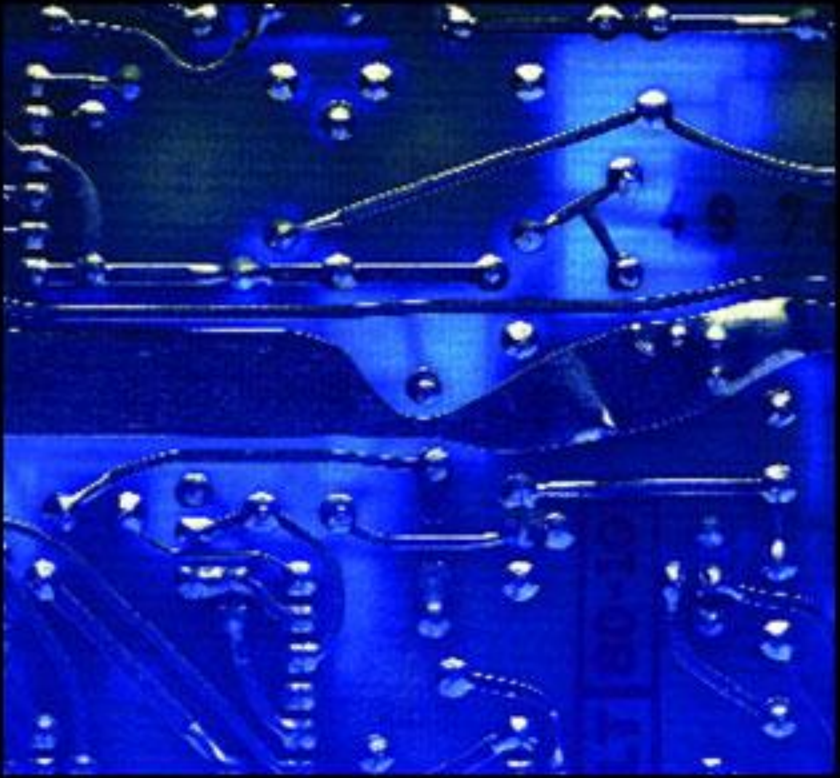
ELECTRONIC DEVICES AND CIRCUIT THEORY

TENTH EDITION



BOYLESTAD

PEARSON

Chapter 2:
Diode Applications

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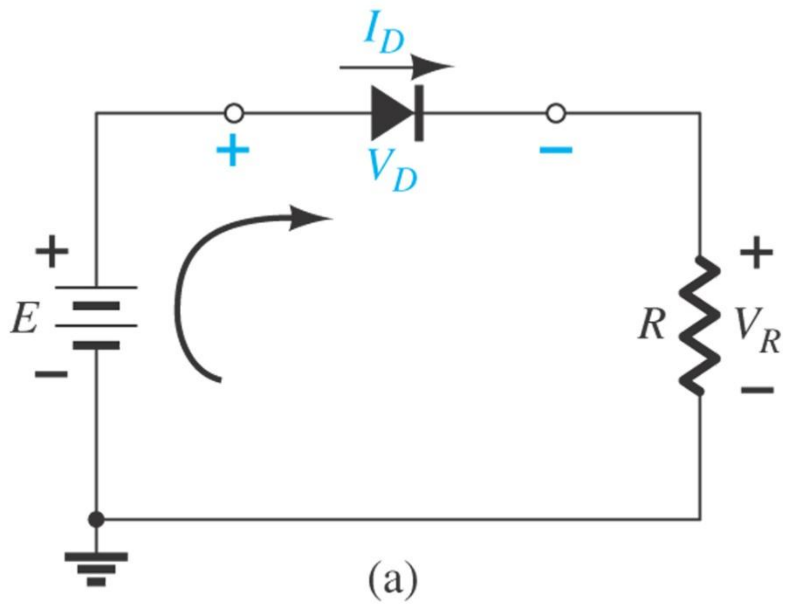
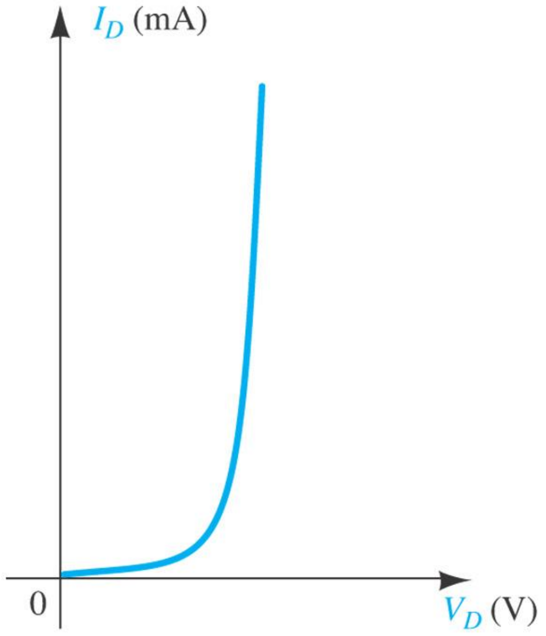
Load-Line Analysis (graphical solution)

- The analysis of diode can follow one of two paths: using the actual characteristics or applying an approximate model for the device.
- Load Line Analysis: is used to analyze diode circuit using its actual characteristics.

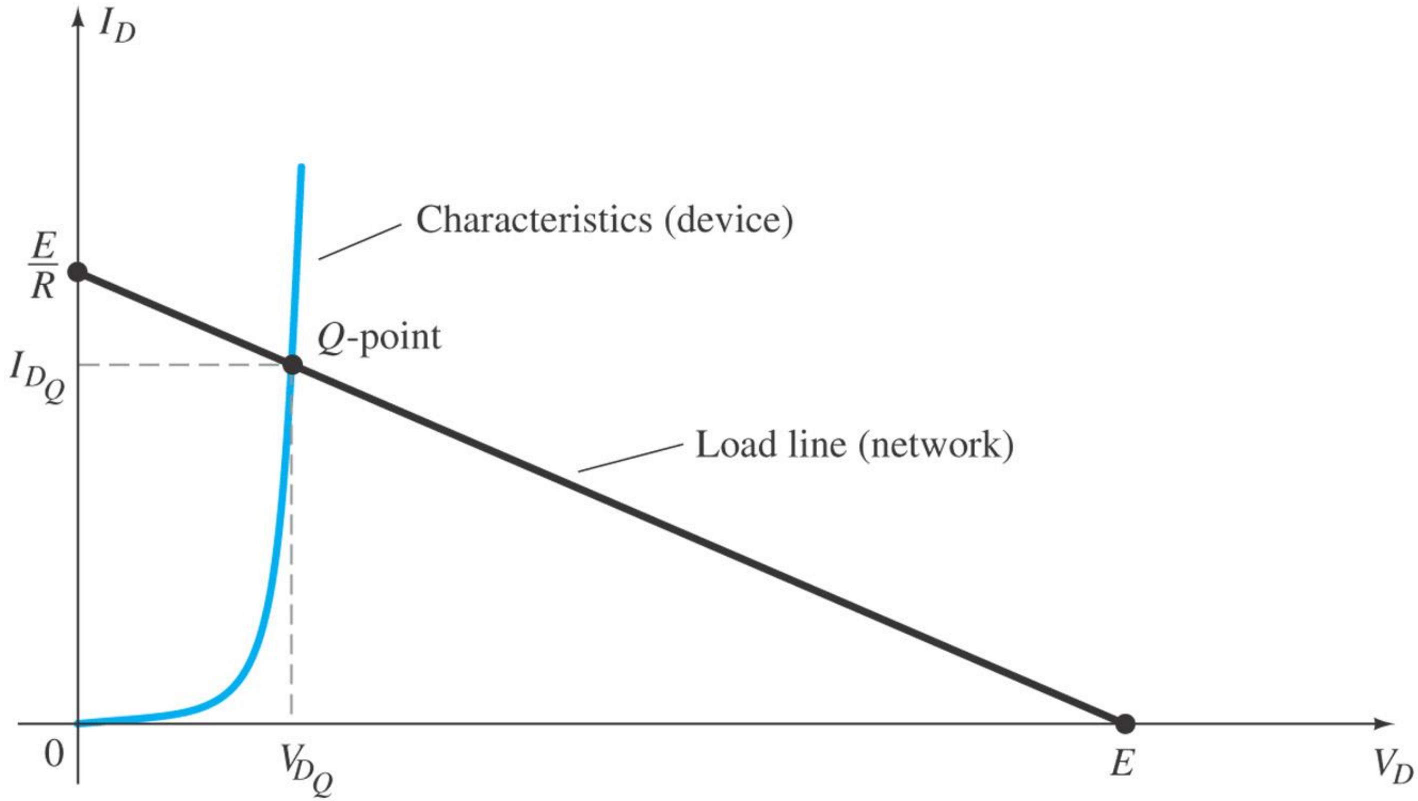


(a)



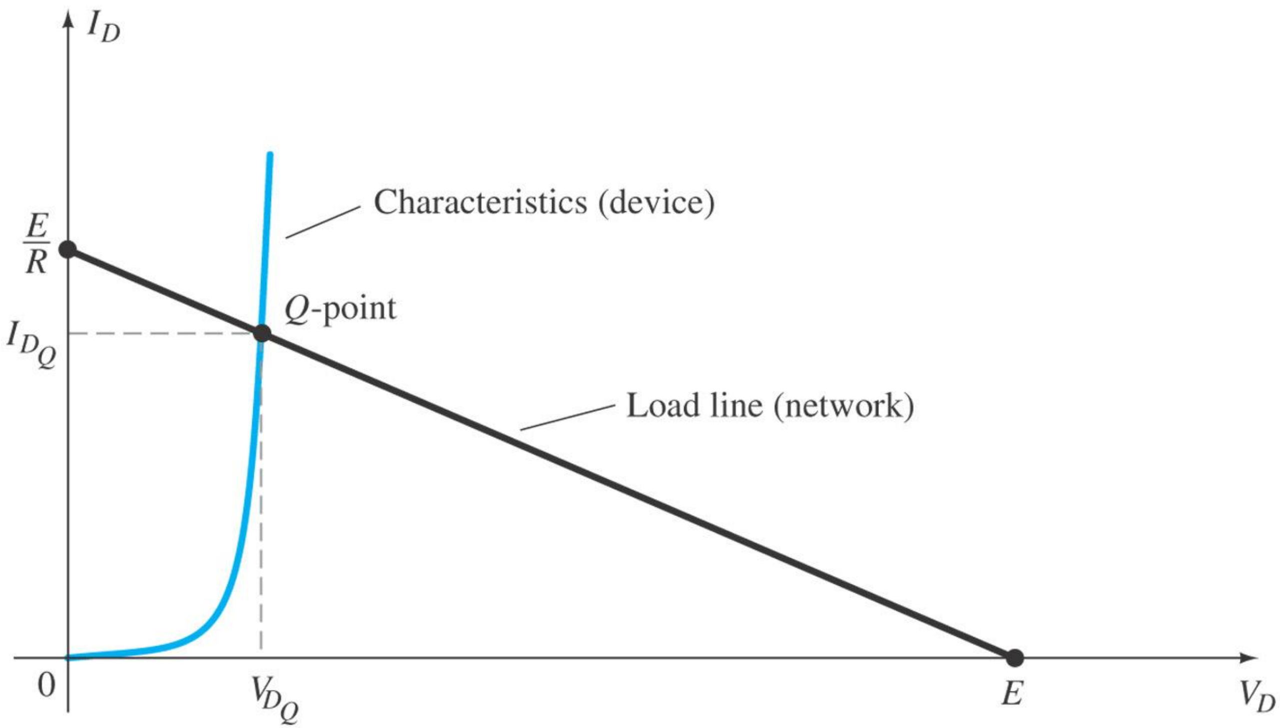
(b)

Load-Line Analysis (graphical solution)



- A straight line is defined by the parameters of the network.
- It is called the **load line** because the intersection on the vertical axes is defined by the applied load R.

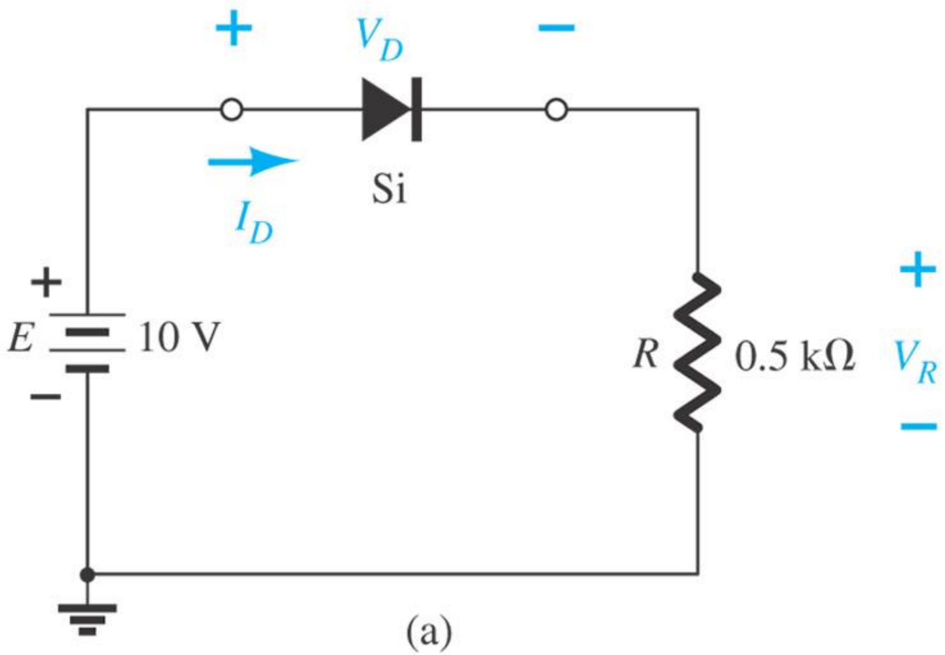
Load-Line Analysis (graphical solution)

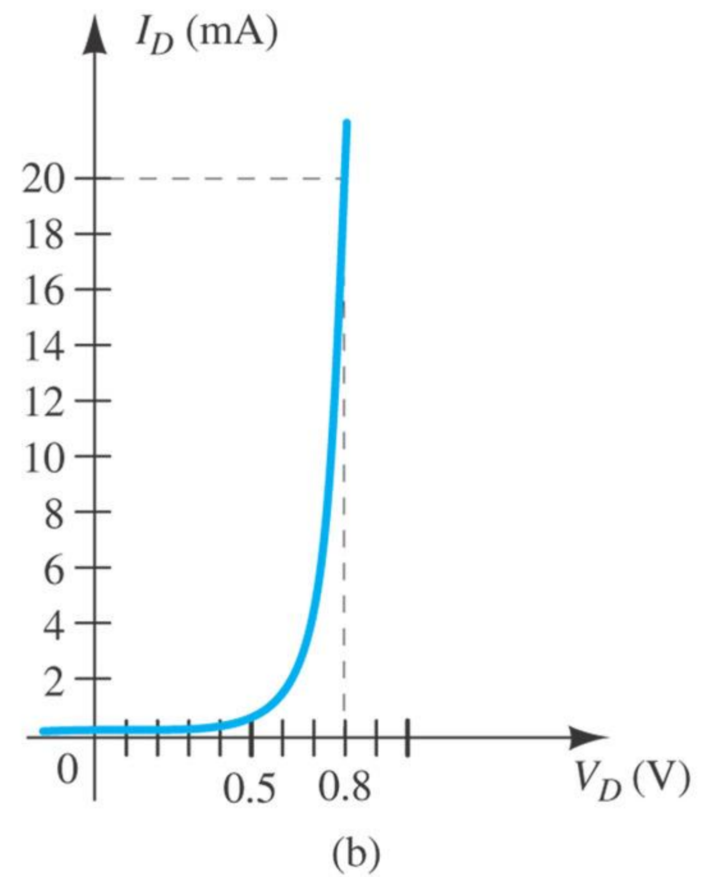


- The maximum I_D equals E/R, and the maximum V_D equals E.
- The point where the load line and the characteristic curve intersect is the Q-point, which identifies I_D and V_D for a particular diode in a given circuit.

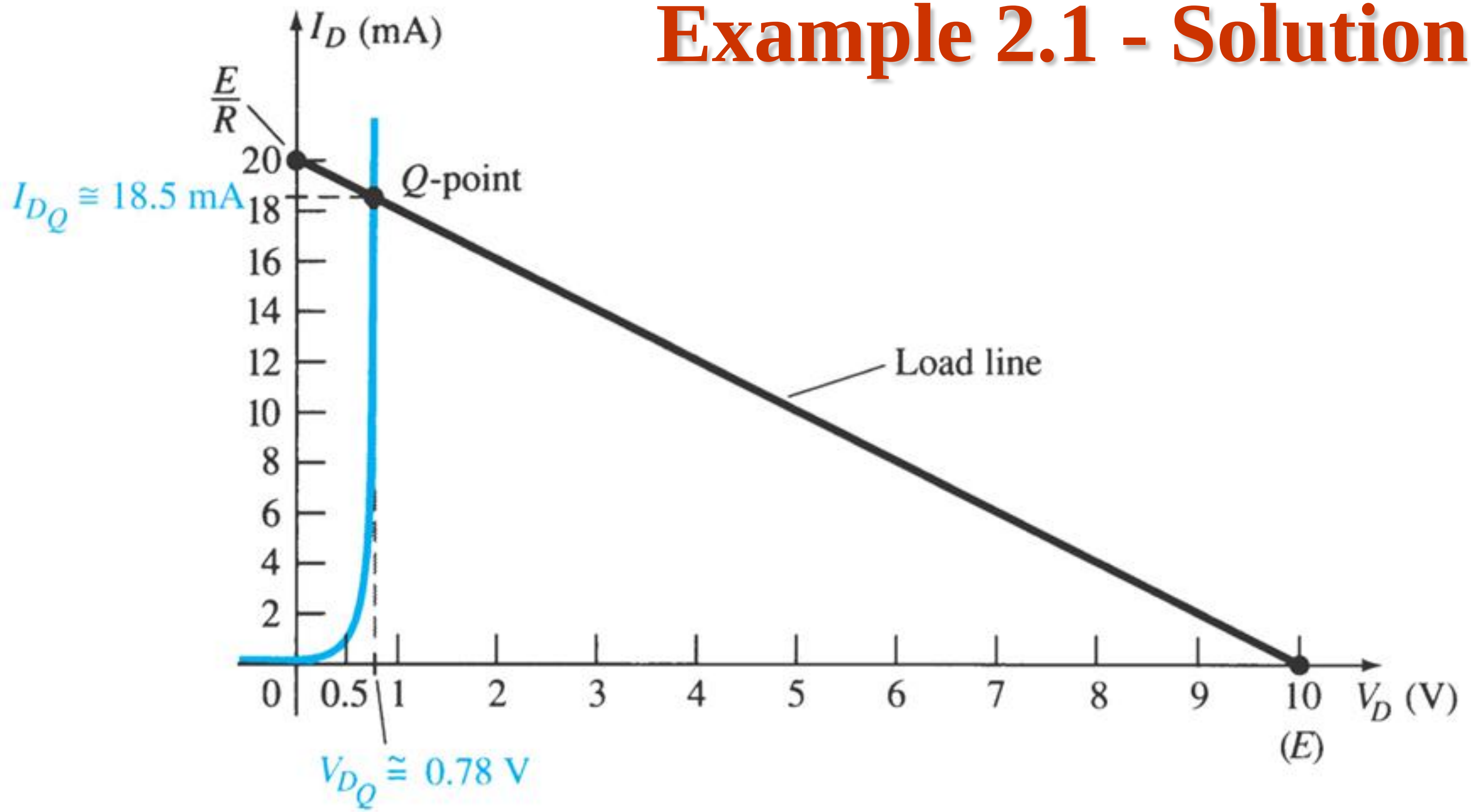
Example 2.1

For the given diode configuration and diode characteristics, determine: V_{DQ} , I_{DQ} and V_R.





Example 2.1 - Solution



- The load line is firstly drawn between V_D=E=10 V and I_D=E/R=10/0.5k=20mA. The intersection between the load line and characteristics defines the Q-point as V_{DQ}=0.78 and I_{DQ}=18.5mA.
- V_R=I_{DQ} R=(18.5mA)(1K)=18.5 V.

Diode Configurations

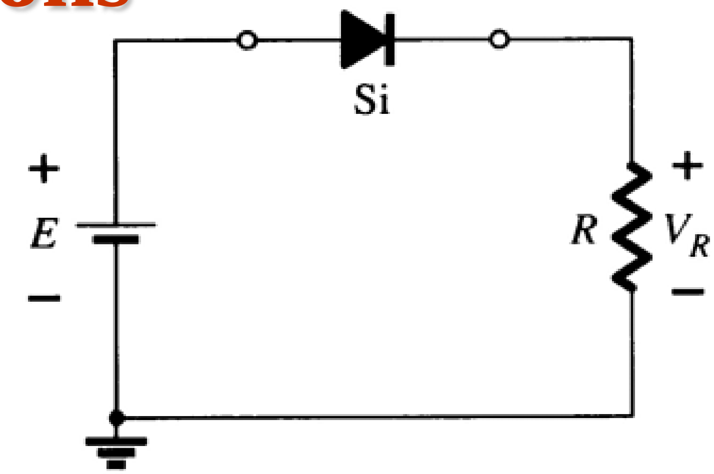
- The forward resistance of the diode is usually so small compared to the other series elements of the network that it can be ignored.

- In general, a diode is in the "on" state if the current established by the applied sources is such that its direction matches that of the arrow in the diode symbol, and $V_D \geq 0.7V$ for silicon, $V_D \geq 0.3V$ for germanium, and $V_D \geq 1.2V$ for gallium arsenide.

- You may assume the diode is "on", and then find the current in the diode. If the current flows into the positive terminal of the diode, then the assumption is right, otherwise, the diode is "off".

Series Diode Configurations

Forward Bias

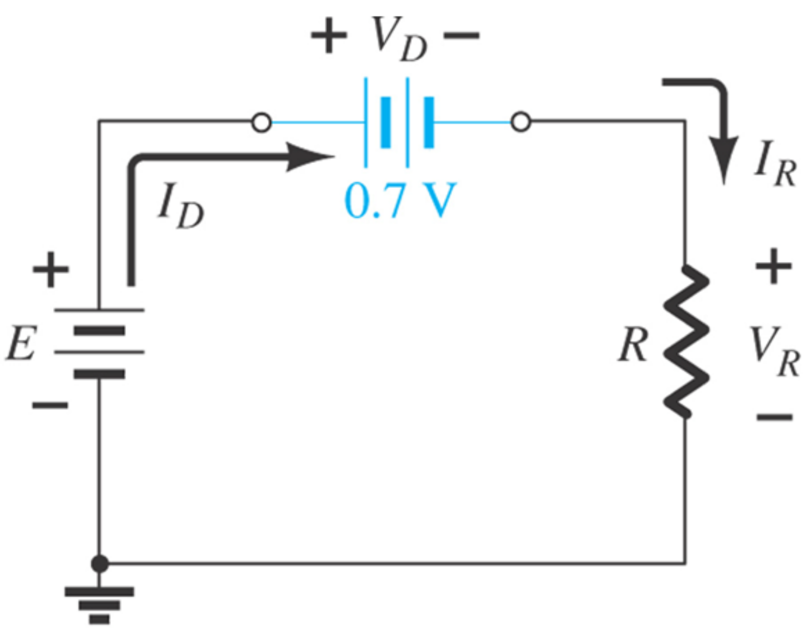


Constants

- **Silicon Diode: $V_D = 0.7$ V**
- **Germanium Diode: $V_D = 0.3$ V**

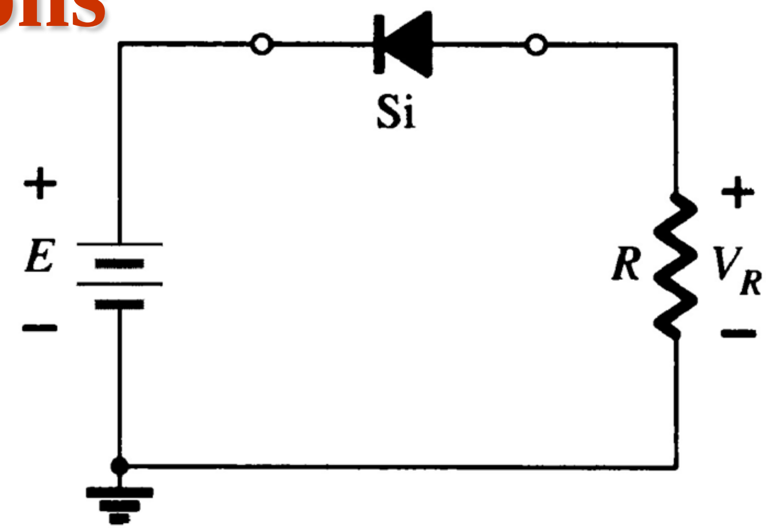
Analysis (for silicon)

- $V_D = 0.7$ V (or $V_D = E$ if $E < 0.7$ V)
- $V_R = E - V_D$
- $I_D = I_R = I_T = V_R / R = (E - V_D) / R$



Equivalent circuit for the “on” diode

Series Diode Configurations

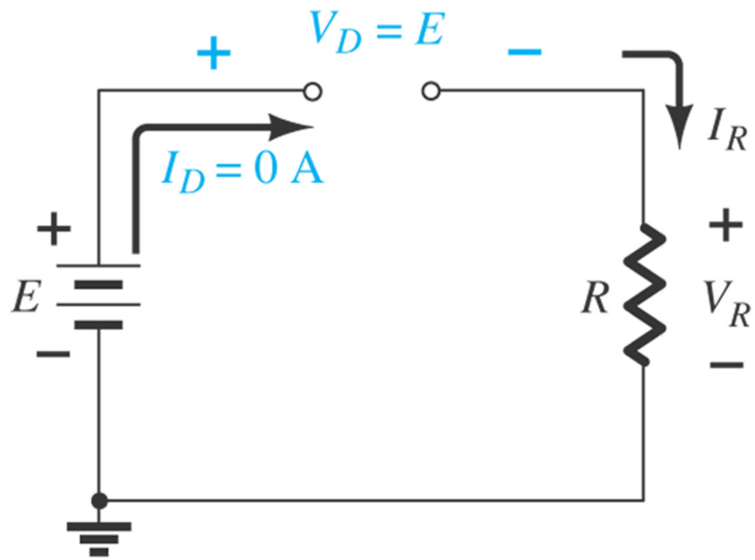


Reverse Bias

Diodes ideally behave as open circuits

Analysis

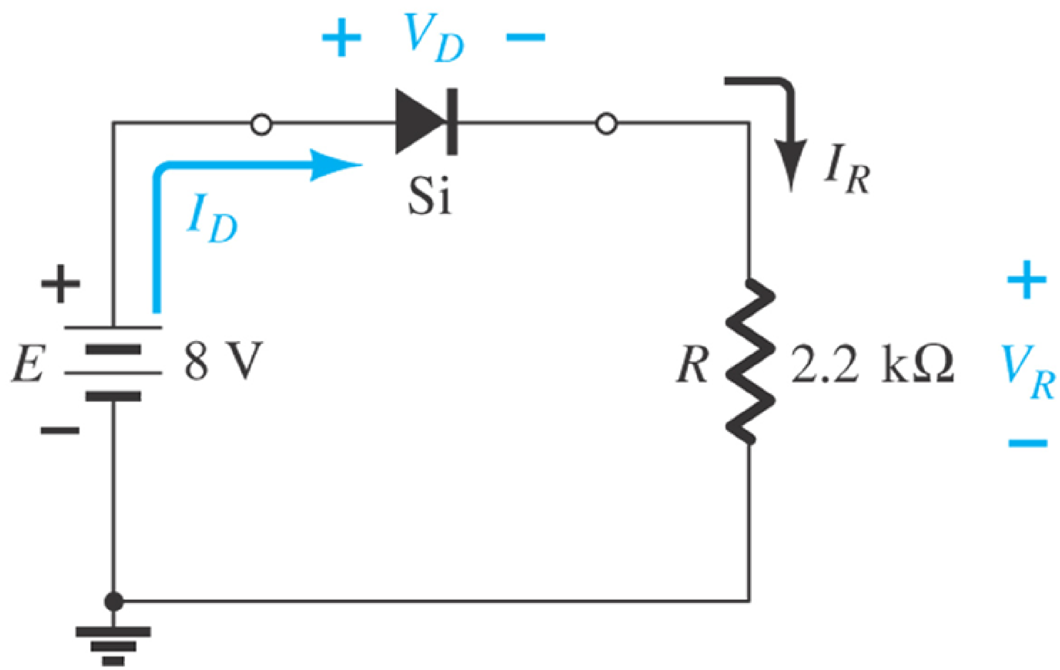
- $V_D = E$
- $V_R = 0\ \text{V}$
- $I_D = 0\ \text{A}$



Equivalent circuit for the "off" diode

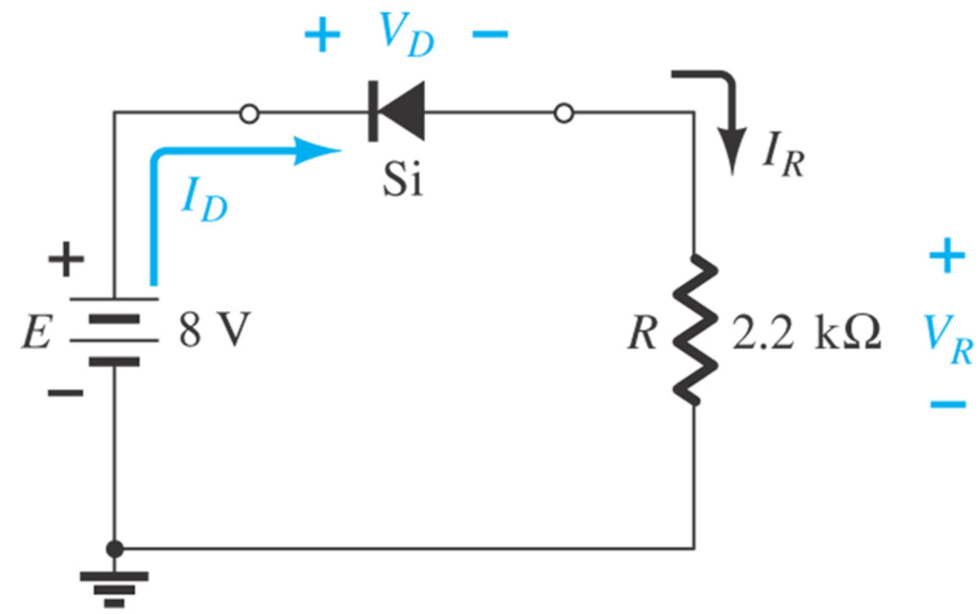
Example 2.4

- Determine V_D, V_R and I_D.

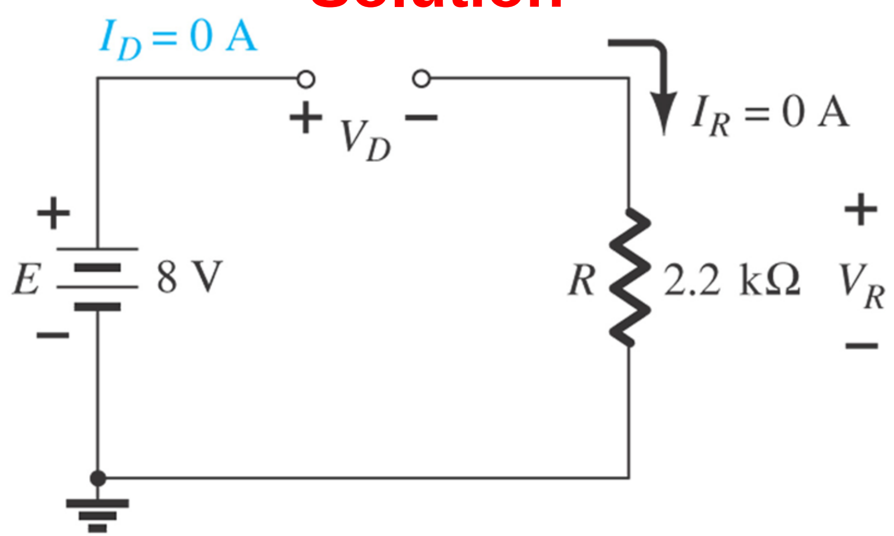


Example 2.5

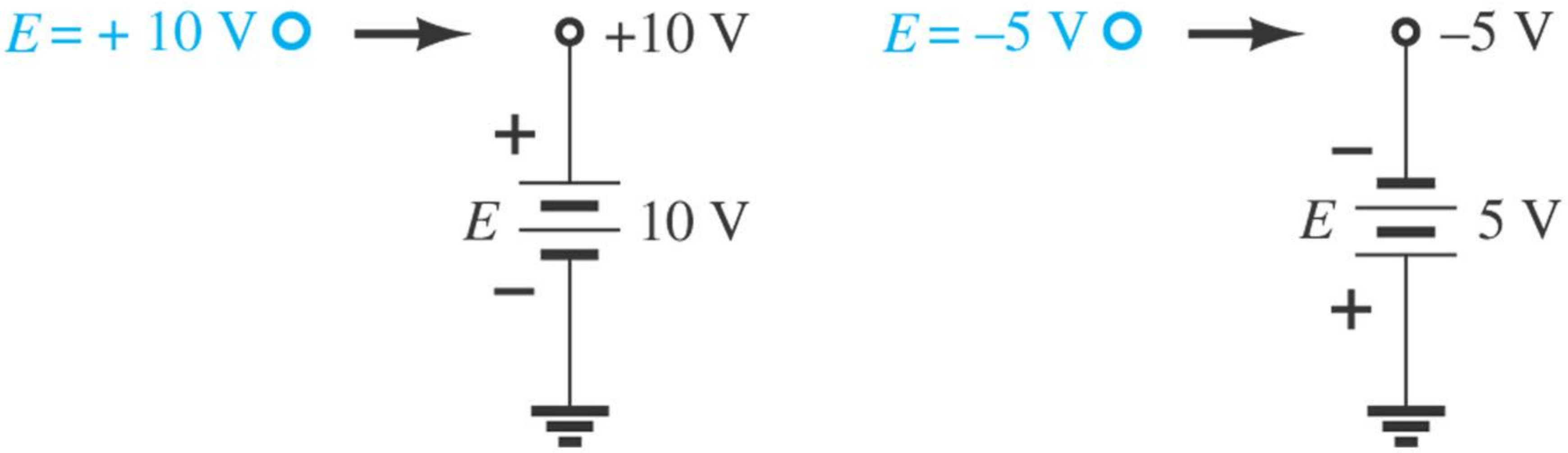
Determine V_D, V_R and I_D.



Solution



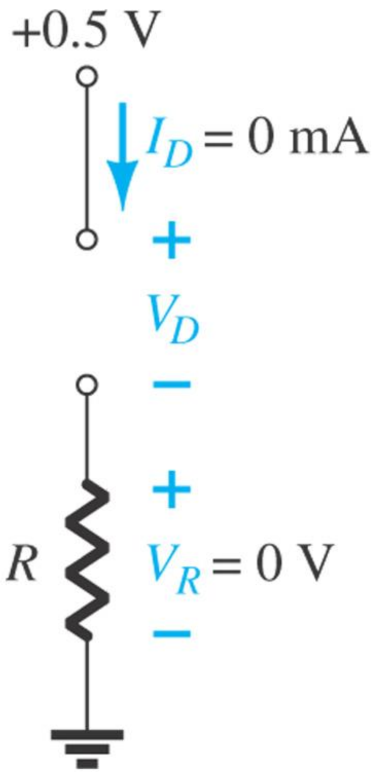
Source Notation

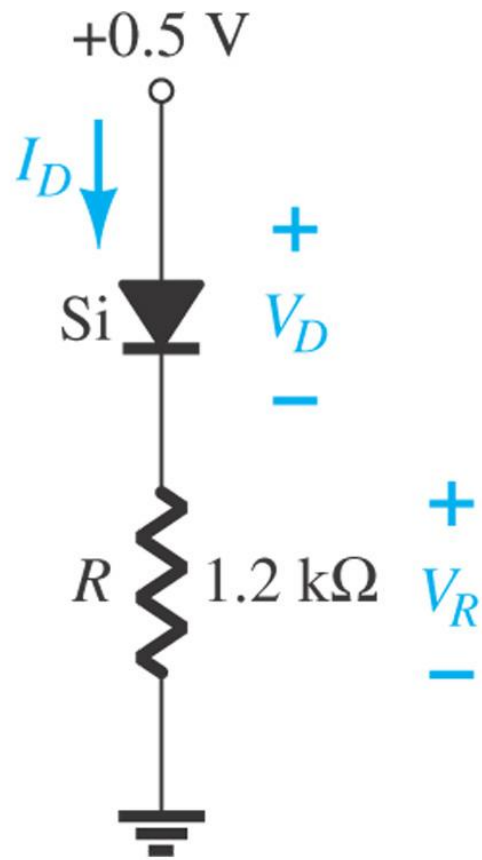


Example 2.6

Determine V_D, V_R and I_D.

Solution

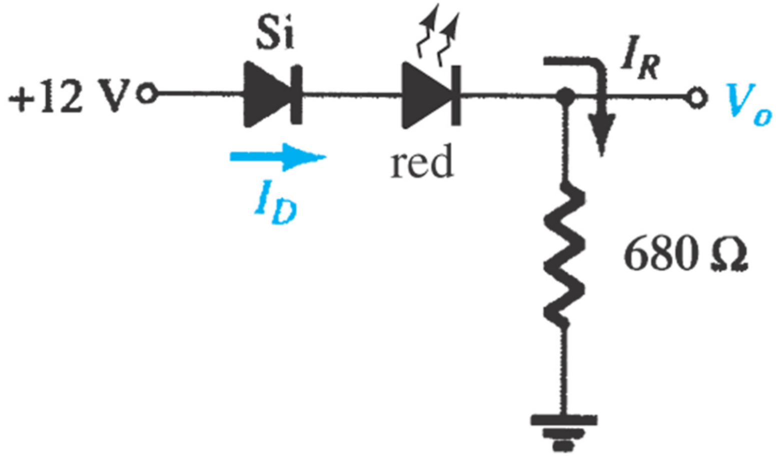


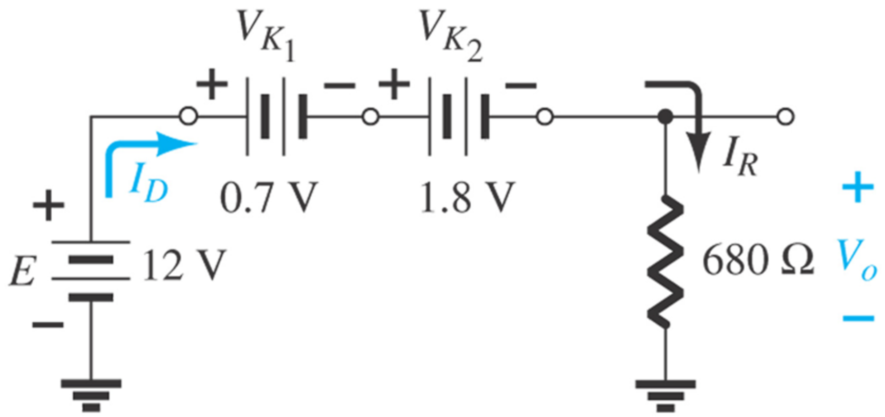


Example 2.7

Determine V_o and I_D. The forward bias voltage for red LED is 1.8 V.

Solution

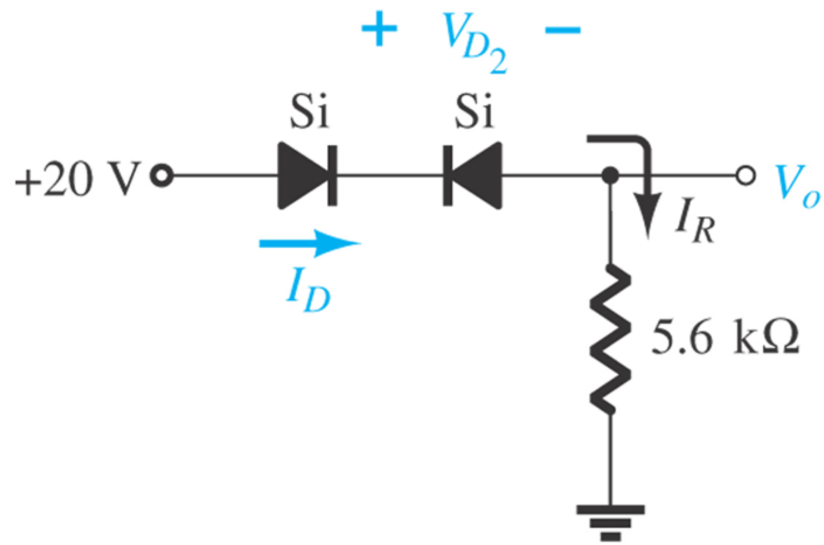


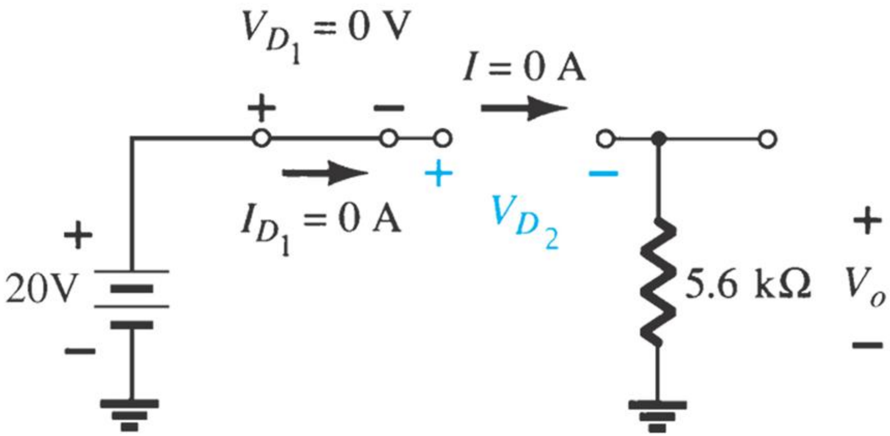


Example 2.8

Determine I_D , V_{D2} and V_o.

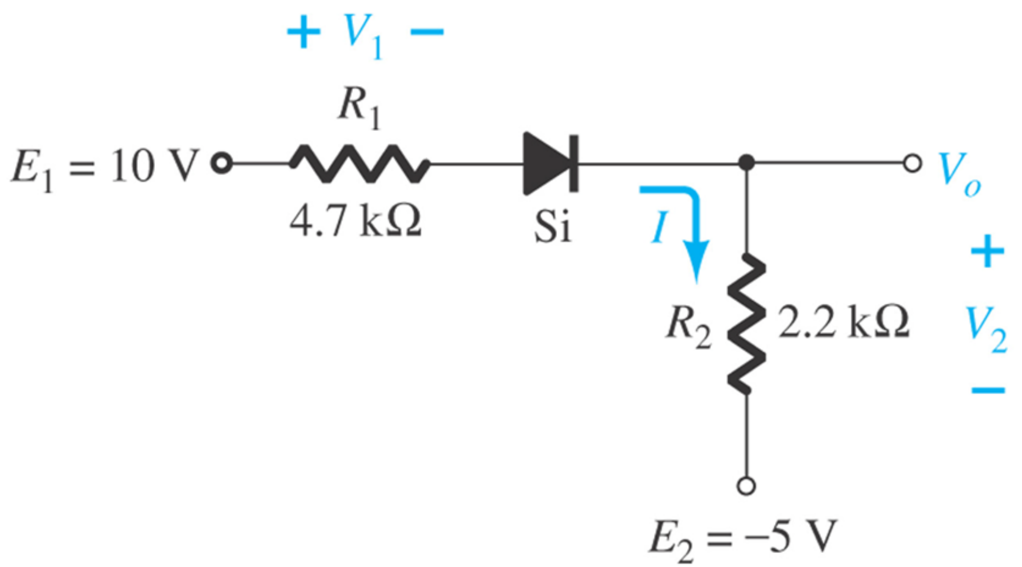
Solution



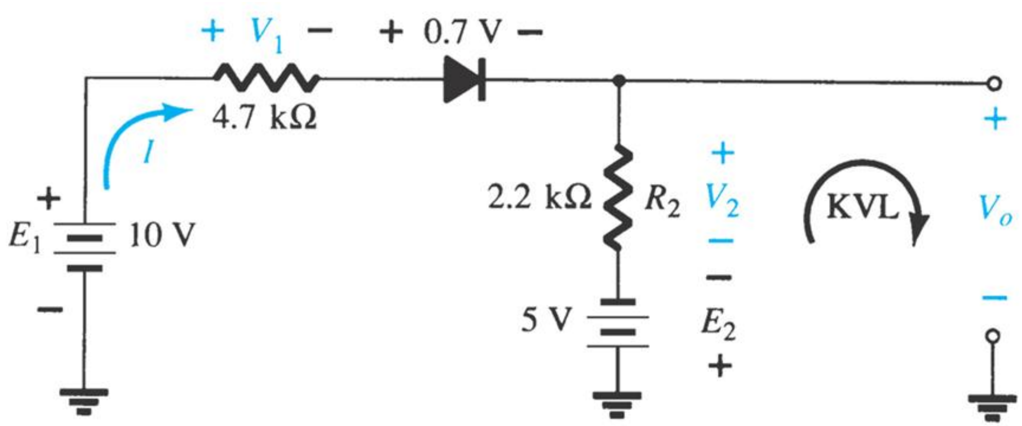


Example 2.9

Determine I , V_1 ,V_2 and V_o

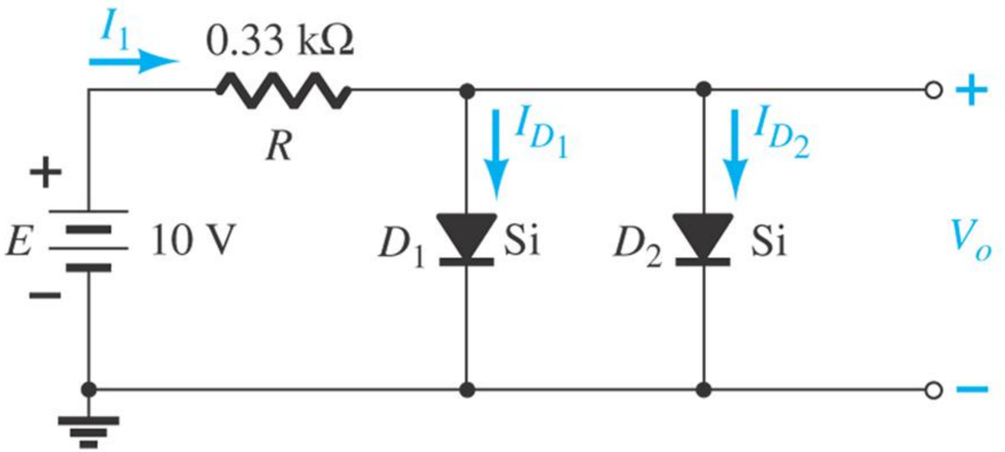


Solution



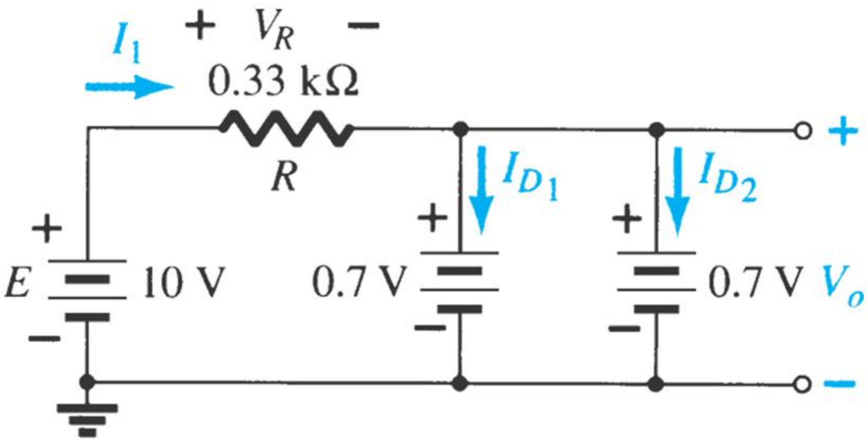
Parallel and Series-Parallel Configurations

Example 2.10



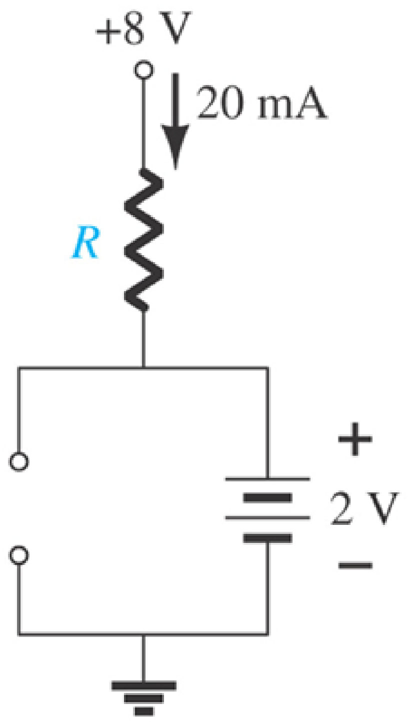
Determine V_O , I_1, I_{D1}, and I_{D2}

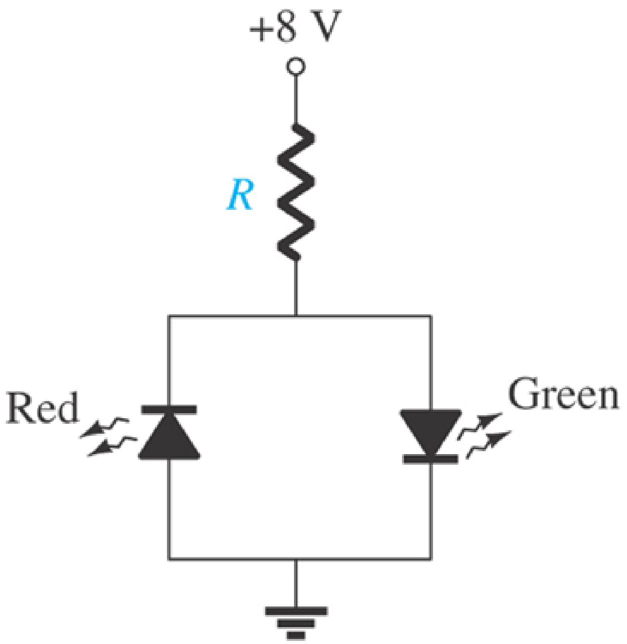
Solution



Example 2.11: Find the resistor R to ensure a current of 20 mA through the "on" diode for the given circuit. Both diodes have reverse breakdown voltage of 3V and average turn-on voltage of 2V.

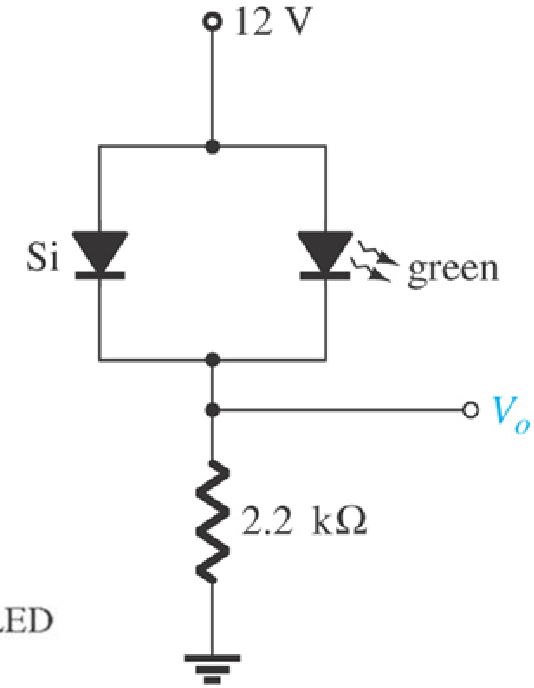
Solution



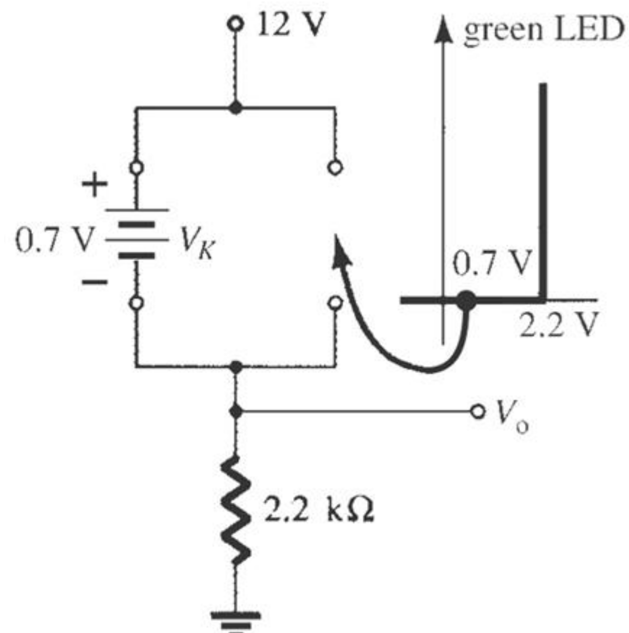


Example 2.12

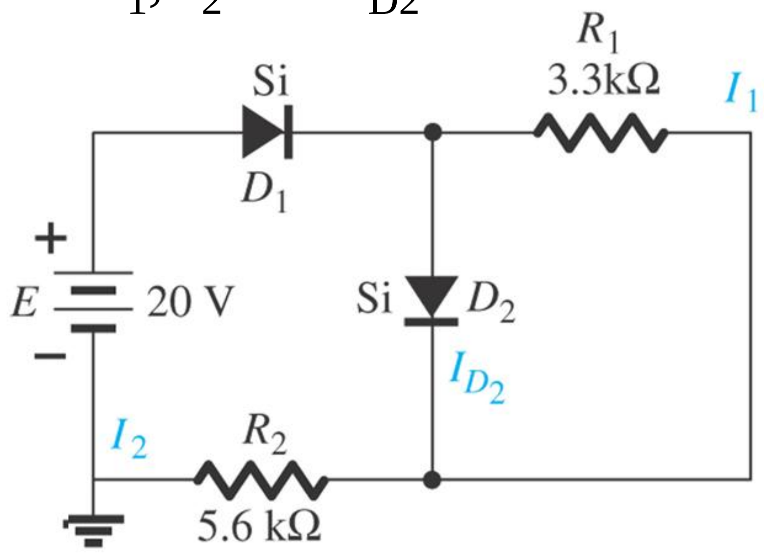
Determine the voltage V_o.



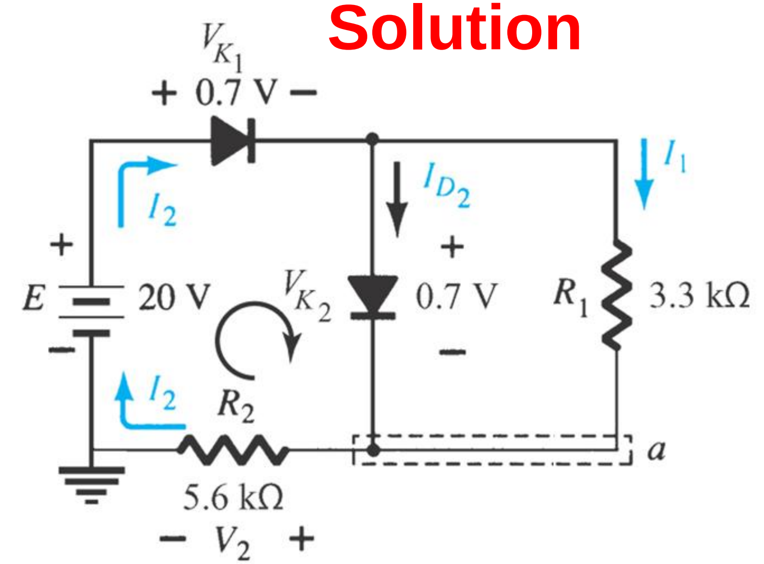
Solution



Example 2.13 Determine the currents I_1, I_2 and I_{D2}

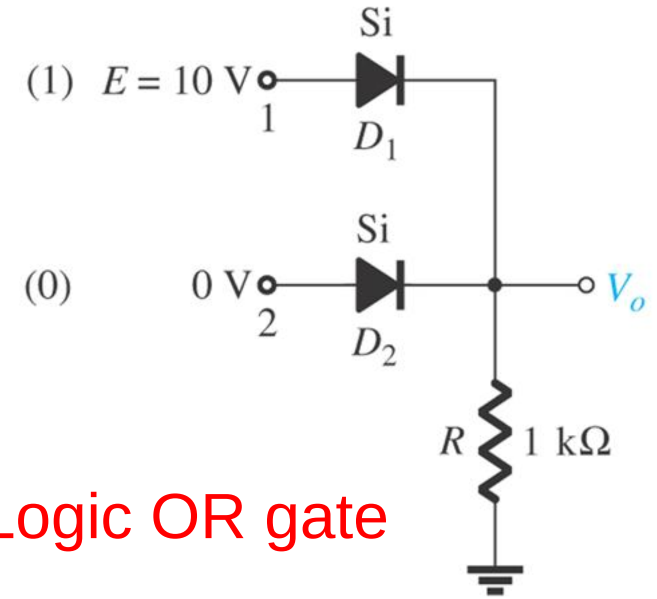


Solution



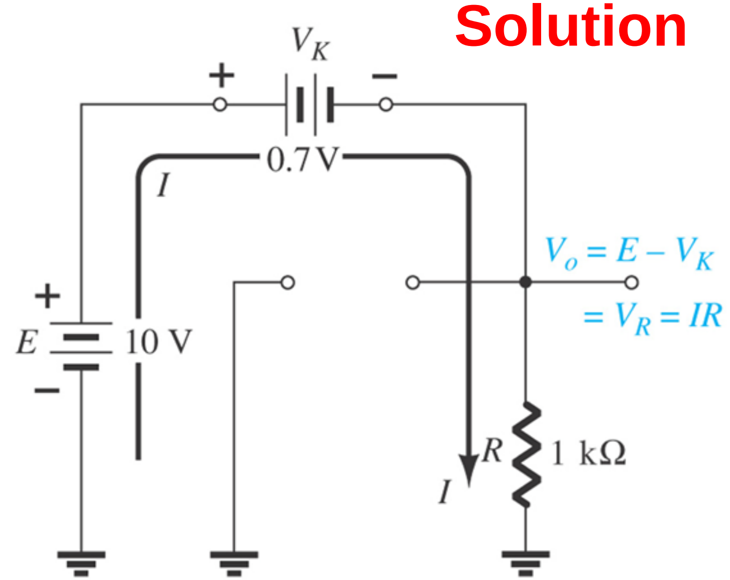
AND/OR Gates

Example 2.14 Determine V_o



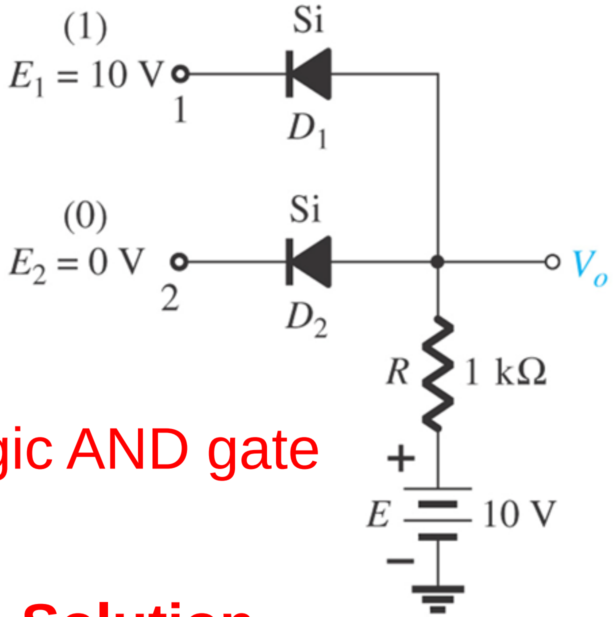
Logic OR gate

Solution



AND/OR Gates: Example 2.15

Determine the output level for the logic AND gate



Logic AND gate

Solution