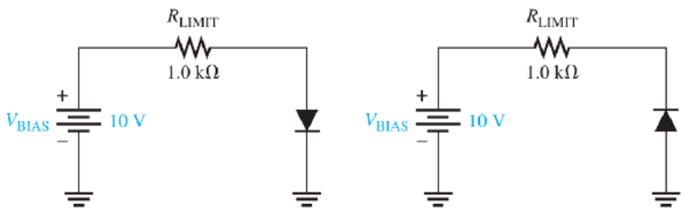
Electronic Engineering

Sheet # 1: Diodes

1- Determine the forward voltage and forward current for the diode in the Figure (a) for each of the diode models. Also find the voltage across the limiting resistor in each case. Assume rd'= 10 ohm at the determined value of forward current.

2- Determine the reverse voltage and reverse current for the diode in the Figure (b) for each of the diode models. Also find the voltage across the limiting resistor in each case. Assume I_R = 1 μA.



(a) (b)

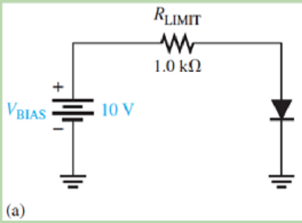
Solution (a)

- **Ideal model:**

$V_F = 0\text{ V}$

$$I_F = \frac{V_{BIAS}}{R_{LIMIT}} = \frac{10\text{ V}}{1.0\text{ k}\Omega} = \mathbf{10\text{ mA}}$$

$$V_{R_{LIMIT}} = I_F R_{LIMIT} = (10\text{ mA})(1.0\text{ k}\Omega) = \mathbf{10\text{ V}}$$



- **Practical model:**

$V_F = 0.7\text{ V}$

$$I_F = \frac{V_{BIAS} - V_F}{R_{LIMIT}} = \frac{10\text{ V} - 0.7\text{ V}}{1.0\text{ k}\Omega} = \frac{9.3\text{ V}}{1.0\text{ k}\Omega} = \mathbf{9.3\text{ mA}}$$

$$V_{R_{LIMIT}} = I_F R_{LIMIT} = (9.3\text{ mA})(1.0\text{ k}\Omega) = \mathbf{9.3\text{ V}}$$

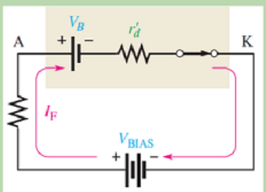
Solution (a)

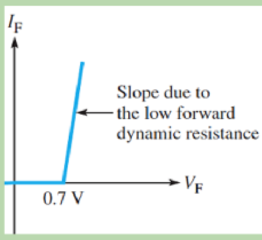
- **Complete model:**

$$I_F = \frac{V_{BIAS} - 0.7\text{ V}}{R_{LIMIT} + r'_d} = \frac{10\text{ V} - 0.7\text{ V}}{1.0\text{ k}\Omega + 10\ \Omega} = \frac{9.3\text{ V}}{1010\ \Omega} = \mathbf{9.21\text{ mA}}$$

$$V_F = 0.7\text{ V} + I_F r'_d = 0.7\text{ V} + (9.21\text{ mA})(10\ \Omega) = \mathbf{792\text{ mV}}$$

$$V_{R_{LIMIT}} = I_F R_{LIMIT} = (9.21\text{ mA})(1.0\text{ k}\Omega) = \mathbf{9.21\text{ V}}$$





Solution (b)

- **Ideal model:**

  $I_R = 0\,\mathrm{A}$

  $V_R = V_{BIAS} = 10\,\mathrm{V}$

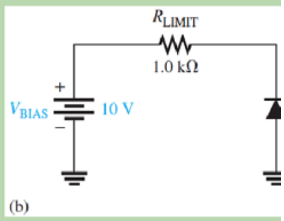
  $V_{R_{LIMIT}} = 0\,\mathrm{V}$

- **Practical model:**

  $I_R = 0\,\mathrm{A}$

  $V_R = V_{BIAS} = 10\,\mathrm{V}$

  $V_{R_{LIMIT}} = 0\,\mathrm{V}$

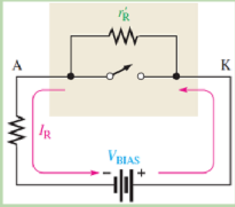


- **Complete model:**

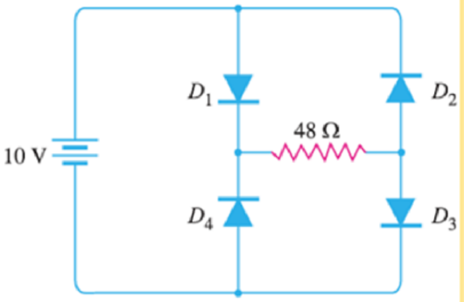
  $I_R = 1\,\mu\mathrm{A}$

  $V_{R_{LIMIT}} = I_R R_{LIMIT} = (1\,\mu\mathrm{A})(1.0\,\mathrm{k\Omega}) = 1\,\mathrm{mV}$

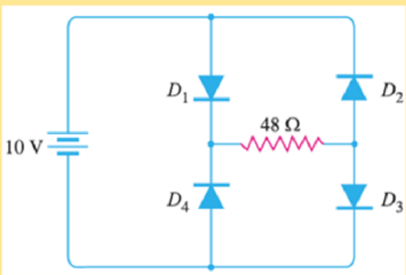
  $V_R = V_{BIAS} - V_{R_{LIMIT}} = 10\,\mathrm{V} - 1\,\mathrm{mV} = 9.999\,\mathrm{V}$

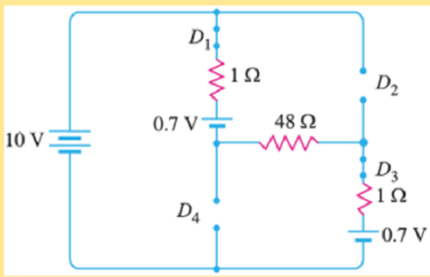


3- Calculate the current through 48 Ω resistor in the circuit shown in the Figure. Assume the diodes to be of silicon and forward resistance of each diode is 1 Ω.



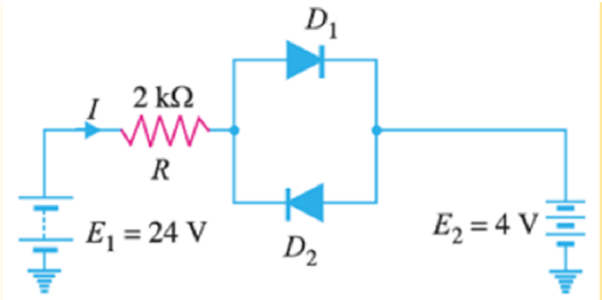
We get the circuit shown in the Figure. Note that for a silicon diode, the barrier voltage is 0.7 V.

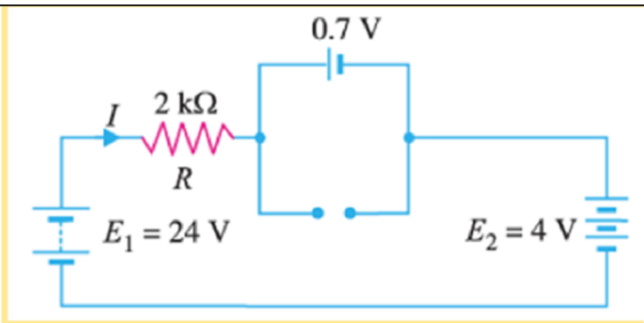




Net circuit voltage = 10 − 0.7 − 0.7 = 8.6 V
Total circuit resistance = 1 + 48 + 1 = 50 Ω
Circuit current = 8.6/50 = 0.172 A = **172 mA**

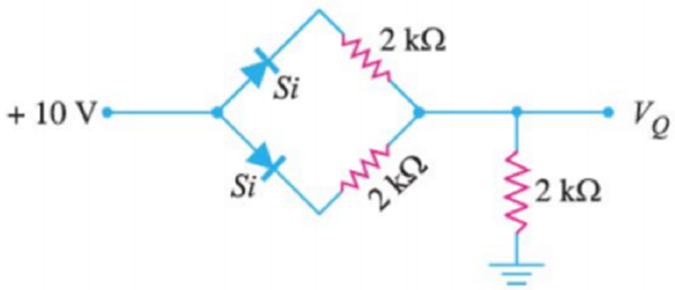
4- Determine the current I in the circuit shown in the Figure. Assume the diodes to be of silicon and forward resistance of diodes to be zero.

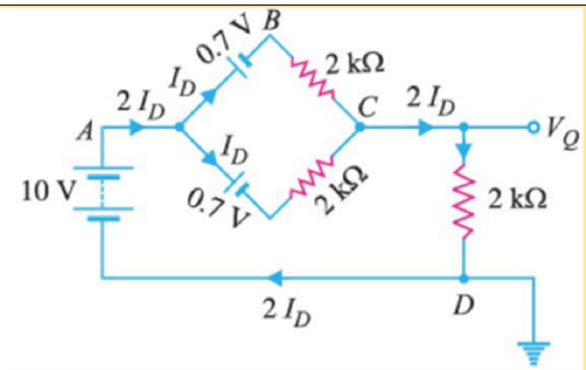




$$I = \frac{E_1 - E_2 - V_0}{R} = \frac{24 - 4 - 0.7}{2\ \text{k}\Omega} = \frac{19.3\ \text{V}}{2\ \text{k}\Omega} = \mathbf{9.65\ mA}$$

5- Find VQ and ID in the network shown. Use practical model.





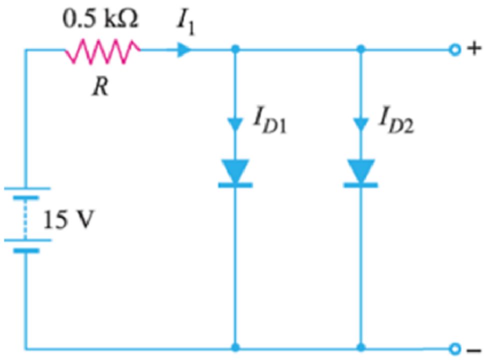
$$-0.7 - I_D \times 2 - 2\,I_D \times 2 + 10 = 0$$

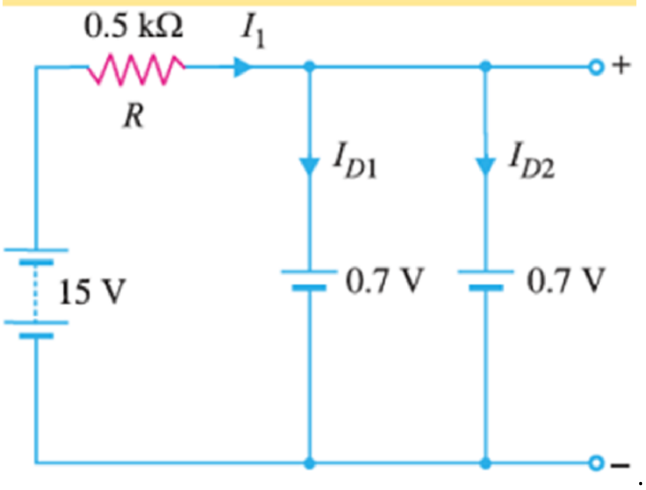
$$6\,I_D = 9.3$$

$$I_D = \frac{9.3}{6} = \mathbf{1.55\ mA}$$

$$V_Q = (2\,I_D) \times 2\,\text{k}\Omega = (2 \times 1.55\,\text{mA}) \times 2\,\text{k}\Omega = \mathbf{6.2\ V}$$

6- Determine current through each diode in the circuit shown. Use practical model. Assume diodes to be similar .



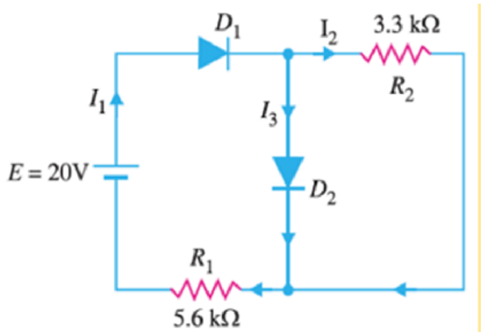


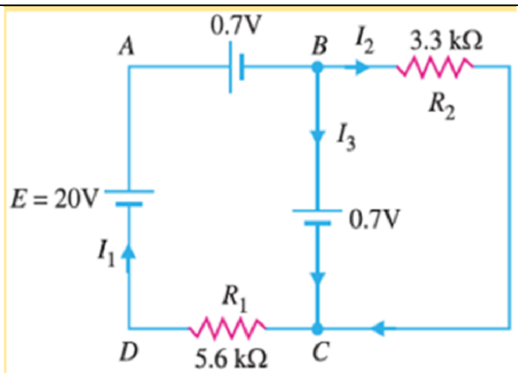
$$I_1 = \frac{\text{Voltage across } R}{R} = \frac{15 - 0.7}{0.5\ \text{k}\Omega} = 28.6\ \text{mA}$$

Since the diodes are similar

$$I_{D1} = I_{D2} = \frac{I_1}{2} = \frac{28.6}{2} = \mathbf{14.3\ mA}$$

7- Determine the currents I1, I2, I3 for the network shown. Use practical model for the diodes.





The voltage across R_2 (= 3.3 k Ω) is 0.7V.

$$\therefore \qquad I_2 = \frac{0.7\ \text{V}}{3.3\ \text{k}\Omega} = \mathbf{0.212\ mA}$$

Applying Kirchhoff's voltage law to loop *ABCDA*, we have,

$$-0.7 - 0.7 - I_1 R_1 + 20 = 0$$

$$I_1 = \frac{20 - 0.7 - 0.7}{R_1} = \frac{18.6\ \text{V}}{5.6\ \text{k}\Omega} = \mathbf{3.32\ mA}$$

$$I_3 = I_1 - I_2 = 3.32 - 0.212 = \mathbf{3.108\ mA}$$