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CAD Tool Summary

CAD 1

1. Part I - Hydrogen Characteristics
    - The first part of this code calculates the radii of atoms and ions for differing quantum levels. Specifically, it finds the first four energy states for Hydrogen, Helium+, and Lithium+2, all single electron atoms. The second part of this code finds the energy differences between Hydrogen's energy levels and finds the wavelength of emitted photons for electrons transition from higher to lower energy levels. In other words, what is the energy level difference between n=10 and n=5. And if an electron transitioned from n=10 to n=5 (losing energy), what is the wavelength of the photon that was emitted.
2. Part II - Photoelectric Effect
    - This code calculates the energy of electrons emitted from a metal when said metal is struck by light. The code tests five different types of metals for a range of incident light, with wavelengths ranging from 3000nm to 100nm. Photon frequency vs emitted electron energy is then graphed.
3. Part III - Infinite Potential Quantum Well
    - This code calculates the energy levels of an electron in an infinite potential well, graphs the electrons probability density for varying energy levels, and calculates the probability of finding an electron between pre-determined points in the infinite well. Additionally, this code finds the energy level transitions of an infinite quantum well necessary to receive photon pulses of 1.0 eV with a well length of approximately 3nm.

CAD 2

1. Part I - Wave Function Graphs
    - The first part of this code plots the probability density of finding the electron at a distance r from the nucleus for Hydrogen's first two energy levels. These are 2D plots with probability on the y-axis and distance r from the nucleus on the x-axis. The second part of this code creates 3D surface plots and 2D “birds-eye heat map” plots for Hydrogen's first four wavefunctions.
2. Part II - Finite Well Energy Level Calculations Using Newtons Method

- This code calculates the energy levels of electrons in a finite potential well. The user enters the well's height and length, as well as the electrons n'th energy level they are interested in. Using Newton's method of successive approximation, the energy level of the electron is calculated and compared to the infinite well case.

CAD 4

1. Part I – Intrinsic Carrier Concentration
    - User is asked to enter the temperature, bandgap, and mobile carrier effective masses of a semiconductor. The code then calculates the intrinsic carrier concentration for the given parameters.
2. Part II – Built-in Potential and Depletion Region Length
    - User is asked to enter donor and acceptor dopant concentrations and the semi-conductor material's permittivity coefficient. The code then calculates the PN junction's built-in potential and the depletion regions length.
3. Part III – Graphing PN Junction Characteristics
    - User is asked which of the following semiconductor information they want to graph: internal electric field, potential, or charge concentration. Code then calculates the necessary parameters and graphs the user's choice.
4. Part IV – Applied Voltage Effect
    - The previous three parts are repeated, but this time the calculations are done with an applied voltage which the user is prompted for.
5. Part V – Diode Carrier Concentration and Current
    - The semiconductor parameters from Part IV are kept except the user is allowed to enter a new applied voltage. Minority carrier concentrations and mobile carrier current densities are calculated and graphed as a function of position. Lastly, the total diode current is calculated.
6. Part VI – Diode Current VS Voltage
    - User is prompted for a voltage range and the subsequent IV graph is calculated and shown from the semiconductor parameters entered in Part IV and Part V.
7. Part VII – Numerical Integration
    - Using numerical integration by rectangles, the area under the electric field graph from Part IV is calculated and compared to the potential drop across the depletion region.

CAD 5

1. Part I – N-Channel MOSFET Drain Current
    - User is prompted for substrate doping, gate length and width, and terminal voltages. The code then calculates the MOSFET's drain current.
2. Part II – N-Channel MOSFET Small Signal Parameters
    - User is asked for a new set of terminal voltages so that the MOSFET is in saturation. If the new voltages meet the saturation requirements, the small signal parameters $g_o, r_o, C_{gs}.\, and\ C_{gd}$ are calculated.