(Selection)

QE Semiconductor: Electronic devices (40 points)

1. (10pts. MOSCAP)
2. (3 pts) Draw a Capacitance-Voltage(C-V) curve for an n-channel MOS capacitor and mark the three regions using VFB(flat band voltage) and VT(threshold voltage).
3. (2 pts) Draw an equivalent circuit using Ci(insulator capacitance) and Cd(depletion capacitance).
4. (5 pts) Briefly explain the C-V behavior of each region via equivalent circuit and carrier concentration.
5. (20 pts. MOSFET) An nMOSFET is fabricated on a p-substrate (Na=1E16 cm-3) with a 10 nm thick SiO2 as a gate insulator (q=1.6E-19 C, ni=1E10 cm-3, ε0=8.85E-14 F/cm, relative dielectric constant of Si and SiO2=11.8 and 3.9)
6. (10 pts) If the effective interface charge, Qi of the SiO2 is 5E10 qC/cm2 and Φms= -0.95 V. Calculate the Flatband voltage (VFB) and threshold voltage (VT).
7. (10 pts) Sketch the energy band diagram from Source to Drain along the interface between the SiO2 and the substrate when VS=VSUB=0 V, VG> VT, and VD=0.05 V.
8. (10 pts. BJT) Consider a pnp BJT where IEp = 1mA, IEn =0.01 mA, ICp =0.98 mA, and ICn= 0.1 A. Calculate  
   a) (5 pts)  and IB  
   b) (5 pts) 