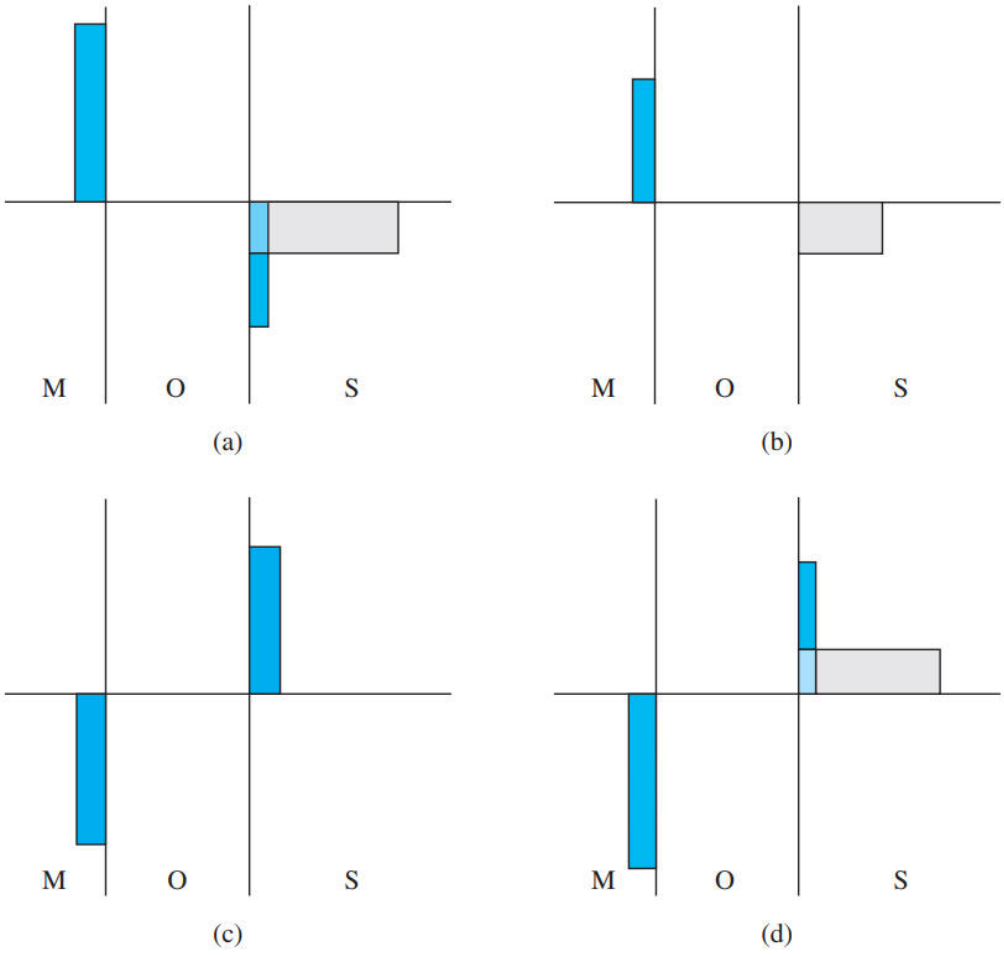
VE320 Homework 7

Due Dec. 3, 23:59pm

1. The dc charge distributions of four ideal MOS capacitors are shown in Figure P10.1. For each case: (*a*) Is the semiconductor n or p type? (*b*) Is the device biased in the accumulation, depletion, or inversion mode? (*c*) Draw the energy-band diagram in the semiconductor region.



2. (*a*) Consider an n^+ polysilicon–silicon dioxide–n-type silicon MOS structure. Let $N_d = 4 \times 10^{15}$ cm^{-3}. Calculate the ideal flat-band voltage for $t_{ox} = 20$ nm $= 200$ Å. (*b*) Considering the results of part (*a*), determine the shift in flat-band voltage for (*i*) $Q'_{ss} = 4 \times 10^{10}$ cm^{-2} and (*ii*) $Q'_{ss} = 10^{11}$ cm^{-2}. (*c*) Repeat parts (*a*) and (*b*) for an oxide thickness of $t_{ox} = 12$ nm $= 120$ Å.

3. A MOS device with an aluminum gate is fabricated on a p-type silicon substrate. The oxide thickness is $t_{ox} = 22$ nm $= 220$ Å and the trapped oxide charge is $Q'_{ss} = 4 \times 10^{10}$ cm^{-2}. The measured threshold voltage is $V_T = +0.45$ V. Determine the p-type doping concentration.

4. An n^+ polysilicon gate–silicon dioxide–silicon MOS capacitor has an oxide thickness of $t_{ox} = 18$ nm $= 180$ Å and a doping of $N_a = 10^{15}$ cm^{-3}. The oxide charge density is $Q'_{ss} = 6 \times 10^{10}$ cm^{-2}. Calculate the (*a*) flat-band voltage and (*b*) threshold voltage.

5. The high-frequency *C–V* characteristic curve of a MOS capacitor is shown in Figure P10.30. The area of the device is 2×10^{-3} cm^2. The metal–semiconductor work function difference is $\phi_{ms} = -0.50$ V, the oxide is SiO_2, the semiconductor is silicon, and the semiconductor doping concentration is 2×10^{16} cm^{-3}. (*a*) Is the semiconductor n or p type? (*b*) What is the oxide thickness? (*c*) What is the equivalent trapped oxide charge density? (*d*) Determine the flat-band capacitance.