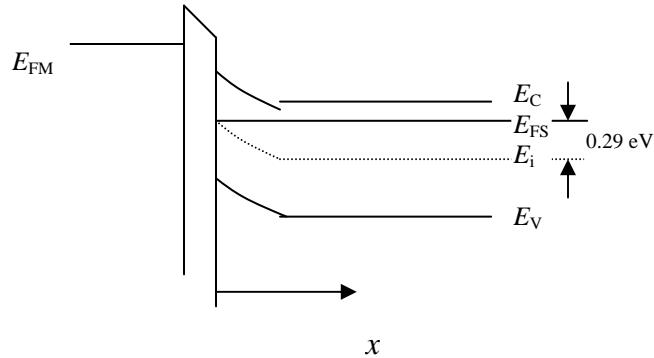


ECSE-2210 Microelectronics Technology
Fall 2005
Class Activity 27

1. The energy band diagram for an ideal MOS-C is shown below ($x_{ox} = 0.2 \mu\text{m}$). The applied gate voltage causes band bending such that $E_F = E_i$ at the Si-SiO₂ interface. Answer the following.



- a. Sketch electrostatic potential ϕ inside the semiconductor as a function of position.

- b. Is the semiconductor in depletion, accumulation or in strong-inversion?

- c. $N_D = ?$ $\phi_S = ?$

- d. Calculate the depletion layer width, W .

- e. Sketch \mathcal{E} -field inside the semiconductor as a function of position, and mark the numerical value of maximum \mathcal{E} -field inside Si.

- f. What is the electron concentration at the Si-SiO₂ interface?

- g. What is the voltage drop across the oxide?

- h. $V_G = ?$

- i. Plot both the high frequency and low frequency $C-V_G$ characteristics as V_G is varied from -5 V to $+5$ V. Mark important points in the graph.

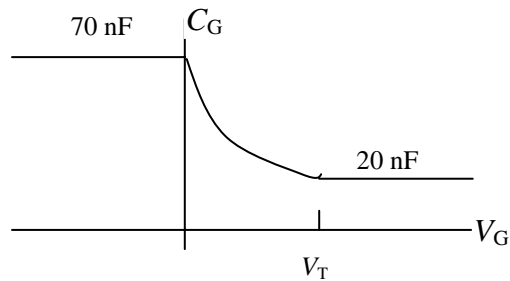
2. (Do this if time permits).The figure below shows the gate capacitance (C_g) versus gate voltage (V_G) measured at high frequency (1 MHz) on a silicon MOS-capacitor with SiO_2 as the insulator. The doping in Si is 10^{16} cm^{-3} . Assume an area $A = 1 \text{ cm}^2$.

- Is the semiconductor n-type or p-type? How did you tell?
- Which part of the curve corresponds to accumulation, depletion and inversion? Identify these regions in the figure.

c. What is the oxide thickness?

d. What is the semiconductor capacitance, C_s , at inversion?

e. If the gate voltage V_G equals V_T in the figure shown below this corresponds to the start of inversion. Calculate V_T .



f. Suppose we apply a gate voltage of 4 Volts. Calculate the inversion charge Q_{inv} in Coulombs. (Hint: use the relation $CV = Q$; if $V_G = V_T$, the inversion layer charge is almost zero. For $V_G > V_T$ you build up inversion charges).