ECE 331: Electronics Principles I
Fall 2013

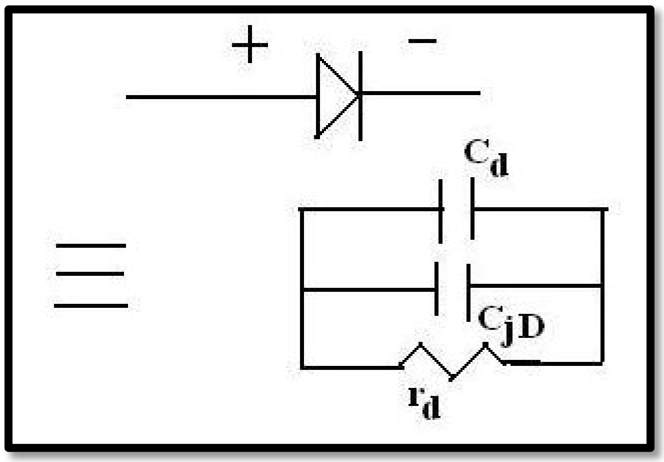
Lab #1: Diodes and Its applications

Report due on Tues, Sept. 24 to Fri, Sept. 27, at the beginning of your registered lab session

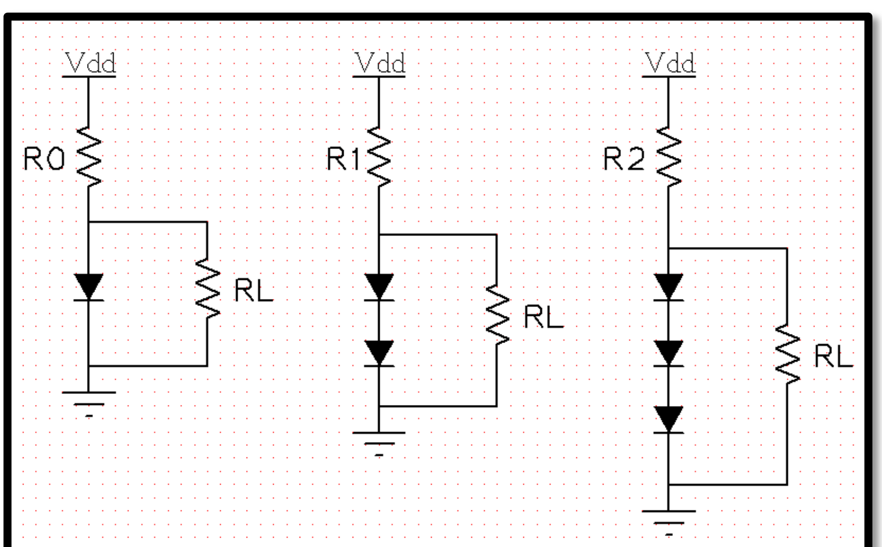
Week 1

1: Using Spectre simulator (ADE L) in Cadence, plot the I-V curves of a 10µm x10µm diode to show the **forward bias region**, **sub-V_t (approximation)**, and **reverse bias region** of operations. Use the "**dioden**" model in the **tsmc018rf** library.

2: Using only a 10 µm x10 µm diode, a voltage source (vpwl from analoglib), and a resistor; find the approximate **junction capacitance** of the diode. (Hint: reverse bias the diode and use transient analysis. Think about the equation ***I = C *(dV/dt)***).



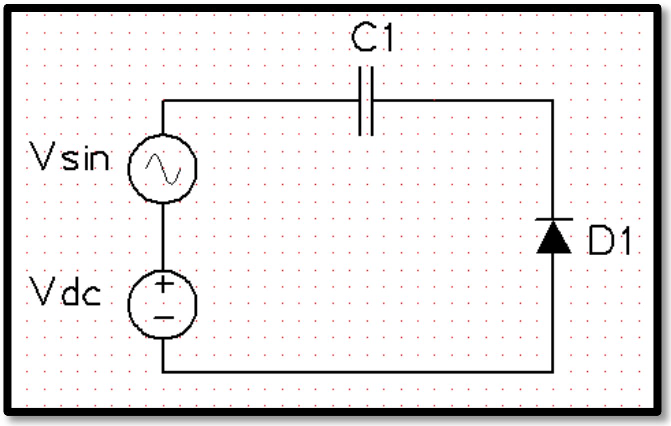
3: Looking at a diode from the point of view of the constant voltage drop model, it would seem that diodes could easily be used to set bias voltages. The following three circuits use diodes to set 3 different bias voltages across a load resistor R_L. Simulate the output voltages of the following 3 circuits for R_L = 6 KΩ and V_{DD} = 1.8 V. $R_0 = R_1 = R_2$ = 1.8 KΩ. Now determine the output voltages as R_L is swept from 150 Ω to 150 KΩ. Explain the relationship between the three output voltages. How well would you say this technique works for setting bias voltages? What are the drawbacks of this kind of biasing method?



4: The input waveform is an AC signal (sinusoidal) with a DC component; the output is taken across the diode.

A. Assume C1= 1pF and Vsin is 2V amplitude @ 5 KHz sinusoidal signal. With Vdc = 0V and 3V separately. Use Transient analysis and plot the output voltage with at least five full cycles. Interpret your plot in first two cycles. Based on the simulation result, do you see any difference with Vdc = 0V and 3V? Why?

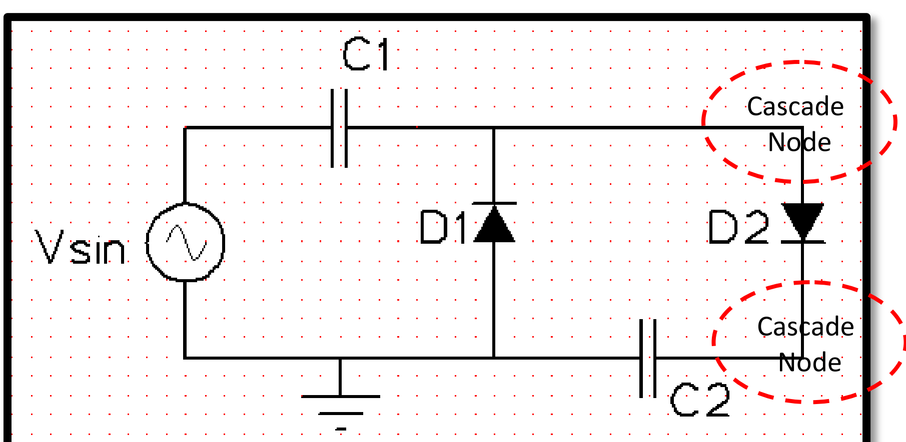
B. With Vdc = 0V, C1 = 1pF and Vsin 2V amplitude @ 5 KHz, run simulation to take a look at the voltage drop on C1, comparing to the output voltage, what is the function of this circuit? How might this be usful? Change C1 from 1pF to 5pF, and recheck the voltage drop on C1, what do you find?



5: Most modern ICs have both analog and digital sections. To keep power consumption down, the supply voltage is lowered to the minimum allowed by the digital portions of the chip. Since many analog structures require higher voltage than this to operate, the analog portion of the chip may have to use on-chip circuitry to increase the supply voltage.

A. Using C1= 2pF, C2= 2pF, and Vin is 2V peak @ 5KHz sinusoidal signal, what is the function of this circuitry shown below? Take a look at the voltage across C2.

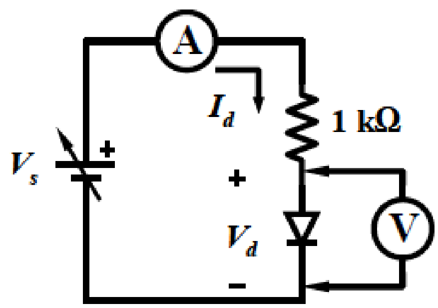
B. Cascade two of these circuits together with no load. Does the output voltage scale approximate linearly with the addition of the second stage? What is the function of this circuit now?



Week 2

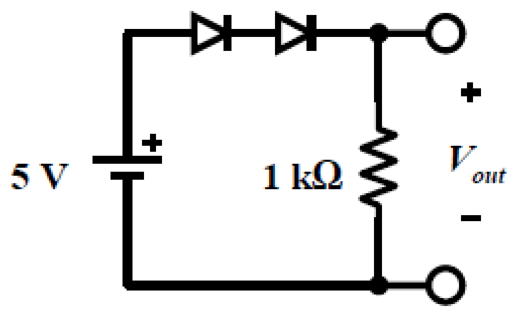
1: *Diode Forward I-V Characteristic*

- Use IN4007 to set up the circuit to measure the diode forward I-V Characteristics. Adjust the power supply output until the Ammeter reads a current of 10µA through the diode. Record the voltage drop across the diode at this current.
- Repeat for 20µA, 50µA, 0.1mA, 0.2mA, 0.5mA, 1mA, 2mA, 5mA and Record the voltage drop across the diode at this current. Use Excel to generate an *I-V* curve. How much does the forward voltage drop (voltage across the diode) change?

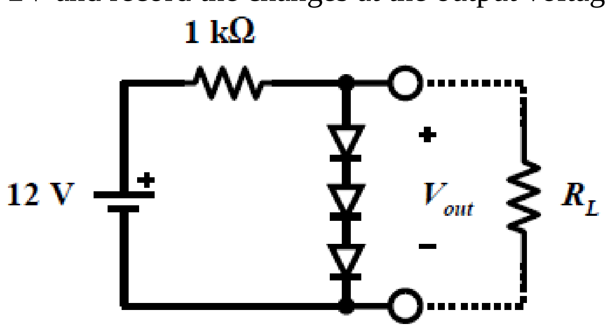


2: *Use Diode as Biasing Circuitry*

- Series connected diodes sometimes can be used to bias the other circuitry.
  A. Construct the circuit as shown below using IN4007 and record the output voltage.
  B. Increasing the resistance by three times and measure the output voltage again.

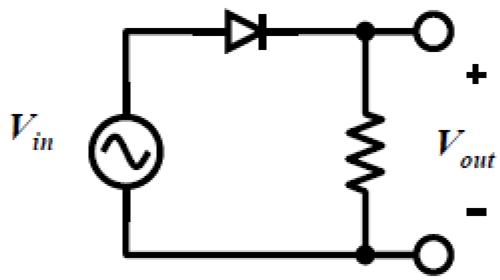


- Construct the circuit below, what is the output voltage now? Vary the supply voltage by ± 2V and record the changes at the output voltage.



3: ***Half-Wave Rectifier***

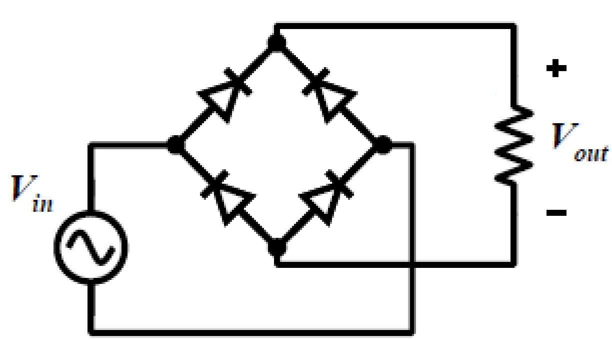
- Build the circuit of a half wave rectifier as shown below. The input voltage VIN is 5V amplitude, 65 Hz sinusoidal waveform. Capture the output voltage across the load resistor on the oscilloscope for R_{load} = 500Ω. Repeat for R_{load} = 2KΩ and obtain a capture.
- Add a capacitor C = 50 uF to form a filtered full wave rectifier. Pay attention to the polarity of the capacitor when you construct the circuit. Capture the output voltages for both R_{load} = 500Ω and R_{load} = 2KΩ.
- Repeat the last step for C = 15uF and C = 100uF and capture the output voltages for R_{load} = 2KΩ.



4: ***Full Wave Rectifier***

- Build the circuit of a full wave rectifier as shown below. The input voltage VIN is 5V amplitude, 65 Hz sinusoidal waveform. Capture the output voltage across the load resistor on the scope for Rload = 500Ω. Repeat for Rload = 2KΩ and obtain a capture.
- Add a capacitor C = 50 uF to form a filtered full wave rectifier. Pay attention to the polarity of the capacitor when you construct the circuit. Capture the output voltages for both Rload = 500Ω and Rload = 2KΩ.
- Repeat the last step for C = 15uF and C = 100uF and capture the output voltages for R_{load} = 2KΩ.

<u>Pay more attention when you hook the grounds of function generator and the scope. Make sure the diode is not shorted out.</u>



For both of part 3 and 4, discuss the following questions:

- ***What is the effect of the load capacitance on the rectified output voltage in term of ripple voltage?***
- ***What is the effect of the load resistance on the rectified output voltage in term of ripple voltage?***
- ***From the measurements you made, comparing the performance of the two rectifiers you built.***