Area: Solid State Devices

1. Consider a pure silicon, a lightly-doped N-type silicon, and a heavily-doped N-type silicon.

(1) Sketch the energy band diagrams of all three materials stated above. Assume the materials are at room temperature with complete ionization. Label all the energy levels including Fermi energy. (25%)

(2) Sketch the resistivity change vs temperature increase for the pure silicon. Consider the temperature range of 0°C to 1000°C. Explain this temperature response. Use equations as needed. (25%)

(3) Repeat (2) for the lightly-doped N-type silicon. (25%)

(4) Repeat (2) for the heavily-doped N-type silicon. (25%)

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2. Assume a particle is trapped in a potential well. The potential is zero inside the well ($0<x<a$) but is infinitely large at the boundaries $x=0$ and $x=a$.

(1) Write down the wave equation for the well ($0<x<a$). (20%)

(2) Derive the normalized wave function. (60%)

(3) Sketch the first and fifth energy level wave functions. (20%)