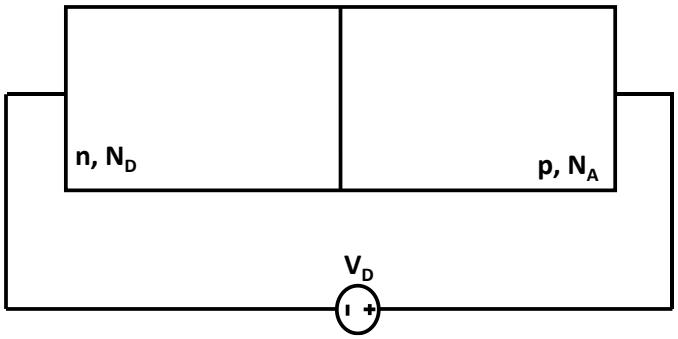
EEE313 Fall 2020-2021 Homework#1 05.10.2020

Please submit your scanned solutions to Moodle by Friday, 16.10.2020, 23:55.

1. You are given the below p-n junction, and the aim of this question is to review the diode operation:



a. A diode consists of an n side and p side that are formed with doping. n side is doped with donors (N_D) and p side is doped with acceptors (N_A). What is a donor and what is an acceptor? Explain by giving examples of typical donor and acceptor materials.

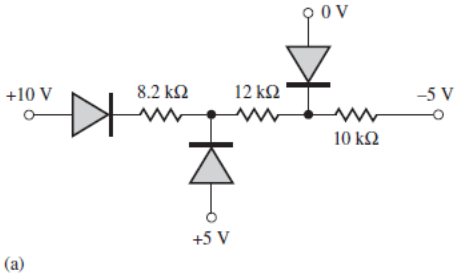
b. Once n and p sides touch each other without any bias, drift and diffusion processes occur forming a depletion region at the boundary. Explain this process and how they balance each other. Plot the built-in potential (V_{bi}), electric field and charge distribution across the diode with respect to position.

c. Explain the I-V relation of the diode based on your answers to parts a and b for forward and reverse bias conditions, i.e. $V_D > V_{ON}$ and $V_D < V_{ON}$. You can use the directions of the E-fields for your explanation.

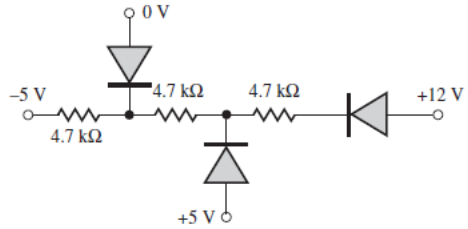
2.

a. Find the states of the diodes, node voltages, and diode currents in the circuits below assuming the diodes have $V_{ON} = 0.6$ V.

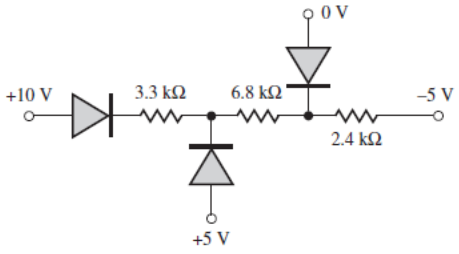
b. Find the node voltages, and diode currents in the circuits below using LTSpice. Ideal diode modeling examples can be found in LT Spice projects examples in Moodle.



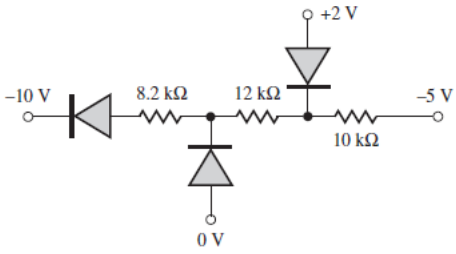
(a)



(c)

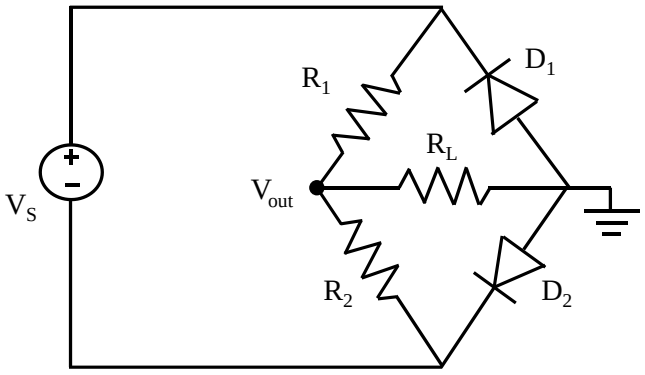


(b)

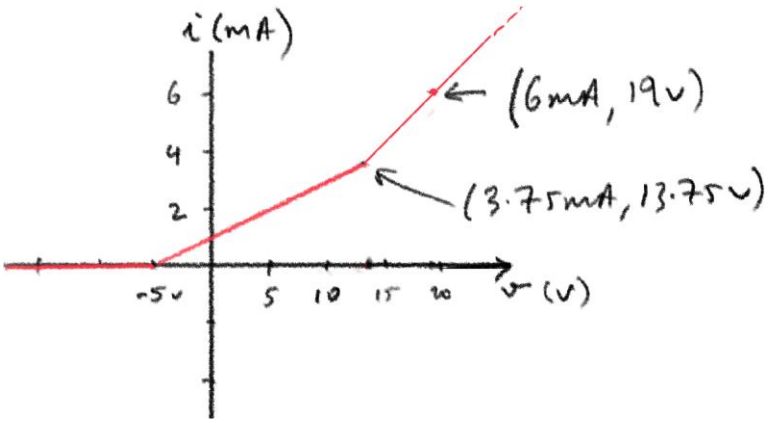


(d)

3. Find and plot $V_{out}(t)$ for the modified full wave rectifier circuit given below by assuming ideal diodes with V_{ON}=0.7V. V_S=8sin(2π10000t) V, R_L = 50 Ω, R_1 = 50 Ω, and R_2 = 75 Ω.
Hint: The diodes can be modeled as a voltage source in ON state. You will also need to write KCL to solve the circuit.



4. Using ideal diodes, resistors, and batteries, synthesize a circuit that will yield the i-v characteristic shown below:



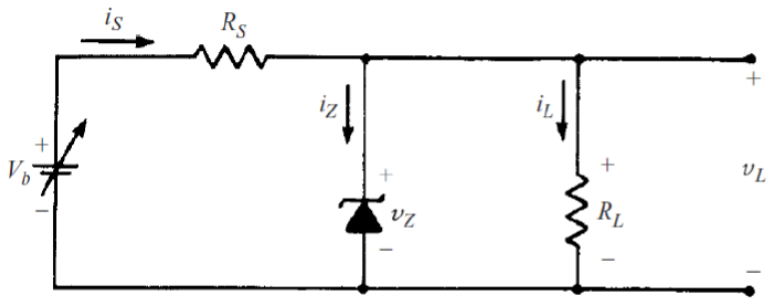
5. In the voltage regulator circuit shown below, the Zener diode has V_{Z0} = 9 V, allowable Zener current of 10 mA ≤ i_Z ≤ 100 mA, and R_L= 9 Ω.

a. Find the range of R_S so that the load voltage v_L is maintained at 9 V while V_B varies by ±10% from its nominal value of 12 V. Take r_Z = 0.

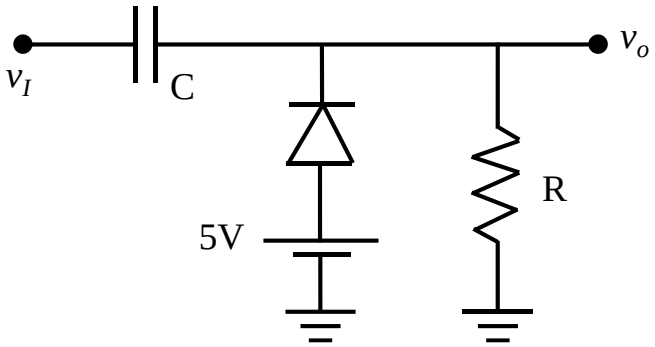
b. Use the midpoint of the Rs range you have found in part a, and take r_Z = 2 Ω.

i. Find source regulation.

ii. Find load regulation for when V_B=12V.



6. For the circuit below let turn-on voltage of the diode be V_{on} = 0.7V, C = 1μF, and v_I = 10sin(100πt) (V). Assume the initial voltage on the capacitor is zero.



a. Assume R = 1 MΩ. Use Spice to obtain and plot v_O versus time for t ≥ 0 over three cycles of input voltage. Also plot capacitor voltage and capacitor current. What is the peak current through the capacitor in the first cycle and also later in steady state?

b. Repeat part a for R = 100 MΩ