PES UNIVERSITY

Department of Electronics and Communication Engineering

UE25EC141A - Electronic Principles and Devices (4-0-0-4-4)

Unit 1: Semiconductor Diode Q&A

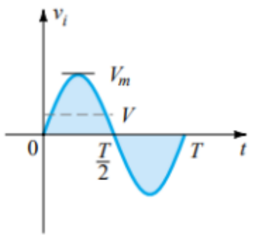
1. Explain the working of a PN-junction diode under No bias, Reverse bias and forward bias.
   Under No bias Under no-bias (no applied voltage) conditions, any minority carriers (holes) in the n-type material that find themselves within the depletion region will pass directly into the p-type material. The closer the minority carrier is to the junction, the greater the attraction for the layer of negative ions and the less the opposition of the positive ions in the depletion region of the n-type material.

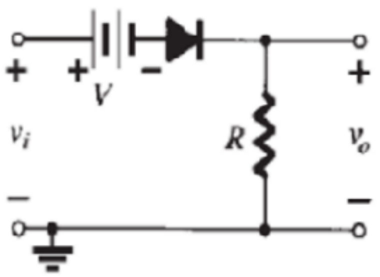
   Reverse-Bias Condition (VD< 0 V) If an external potential of V volts is applied across the p-n junction such that the positive terminal is connected to the n-type material and the negative terminal is connected to the p-type material. The number of uncovered positive ions in the depletion region of the n-type material will increase due to the large number of "free" electrons drawn to the positive potential of the applied voltage. For similar reasons, the number of uncovered negative ions will increase in the p type.

   Forward-Bias Condition (VD> 0 V) The application of a forward-bias potential VD will "pressure" electrons in the n-type material and holes in the p-type material to recombine with the ions near the boundary and reduce the width of the depletion region.The resulting minority-carrier flow of electrons from the p type material to the n-type material (and of holes from the n-type material to the p-type material) has not changed in magnitude (since the conduction level is controlled primarily by the limited number of impurities in the material), but the reduction in the width of the depletion region has resulted in a heavy majority flow across the junction material.

2. Determine the thermal voltage for a diode at a temperature of 20°C and also find the diode current if reverse saturation current Is = 30 nA, n= 2, and the applied voltage is 0.5 V.
   Solution: 2020 VT = kT/q = (1.38 x 10-23 J/K) (20 + 273) / 1.6 x 10^-19 C = 25.27 mV VD = 0.5 V, Is = 50 nA, n = 2, VT = 25.27 mV. ID = 0.591 mA

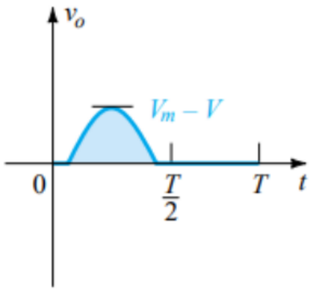
3. Assuming ideal diode, explain the working of the clipper circuit shown below and draw the output waveform.





Solution:

Output waveform:



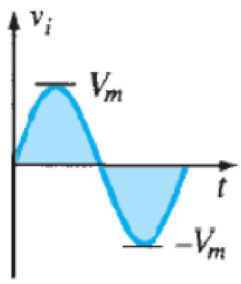
Positive half cycle:

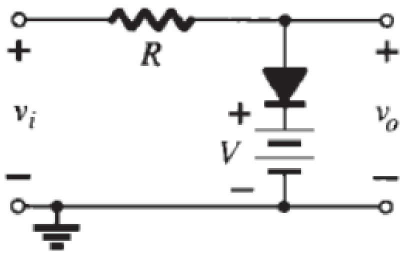
- When v_i< V, the diode is reverse-biased;hence,the current is zero. Therefore,v_o = 0
- When v_i> V, the diode is forward biased, $v_o = v_i$ - V (Mark 2)

Negative half cycle:

The diode is reverse-biased, hence the current is zero. Therefore,v_0 = 0

4. Briefly explain the working of the following circuit and draw its output waveforms assuming an ideal diode.





Solution:

It is a Clipper circuit.

- During the positive half cycle, when $v_i \geq$ V, the diode is forward-bias and hence it is a closed switch. Therefore, v_o = V
- For all other values of input, the diode is reverse-biased and open switch. Hence v_o = v_i

Output waveform: