Semiconductors, pn Junction, ideal diodes - Spring 2021

1) For semiconductors, current can flow using either holes or electrons.

1a) What are holes?

1b) Why is the resistance of n-type silicon slighly less than the resistance of p-type silicon?
2) Thermistors: Assume the VI characteristics of a thermistor are

$$
R_{T}=1000 \exp \left(\frac{4440}{T+273}-\frac{4440}{298}\right) \Omega
$$

where T is the temperature in degrees C . Determine RT and the temperature if $\mathrm{V} 1=4.3 \mathrm{~V}$
Let R be $1000+$ ( your birth month ) * $100+$ your birthday. For example, March 14th would give $\mathrm{R}=1514$ Ohms.

| R <br> $1000+100 *$ Month + Day | RT (Ohms) <br> Thermistor | Temperature (C) |
| :---: | :---: | :---: |
|  |  |  |
|  |  |  |


3) Load Lines: The VI characteristic for a diode is show on the graph below. Draw the load line for the following circuit and from the graph, determine Vd and Id

- Let R be $1000+100^{*}$ (Birth Month) + (Birthday)

| R <br> $1000+100 *$ Month + Day | Load Line | Vd | Id |
| :---: | :---: | :---: | :---: |
|  | show on graph |  |  |
|  |  |  |  |


4) More Load Lines: Determine the Thevenin equivalent for the circuit up top. Then, draw the load line and determine Vd and Id.

- Let R be $1000+100 *$ (Birth Month $)+$ (Birthday)

| R | Vth | Rth | Vd | Id |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |
|  |  |  |  |  |



5) Assume the VI characteristics of the diodes below are:

$$
V_{d}=0.052 \ln \left(\frac{I_{d}}{10^{-8}}+1\right) \quad I_{d}=10^{-8}\left(\exp \left(\frac{V_{d}}{0.052}\right)-1\right)
$$

Write the voltage node equations for the following circuit (don't solve).

- Let R be $1000+100^{*}$ (Birth Month $)+$ (Birthday)


6) By symmetry, if you have three identical diodes in series, the voltage drop across each diode will be $1 / 3$ of the total voltage. Assume the VI relationship for the diodes below are

$$
V_{d}=0.052 \ln \left(\frac{I_{d}}{10^{-8}}+1\right) \quad I_{d}=10^{-8}\left(\exp \left(\frac{V_{d}}{0.052}\right)-1\right)
$$

Write the voltage node equations for the following circuit.

- Let R be $1000+100^{*}$ (Birth Month $)+($ Birthday $)$


