IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

MICRORLECTRONICS: DEVICES TO CIRCUITS

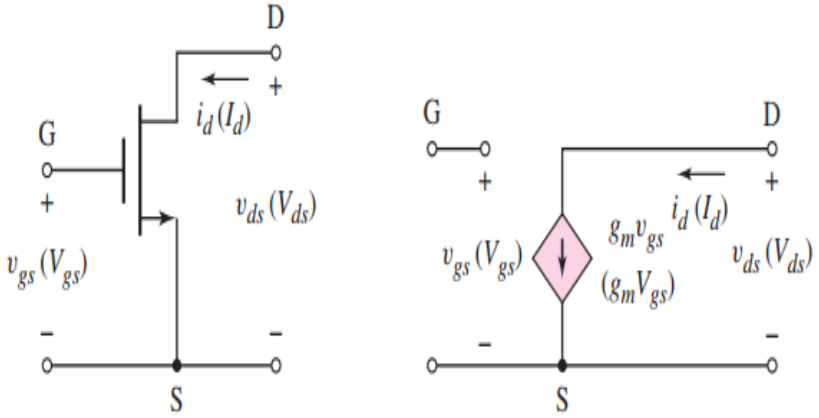
Biasing of MOS Amplifier and its Behavior as an analog switch-III

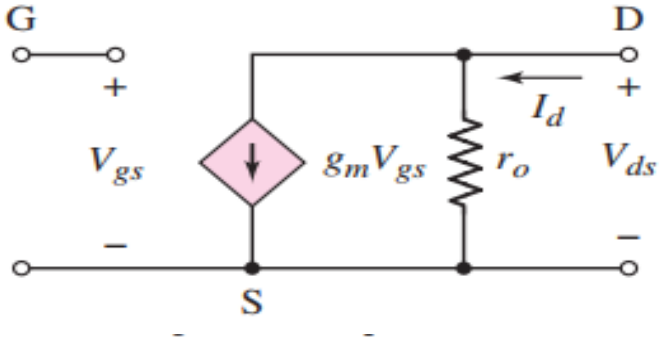
SUDEB DASGUPTA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

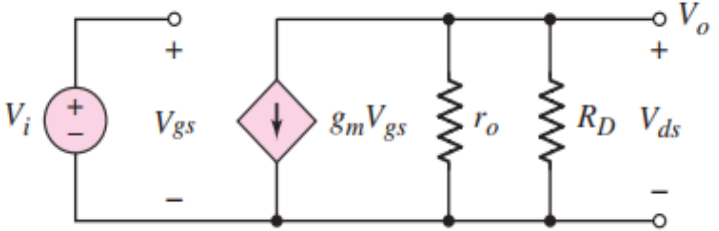


Small signal Model (NMOS)





$$i_D = K_n\left[(v_{GS} - v_{TN})^2(1 + \lambda v_{DS})\right]$$

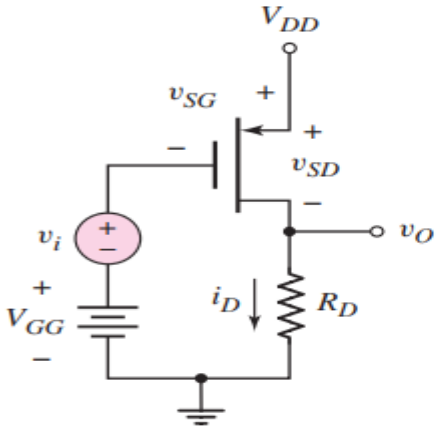


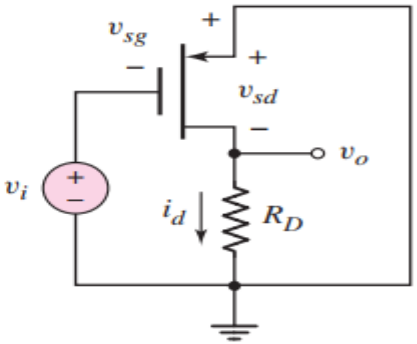
$$r_0 = \frac{1}{\lambda i_{DQ}}$$

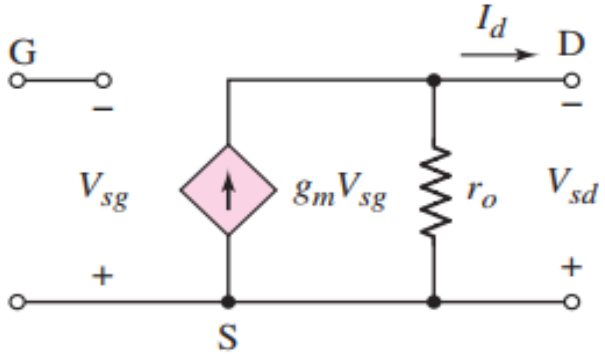
r_0 Output resistance

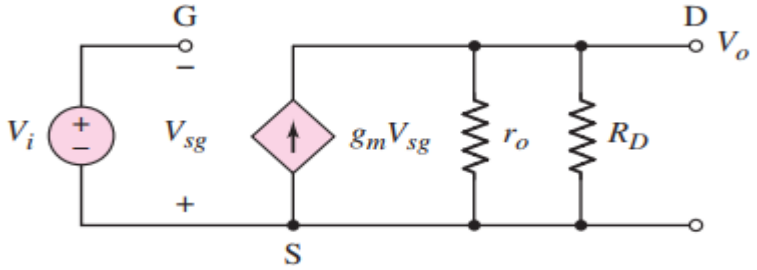
Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

Small signal Model (PMOS)







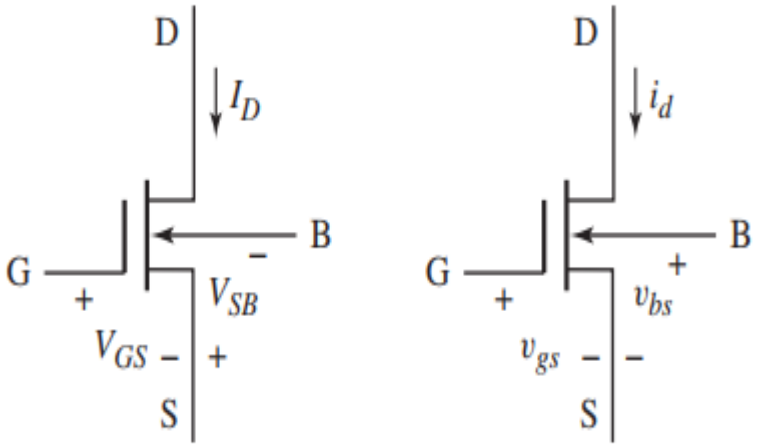


$$A_v = -g_m (r_0 \parallel R_D)$$

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

Small signal Model with body bias

- The body effect occurs in a MOSFET in which the substrate , or body ,is not directly connected to the source.

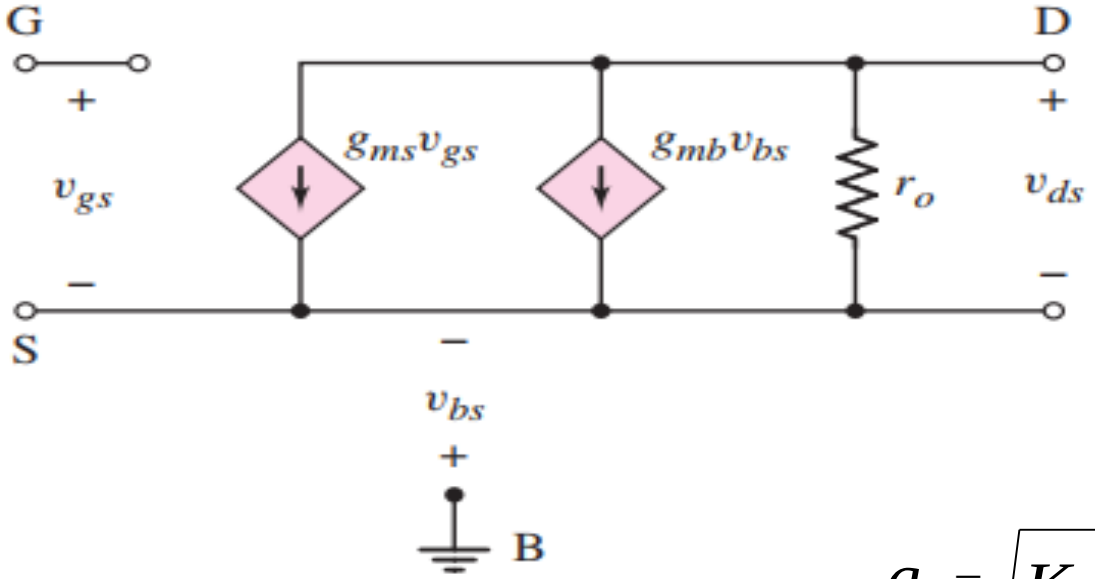


$$i_D = K_n\left(v_{GS} - V_{TN}\right)^2$$

$$V_{TN} = V_{TNO} + \gamma\left[\sqrt{2\phi_f + v_{SB}} - \sqrt{2\phi_f}\right]$$

$$\eta = \frac{\gamma}{2\sqrt{2\phi_f + v_{SB}}} \qquad g_{mb} = \eta g_m$$

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

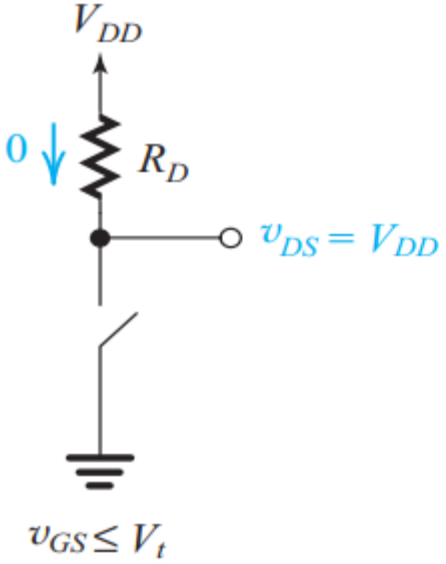


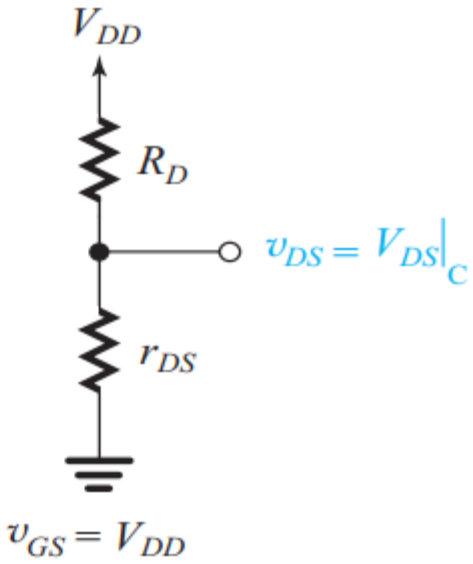
$$g_m = \sqrt{K_n'}\sqrt{W/L}\sqrt{I_D}$$

$$g_m = K_n'(W/L)V_{OV}$$

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

MOS as Analog Switch





Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

- For a given MOSFET g_m is proportional to square root of the dc current.
- At a given dc bias current g_m is proportional to $\sqrt{\frac{W}{L}}$.
- Linear amplification can be obtained by biasing the MOSFET in the saturation region and by keeping the input signal small.
- The bias point Q is determine by the value of V_{GS} and load resistance R_D.
- Two important factor parameter depends on the location of Q, which are gain and signal swing at the output.
- MOSFET used as switch in deep triode region.

Thank You