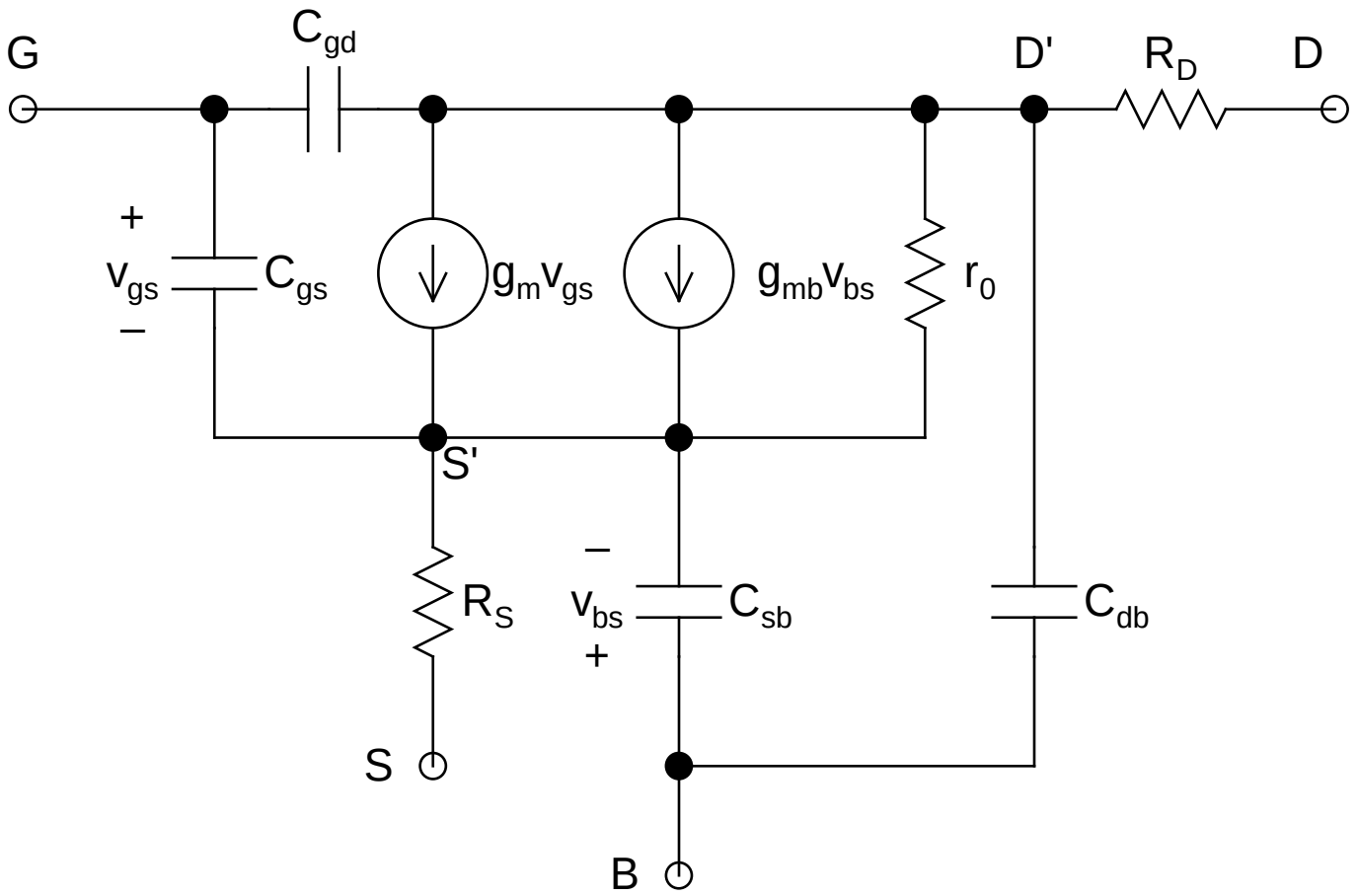
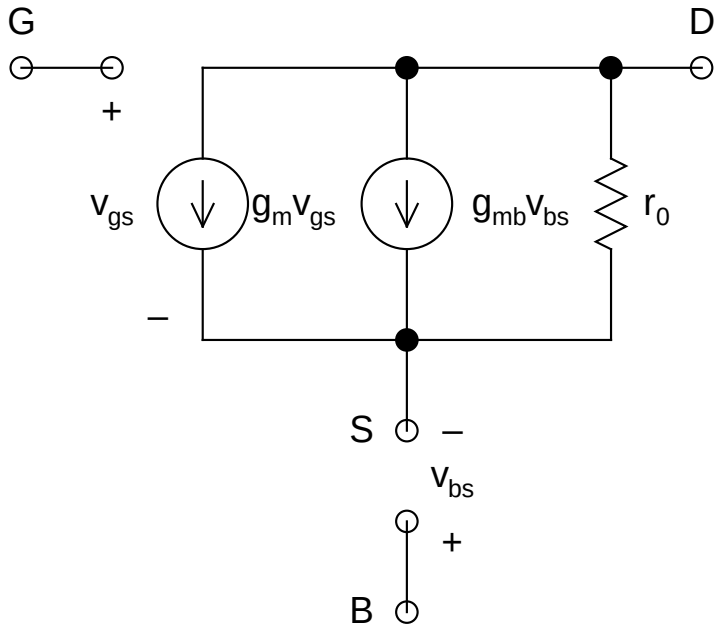
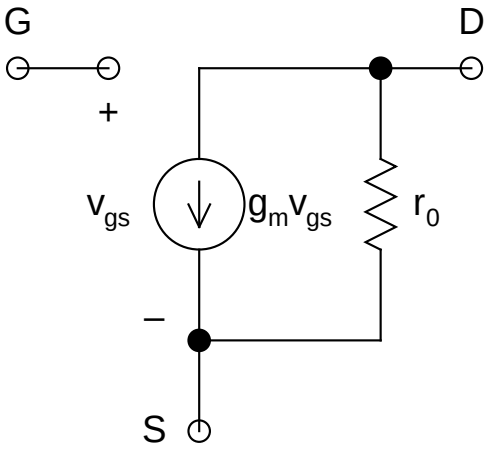
The Hybrid-π Model



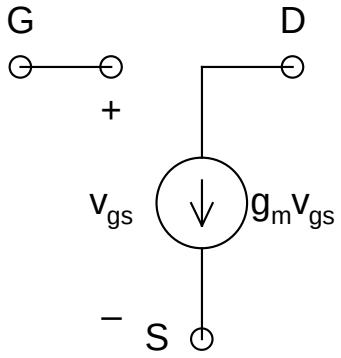
- ***Simplifications***:
  - ***R_S and R_D can be safely neglected***
  - For ***low to moderate frequencies***, the ***capacitive reactances*** of all the capacitances will be ***extremely large*** $\Rightarrow$ ***can be neglected***
  - ***If both B and S are connected to fixed DC potentials***, ***current source $g_{mb}v_{bs}$ disappears***
  - Leads to the ***Low-Frequency T-Model***, having only ***two components***: $g_m v_{gs}$ and r_0
  - ***Simplest possible equivalent results if r_0 is also neglected*** (***ideal current source***!)



Low-Frequency T-Model With Body Effect



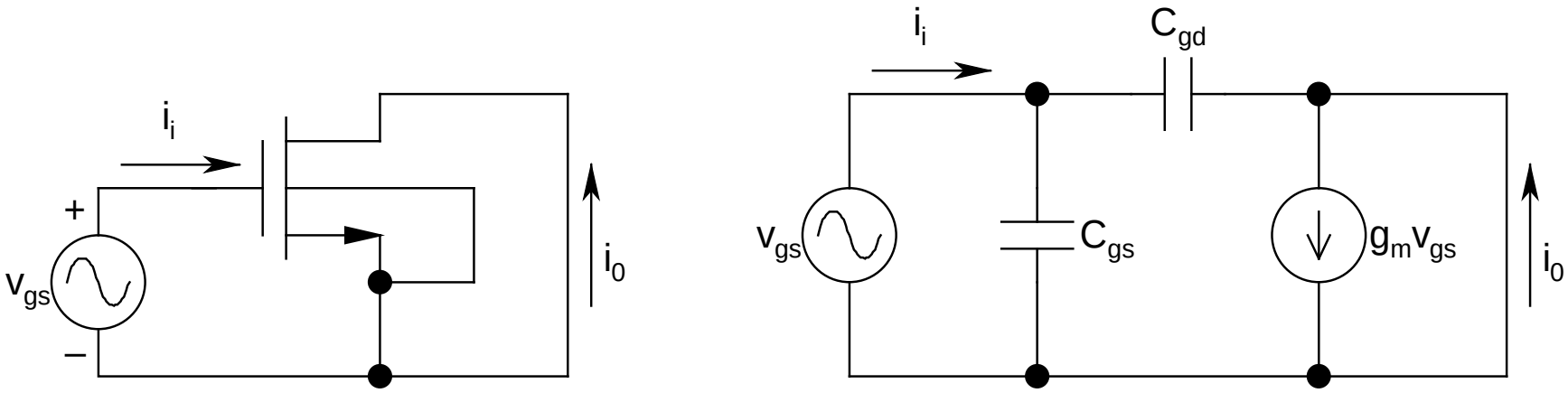
Low-Frequency T-Model Without Body Effect



Without CLM

Frequency Specification of MOSFETs

- Only ***Unity-Gain Frequency*** (f_T)



- $i_0 \approx g_m v_{gs}$ (neglecting ***reverse transmission*** through C_{gd})
- $i_i = j\omega(C_{gs} + C_{gd})$

$$\Rightarrow \frac{i_0(j\omega)}{i_i(j\omega)} = \frac{g_m}{j\omega(C_{gs} + C_{gd})}$$

$$\text{At } f = f_T,\ |i_0/i_i| = 1$$

$$\Rightarrow f_T = \frac{g_m}{2\pi(C_{gs} + C_{gd})}$$

- ***Remarkable similarity with that for BJT***

- ***Maximum Operable Frequency*** (f_{max}):
  - ***Maximum possible f_T***
  - Noting that ***$C_{gs} >> C_{gd}$***, ***neglecting C_{gst}***, and ***substituting the expressions for C_{gsi} and g_m***:

$$f_{max} = f_T\big|_{max} = \frac{3\mu_n V_{GT}}{4\pi L^2}$$

  - $f_{max} \propto 1/L^2$
    - ***Thrust towards making L as small as possible***
  - $f_{max} \propto V_{GT}$
    - ***Making V_{GT} large may be detrimental***!