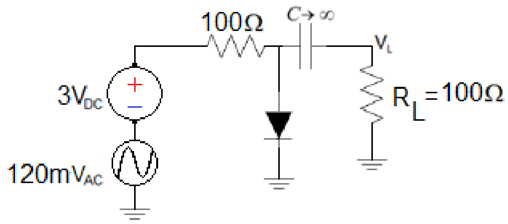
Electronics

Diodes dynamic response

Problem 1.- In the circuit shown below a sample of the AC voltage is taken and controlled by the DC voltage. Calculate the voltage in the load resistance V_L in the conditions shown.
Take the knee voltage in the diode as 0.7V and its I-V curve as described by the Shockley equation.



Solution: We first analyze the circuit in DC. In this case, the capacitor behaves as an open circuit and the diode current is

$$I_D = \frac{3-0.7}{100} = 23mA$$

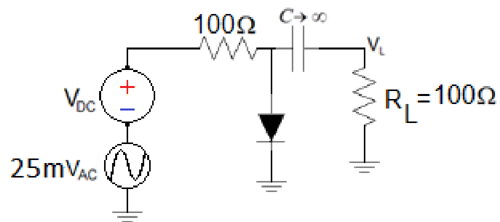
With this result, in AC the diode will behave as a resistance given by

$$r_d = \frac{26mV}{23mA} = 1.13\Omega$$

In AC, the capacitor will behave as a short circuit and hence the voltage in the load will be the same as in the diode. This can be calculated as a voltage divisor, obtaining:

$$V_L = 120mV \frac{1.13//100}{1.13//100+100} = 1.33mV$$

Problem 1a.- Similar to the previous problem, the circuit is used to get a sample of the AC controlled by the DC voltage. Calculate the DC voltage to get a dynamic resistance of 1ohm and calculate the value of V_L.
Take the knee of the diode at 0.7V and its I-V curve given by the Shockley equation.



Solution: The DC analysis gives us

$$I_{DC} = \frac{V_{DC} - 0.7V}{100\Omega}$$

Then, based on this current, the dynamic resistance will be

$$r = \frac{26mV}{I_{DC}} = \frac{100\Omega \times 26mV}{V_{DC} - 0.7V} = \frac{2.6V\Omega}{V_{DC} - 0.7V}$$

We want this to be 1 ohm, so

$$1\Omega = \frac{2.6V\Omega}{V_{DC} - 0.7V} \rightarrow V_{DC} = 3.3V$$

In AC, the capacitor will put the 100 ohm load resistance in parallel with the dynamic resistance and the AC voltage will be approximately 1% of the source voltage, which is 250µV.