ENEE 601 MID-TERM EXAM 4 APRIL 2006

1. RESISTORS

1.a Consider the resistivity of a bar of silicon. First, calculate the resistivity when there is no doping present (intrinsic material). Now calculate the resistivity when N_a is $1.73 \times n_i$. Hint: use the consistency of the pn-product.

1.b. The second resistivity calculated is actually larger than the first, even though you've added dopant. Give a verbal for explanation why this is so.

2. DIODES

2.a Assume that the N_a and N_d dopings of a pn-junction were both equal to $10^{17}/\text{cm}^3$. Further, assume the breakdown field of silicon is 10^5. What is the reverse breakdown voltage for this structure?

3. CAPACITORS

3.a Assume N_{it}, the interface charge density is 10^{11}/V-cm^2. Further assume that the charge traps at the interface all donor-like. The gate insulator is 10nm thick and the substrate doping is 10^{16}cm^3. What is the change in threshold voltage caused by the interface trapped charge?

4. MOSFETs

4.a Reach-thru is a condition in which the drain-substrate diode space charge extends to the source-substrate diode. For a MOSFET with a 3 micron channel length, take the acceptor-like substrate doping to be 10^{16}cm^3. Take the source and drain doping to be donor-like, with a density 10^{19}cm^3. At what drain voltage does reach-through occur.

4.b What is the maximum electric field parallel to the channel at which this orrurs?