**Homework Assignment 2 (Due 10/1)**

**Instructions:** Answer the following questions based on the concepts discussed in class. Be sure to show all work where applicable. Please do not write your solutions on the question PDF

**Problem 1:** What are the different types of materials used in electronics? What are their charge carrier densities?

**Problem 2:** Why is silicon used in electronics?

**Problem 3:** Draw the atomic models of the p-type and n-type semiconductors.

**Problem 4:**

A black and blue rectangular object with a blue line

Description automatically generated

* What is this electronic device?
* Draw the I-V characteristics and explain what the threshold voltage is.

**Problem 5:** Write the ideal diode equation and explain each quantity in the equation.

* A silicon diode is connected in a circuit with a 5V power supply and a series resistor of 1kΩ. Draw the circuit. The saturation current of the diode is . Use the diode equation to calculate the current through the diode when the voltage across it is 0.7V.
* Find the voltage across the diode when the current through it is 1mA.

**Problem 6:** What is a MOSFET? What is a p-channel and n-channel MOSFET? Draw their side view and label each segment.

* A n-channel MOSFET is used in a circuit with a drain resistor RD=1kΩ and a supply voltage VDD=10V. The MOSFET has the following parameters:

=2V

=

If 𝑉𝐺𝑆=4V, assuming the MOSFET is in the saturation region, calculate the current and voltage across the resistor.

A diagram of a circuit

Description automatically generated

**Problem 7:** Draw the circuit symbol of p-channel and n-channel MOSFET.

**Problem 8:**

A graph of a function

Description automatically generated

In the shown plot, draw curves for Vg<Vth. What is the state of the N-channel MOSFET?

**Problem 9:** Fill up the table.

A diagram of a circuit

Description automatically generated

|  |  |
| --- | --- |
| Vin | Vout |
| 0 |  |
| VDD |  |

* What is this electronic device? Where can you use such a device?

**Problem 10:** What are these electronic component symbols?

A close-up of arrows

Description automatically generated

**Problem 11:** Define direct and indirect semiconductors that are used for optoelectronics.

**Problem 12:** If you shine light, show where the electron-hole pair will be generated. Draw a circuit to show the current flow direction.

A diagram of a circuit

Description automatically generated

**Problem 13:** How can you design a white-light LED?

**Problem 14:** Write the equation for circuit below if Vs=3.3V, VLED=2V. What value of Rs will give you 10mA of current.

A diagram of a circuit

Description automatically generated

**Problem 15:** Can you use the bottom photodetector to sense the light from the LED?

A graph of a blue line

Description automatically generated A graph of a red line

Description automatically generated