Problems

1. Consider an n-type MOSFET which consists of a 10 nm thick oxide (\(\varepsilon_r = 3.9\)) and has a gate length of 1 micron, a gate width of 20 micron and a threshold voltage of 1.5 Volt. Calculate the resistance of the MOSFET in the linear region as measured between source and drain when applying a gate-source voltage of 3 Volt. What should the gate-source voltage be to double the resistance? The surface mobility of the electrons is 300 cm\(^2\)/V-sec.

2. Consider an n-type MOSFET with an oxide thickness \(t_{ox} = 20\) nm (\(\varepsilon_r = 3.9\)) and a gate length, \(L = 1\) micron, a gate width, \(W = 10\) micron and a threshold voltage, \(V_T = 1\) Volt. Calculate the capacitance per unit area of the oxide, \(C_{OX}\), and from it the capacitance of the gate, \(C_G\). Calculate the drain current, \(I_D\), at a gate-source voltage, \(V_{GS} = 3\) Volt and a drain-source voltage, \(V_{DS} = 0.05\) Volt. The surface mobility of the electrons \(\mu_n = 300\) cm\(^2\)/V-sec. Use the linear model of the MOSFET.

3. A MOSFET (\(L = 1\) \(\mu\)m, \(t_{ox} = 15\) nm, \(V_T = 1\) V and \(\mu_n = 300\) cm\(^2\)/V-sec) must provide a current of 20 mA at a drain-source voltage of 0.5 Volt and a gate-source voltage of 5 Volt. How wide should the gate be?

4. A MOSFET (\(L = 1\) \(\mu\)m, \(t_{ox} = 10\) nm, \(V_T = 1\) V and \(\mu_n = 300\) cm\(^2\)/V-sec) is to be used as 50 \(\Omega\) terminating resistor when applying a gate-source voltage, \(V_{GS} = 5\) Volt. How wide should the gate be?

5. The capacitance of an n-type silicon MOSFET is 1 pF. Provided that the oxide thickness is 50 nm and the gate length is 1 micron, what is the resistance of the MOSFET in the linear regime when biased at a gate voltage which is 5 Volt larger than the threshold voltage? Use a reasonable value for the surface mobility knowing that the bulk mobility equals 1400 cm\(^2\)/V-sec.