

**ECSE-2210 Microelectronics Technology**  
**Fall 2005 Homework -9**

Reading list: Chapter 16.

1. An ideal MOS-C has  $x_{\text{ox}} = 0.1 \mu\text{m}$ ,  $N_{\text{D}} = 10^{15} \text{cm}^{-3}$ , and an area  $A = 10^{-3} \text{cm}^2$ .
  - a. Calculate  $\phi_{\text{F}}$  in units of  $kT/q$  and in Volts.
  - b. Calculate  $W$  when  $\phi_{\text{S}} = 2\phi_{\text{F}}$ .
  - c. Calculate  $\mathcal{E}_{\text{S}}$  when  $\phi_{\text{S}} = 2\phi_{\text{F}}$ .
  - d. Calculate  $V_{\text{G}} = V_{\text{T}}$  when  $\phi_{\text{S}} = 2\phi_{\text{F}}$ .
  - e. Sketch the general shape (qualitative) of the high frequency  $C_{\text{G}} - V_{\text{G}}$  characteristic to be expected from this device.
  - f. Defining  $C_{\text{max}}$  to be the maximum high-frequency capacitance, determine  $C_{\text{max}}$ .
  - g. Defining  $C_{\text{min}}$  to be the minimum high-frequency capacitance, determine  $C_{\text{min}}$ .
  - h. Suppose the gate bias is such that  $\phi_{\text{S}} = 3\phi_{\text{F}}/2$ . Draw the MOS-C energy band diagram corresponding to the specified gate bias. (be sure to include the diagrams for all three components of the MOS-C, show the proper band bending in both the oxide and the semiconductor, and properly position the Fermi level in the metal and the semiconductor.)
  - i. The  $C$ - $V$  characteristic of the device is measured as the dc bias is **rapidly** swept from accumulation into inversion. Using a dashed line, sketch the expected form of the resulting  $C$ - $V$  characteristic on the same set of coordinates as in the part (e) answer.