6.012 Microelectronic Devices and Circuits

Tutorial #5

Problem 1 – n-MOSFET

You are given an n- MOSFET with the following parameters —

$V_{Tn} = 0.5V, \quad \mu_n = 250\,cm^2/Vs, \quad t_{ox} = 10\,nm, \quad L = 0.5\,\mu m, \quad W = 25\,\mu m$

The MOSFET is biased as shown in Figure T5-1 with the following initial bias conditions:

$V_{GS} = 2.5V, \quad V_{DS} = 2.5V, \quad V_{BS} = 0V$

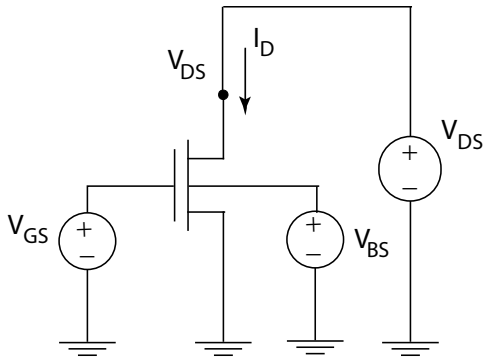

Figure T5-1.

a) In what regime of operation is the MOSFET?
b) Ignoring secondary effects such as channel length modulation (CLM), what is the drain current I_D?
c) If the substrate doping is $N_a=10^{17}$ cm^{-3}, what is the maximum bulk depletion charge density when the surface is inverted at the source end $Q_{Bmax}(y=0)$ for $V_{BS}=0$?
d) If the body-to-source voltage V_{BS} is now changed to $V_{BS}=-2$ V, with other bias conditions remaining the same, in what regime is the n-MOSFET?
e) If the body-to-source voltage V_{BS} is now changed to $V_{BS}=-2$ V, with other bias conditions remaining the same, what are the new values of $Q_{Bmax}(y=0)$?
f) How does $Q_N(y=0)+Q_{B\max}(y=0)$ when $V_{BS}=-2$ V compare to $Q_N(y=0)+Q_{B\max}(y=0)$ when $V_{BS}=0$ V?

6.012 Microelectronic Devices and Circuits
Spring 2009