COLLEGE OF ENGINEERING AND TECHNOLOGIES
ALMUSTAQBAL UNIVERSITY

Electronics

CTE 207

Lecture 7

- Semiconductor diode models -

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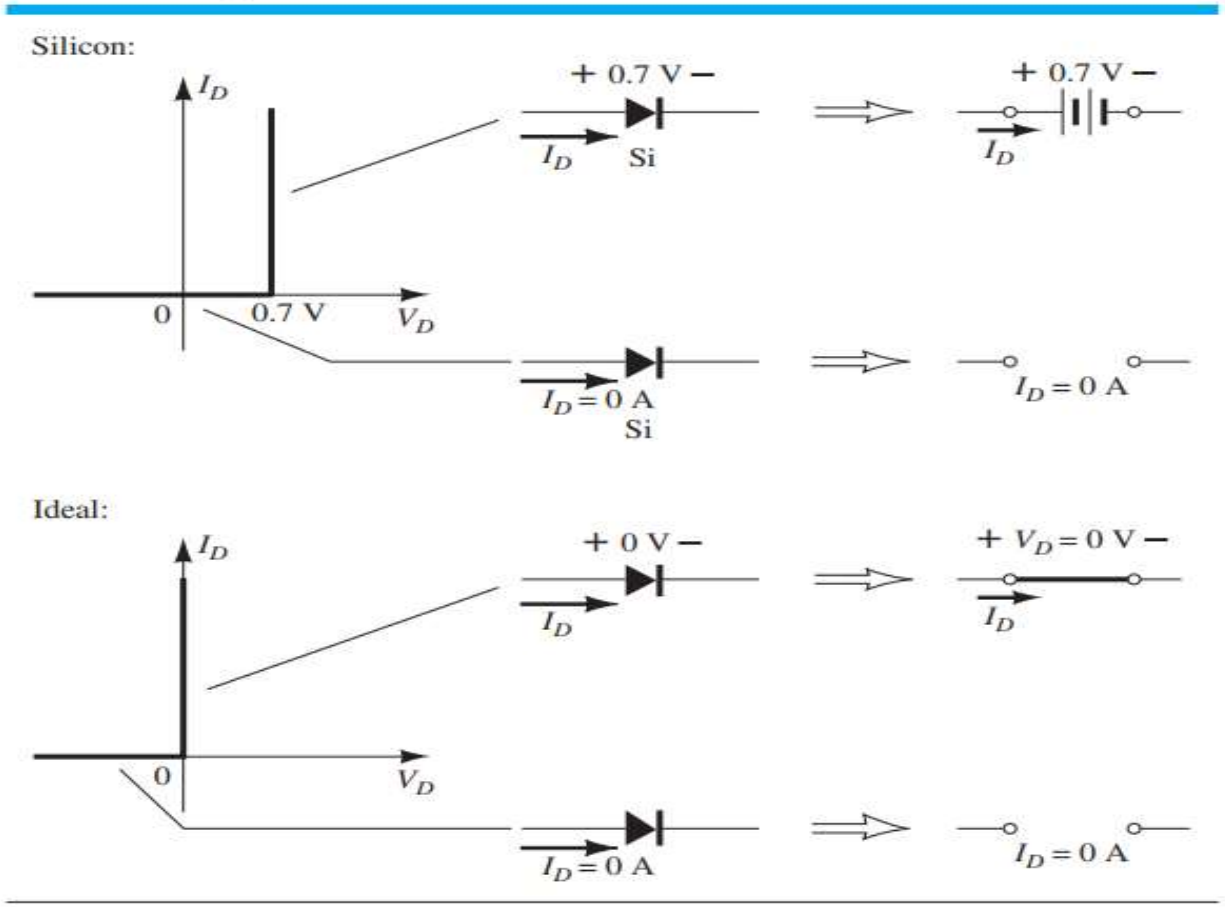
TABLE. 1.

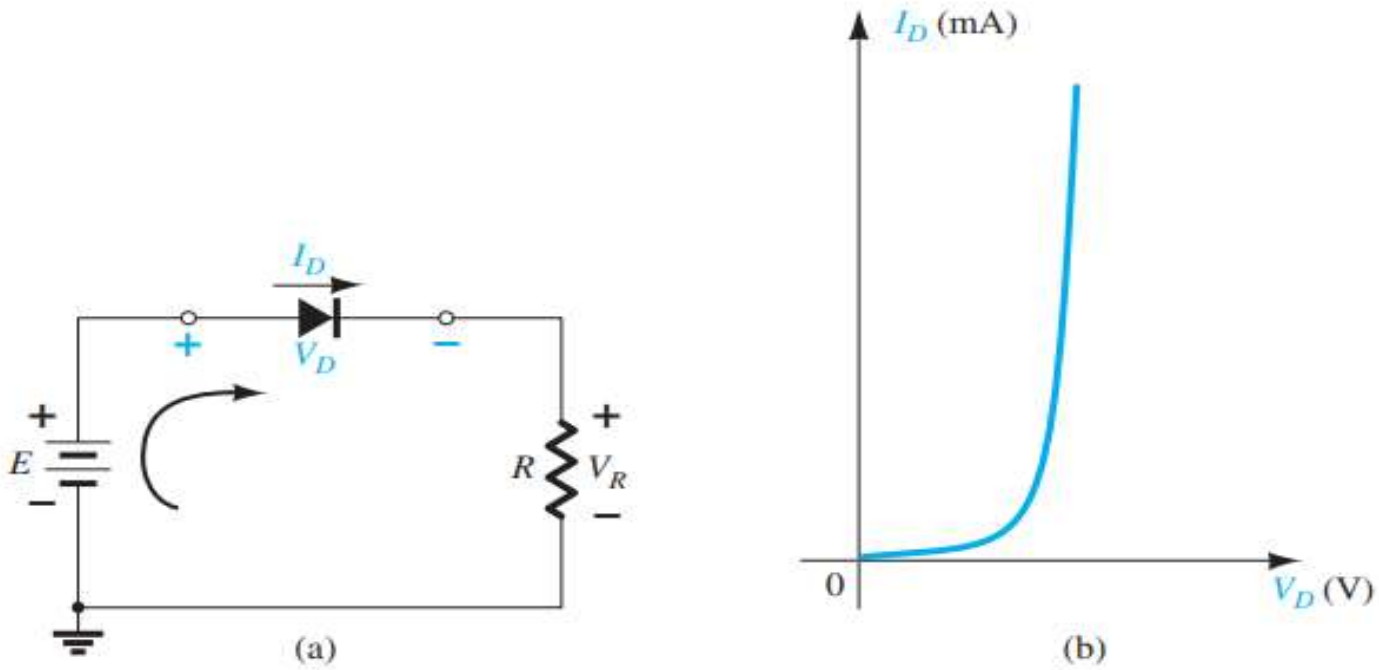
Approximate and Ideal Semiconductor Diode Models



Load line

- The applied load will normally have an important impact on the point or region of operation of a device.
- If the analysis is performed in a graphical manner, a line can be drawn on the characteristics of the device that represents the applied load.
- The intersection of the load line with the characteristics will determine the point of operation of the system.

Load line



Series diode configuration: (a) circuit; (b) characteristics.

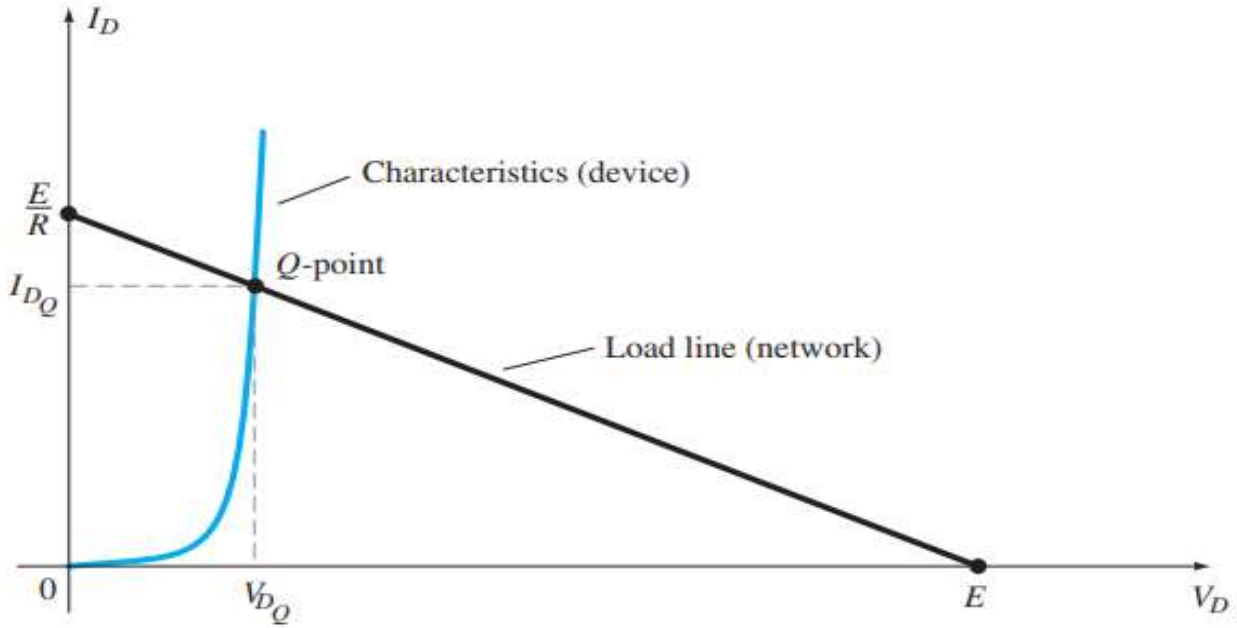
Load line

- The fact that the direction of this current has the same direction as the arrow in the diode symbol reveals that the diode is in the “on” state and will conduct a high level of current.

- The polarity of the applied voltage has resulted in a forward-bias situation.

- With the current direction established, the polarities for the voltage across the diode and resistor can be superimposed.

Load line



Drawing the load line and finding the point of operation

Load line

- The diode characteristics are placed on the same set of axes as a straight line defined by the parameters of the network.
- The straight line is called a load line because the intersection on the vertical axis is defined by the applied load R.
- The analysis to follow is therefore called load-line analysis.

- Applying Kirchhoff's voltage law to the series circuit will result in:

$$+E - V_D - V_R = 0$$

$$\boxed{E = V_D + I_D R}$$

- The two variables (VD and ID) are the same as the diode axis variables.

- This similarity permits a plotting of last equation on the same characteristics.

- If we set VD = 0V in equation (1) and solve for ID, we have the magnitude of ID on the vertical axis.

- Therefore, with VD = 0V, equation (1) becomes:

$$E = V_D + I_D R$$
$$= 0\,\text{V} + I_D R$$

$$\boxed{I_D = \left.\frac{E}{R}\right|_{V_D = 0\,\text{V}}}$$

- If we set ID = 0A in equation (1) and solve for VD, we have the magnitude of VD on the horizontal axis.

- Therefore, with ID = 0 A, equation (1) becomes:

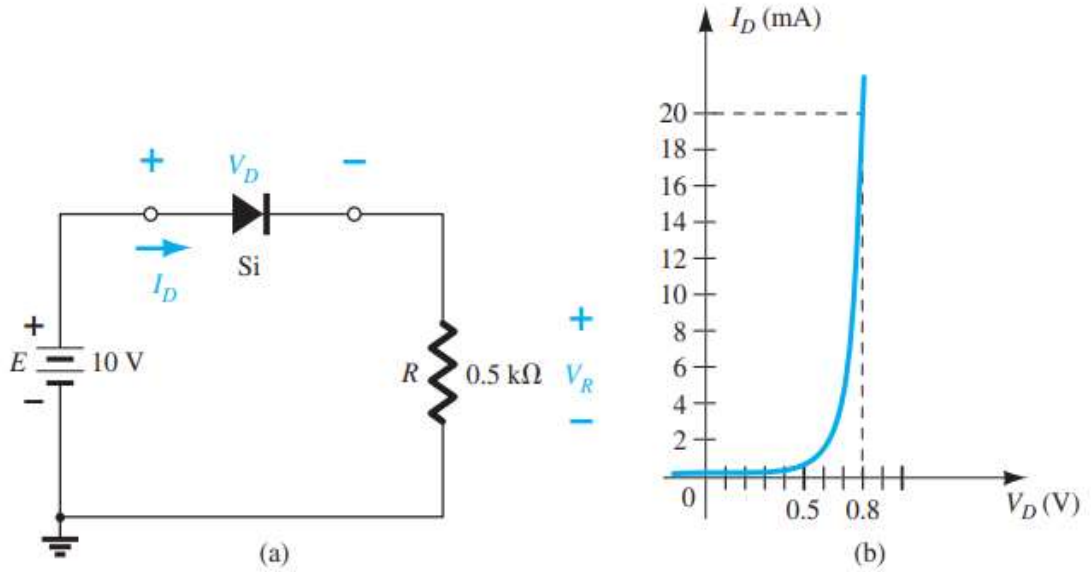
$$E = V_D + I_D R$$
$$= V_D + (0\ \text{A})R$$

$$\boxed{V_D = E|_{I_D=0\ \text{A}}}$$

Example 1

For the series diode configuration of Figure below, employing the diode characteristics, and determine:

a. V_{D_Q} and I_{D_Q}.
b. V_R.



(a) Circuit; (b) Characteristics.

Solution

(a)

$$I_D = \frac{E}{R}(at\ VD = 0v) = \frac{10\ V}{0.5\ K\Omega} = 20mA$$

$$V_D = E\ (at\ ID = 0A) = 10V$$

- The resulting load line appears in Figure below.

- The intersection between the load line and the characteristic curve defines the Q-point as:

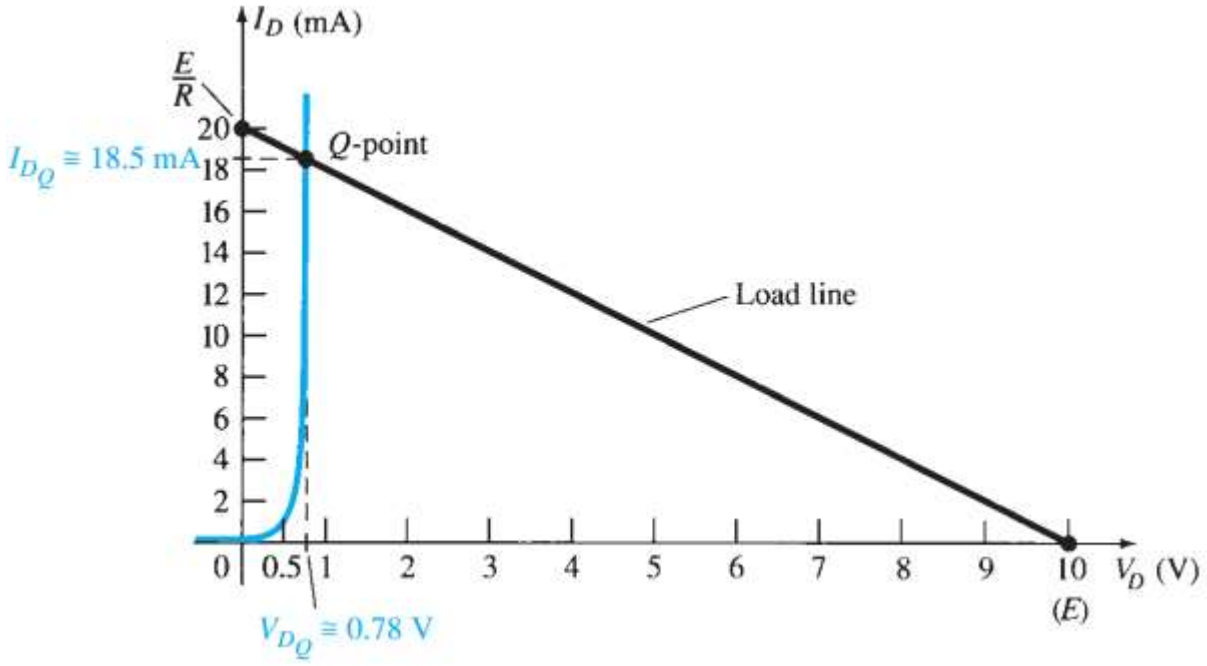
$$V_{DQ} = 0.78V$$

$$I_{DQ} = 18.5\ mA$$

Solution

(b)

$$V_R = I_R R = I_{DQ} R = (18.5\ mA)\ (0.5K) = 9.25V$$



Solution to Example

Semiconductor diode models

- The procedure described can, in fact, be applied to networks with any number of diodes in a variety of configurations.
- For each configuration, the state of each diode must first be determined.
- Which diodes are “on” and which are “off”? Once determined, the appropriate equivalent can be substituted and the remaining parameters of the network determined.