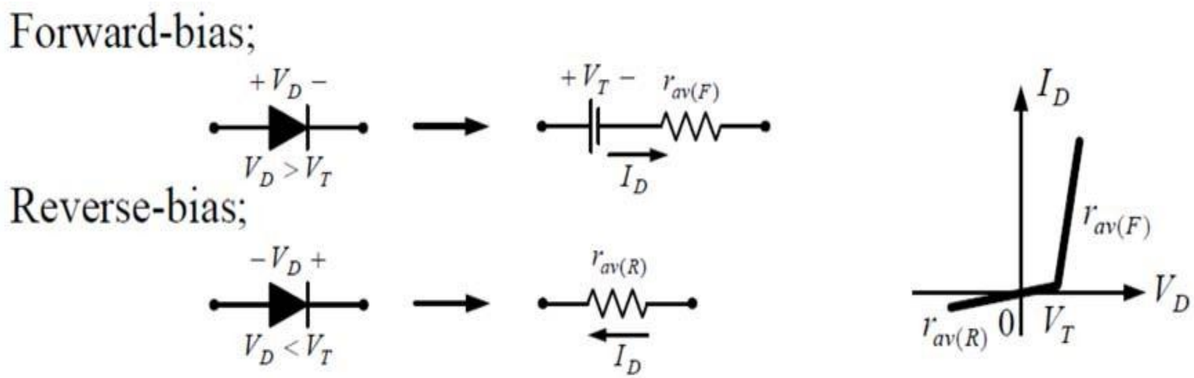
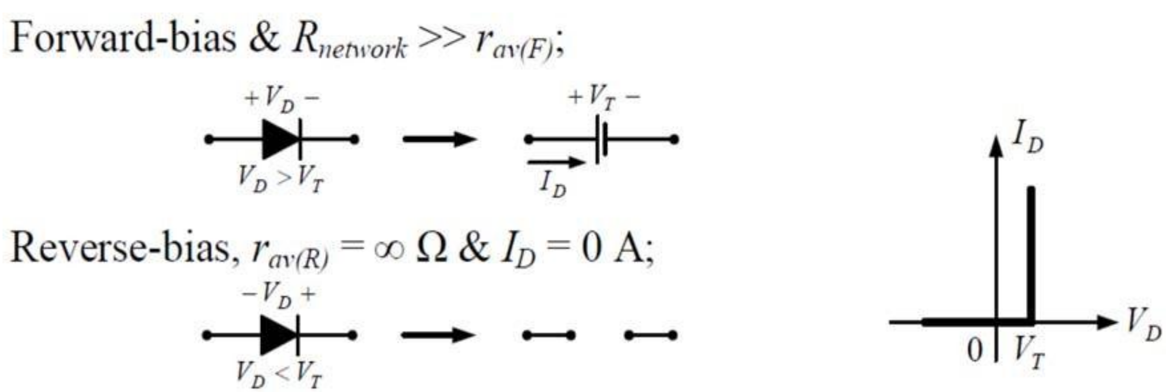
Equivalent Circuits (Models):

1. Piecewise-Linear Model:



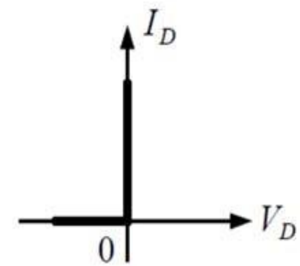
2. Simplified Model:



3. Ideal Model:

Forward-bias, $E_{network} >> V_T$, $R_{network} >> r_{av(F)}$ & $V_D = 0$ V;

Reverse-bias, $r_{av(R)} = \infty\ \Omega$ & $I_D = 0$ A;



Load-Line Analysis:

From Fig. 1-11:

$E = V_D + V_R$

$E = V_D + RI_D$

$I_D = \frac{E - V_D}{R}$ (1.7)

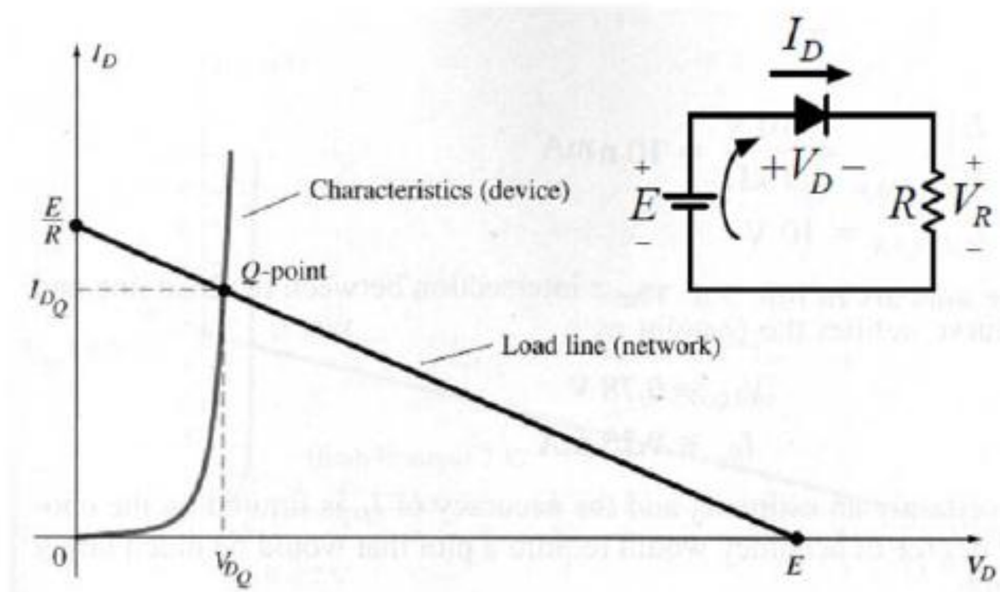
Eq. [1.7] is a linear equation;

$\boldsymbol{y = mx + c}$

Where $m = -1/R$ & $c = E/R$

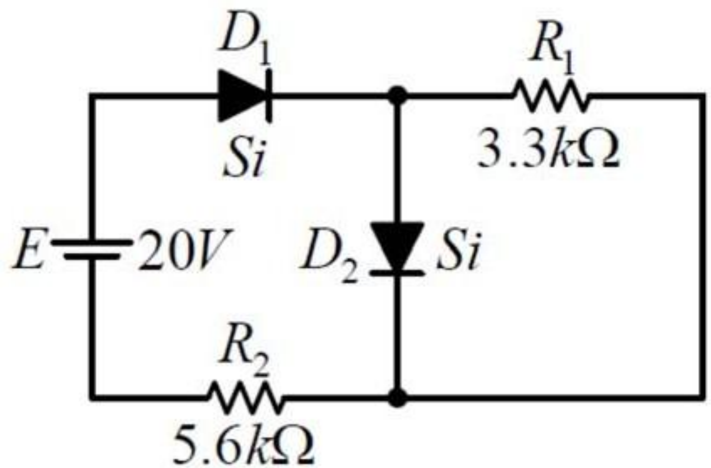
$\boldsymbol{I_D = 0} \Rightarrow \quad \boldsymbol{E = V_D}$

$\boldsymbol{V_D = 0} \Rightarrow \quad \boldsymbol{I_D = E/R}$



Example 1:

Determine the currents I_{D1} & I_{D2} for the network :



$$I_{R1} = \frac{V_{D2}}{R_1} = \frac{0.7}{3300} = 0.212\ mA$$

$$E = V_{D1} + V_{D2} + V_{R2}$$

$$V_{R2} = E - V_{D1} - V_{D2}$$

$$V_{R2} = 20 - 0.7 - 0.7 = 18.6\ V$$

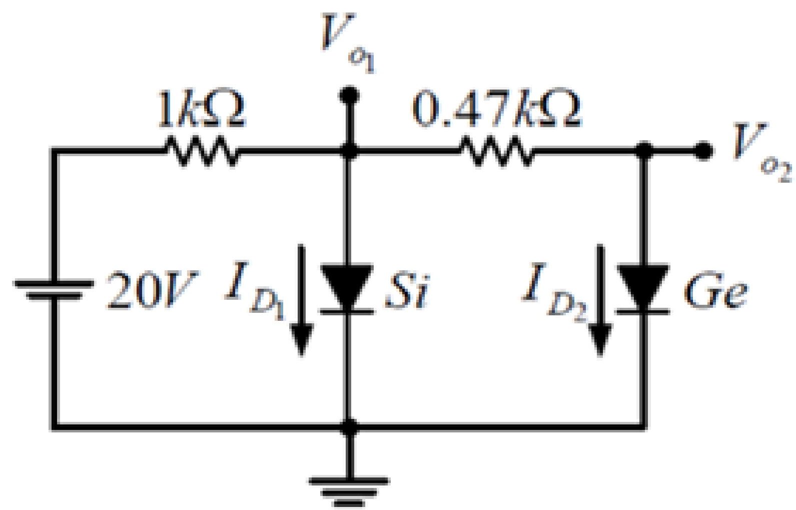
$$I_{R2} = \frac{V_{R2}}{R_2} = \frac{18.6}{5600} = 3.32\ mA$$

$$I_{R2} = I_{D2} + I_{R1}$$

$$I_{D2} = I_{R2} - I_{R1} = 3.32 - 0.212 = 3.108\ mA$$

$$I_{D1} = I_{D2} + I_{R1} = I_{R2} = 3.32\ mA$$

Exercise : Determine the currents I_{D1} & I_{D2} for the network :

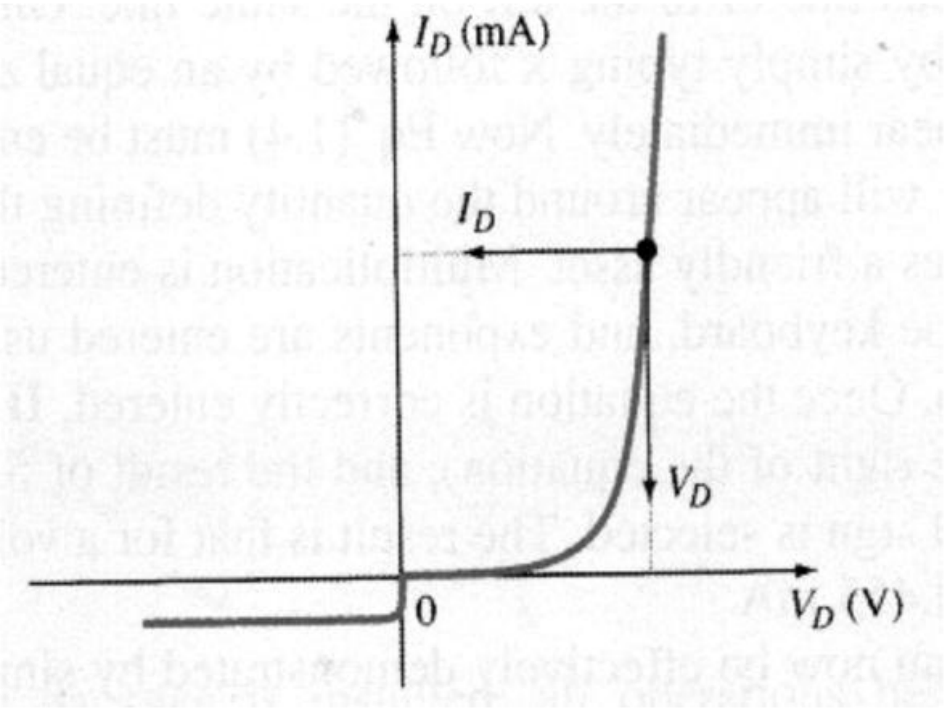


Resistance Levels:

1. DC or Static Resistance:

The application of a dc voltage to a circuit containing a p-n junction diode will result in an operating point on the characteristic carve that will not change with time. The resistance of the diode at the operating point can found simply by finding the corresponding levels of V_D and I_D as shown in below figure and applying the following equation:

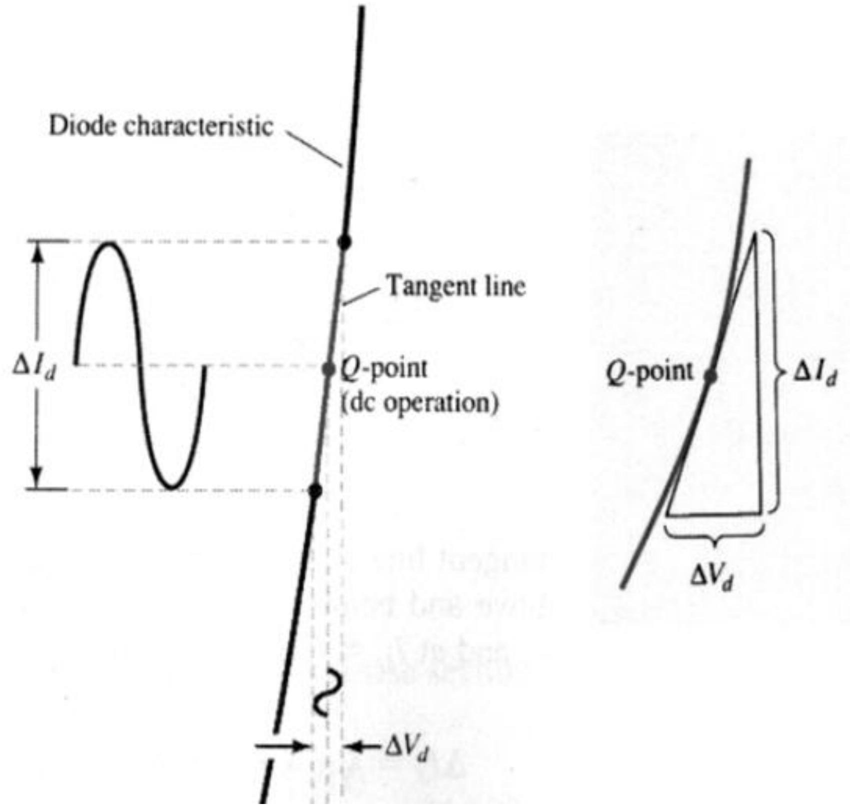
$$R_D = \frac{V_D}{I_D}$$



2. Ac or Dynamic Resistance:

If a sinusoidal rather than dc input is applied, the varying input will move the instantaneous operating point up and down a region of the characteristics and thus defines a specific change in current and voltage as shown in Figure below. With no applied varying signal, the point of operation would be the *Q*-point determined by the applied dc levels. A straight line drawn tangent to the curve through the *Q*-point will define a particular change in voltage and current that can be used to determine the ac or dynamic resistance for this region of the diode characteristics. In equation form,

$$r_d = \frac{\Delta V_d}{\Delta I_d}$$



Average AC Resistance:

If the input signal is sufficiently large to produce a board swing such as indicated in Fig. below , the resistance associated with the device for this region is called the average ac resistance. The average ac resistance is, by definition, the resistance determined by a straight line drawn between the two intersection establish by the maximum and minimum value of input voltage. In equation form,

$$r_{av} = \frac{\Delta V_d}{\Delta I_d}\bigg|_{pt.\ to\ pt.}$$