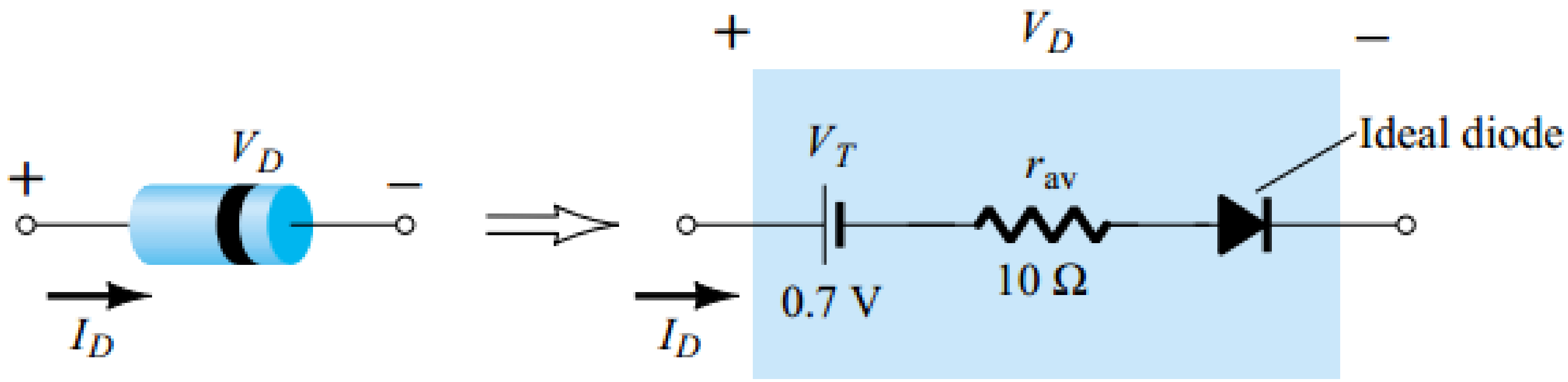
CO2015

Exercise on Diode



Dept. of Computer Engineering

Diode Equivalent Circuit

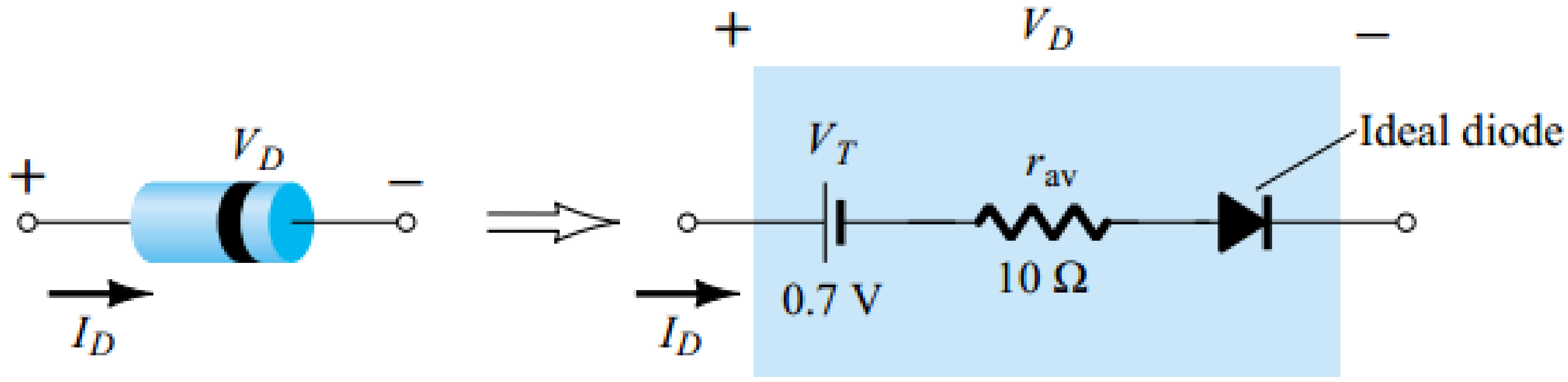
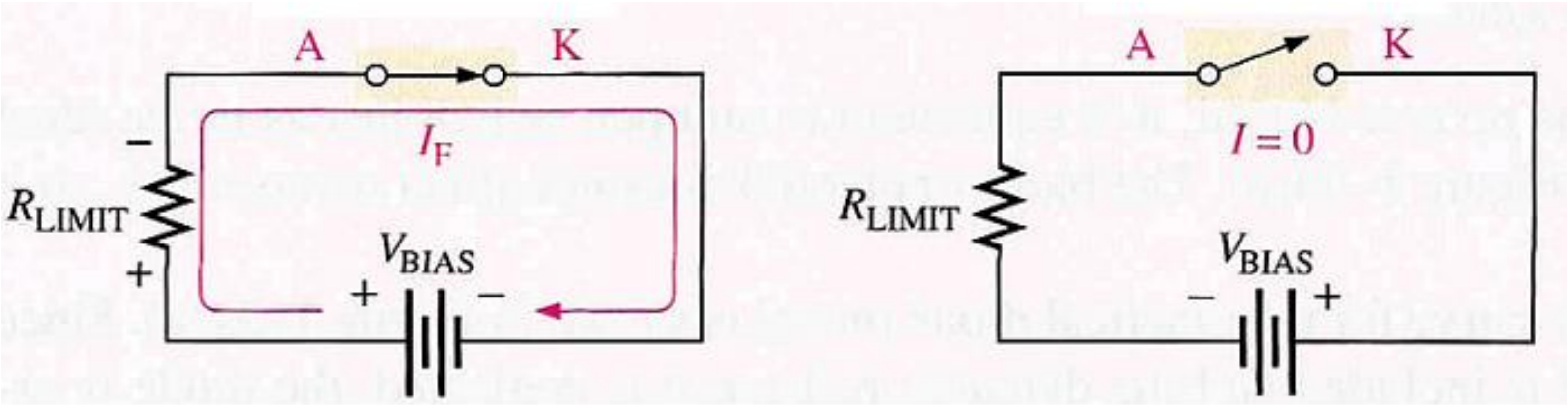


Figure 1.32 Components of the piecewise-linear equivalent circuit.

Ideal Diode Model

- Works as a switch
  - Forward bias (switch is close)
  - Reverse bias (switch is open)
- Threshold battery voltage and internal resistance are ignored.



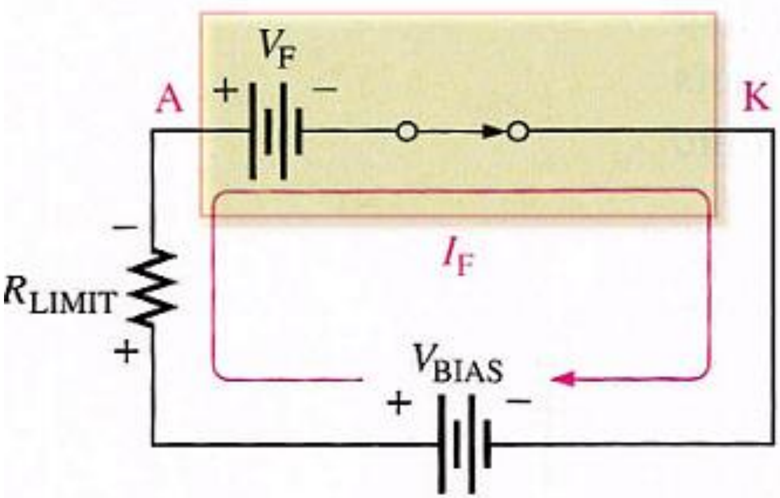
$$I_F = \frac{V_{BIAS}}{R_{LIMIT}}$$

Forward bias

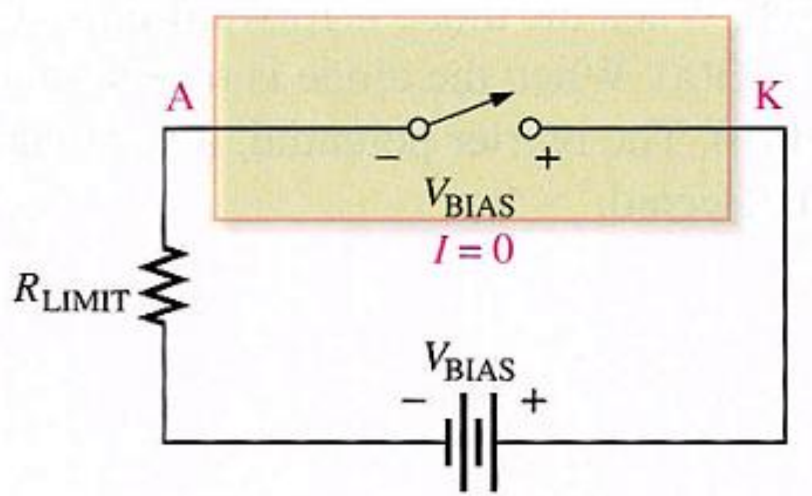
Reverse bias

Practical Diode Model

$$I_F = \frac{V_{BIAS} - V_F}{R_{LIMIT}}$$



Forward bias



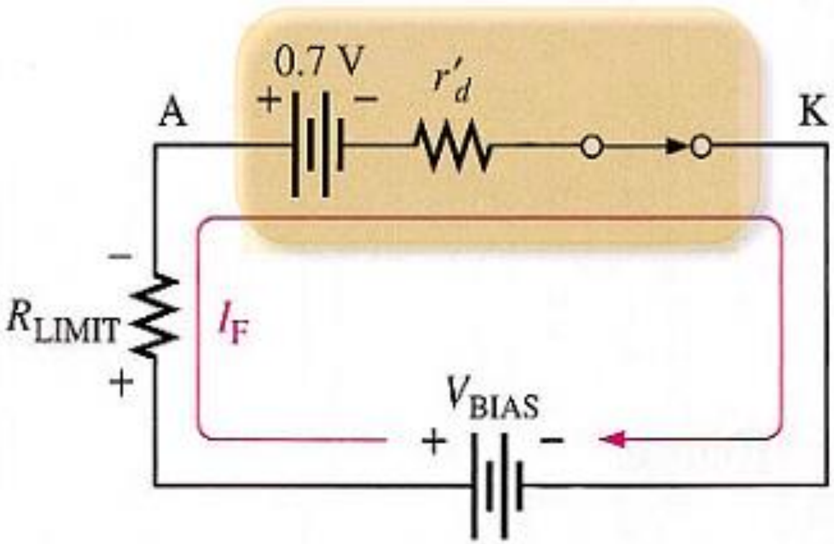
Reverse bias

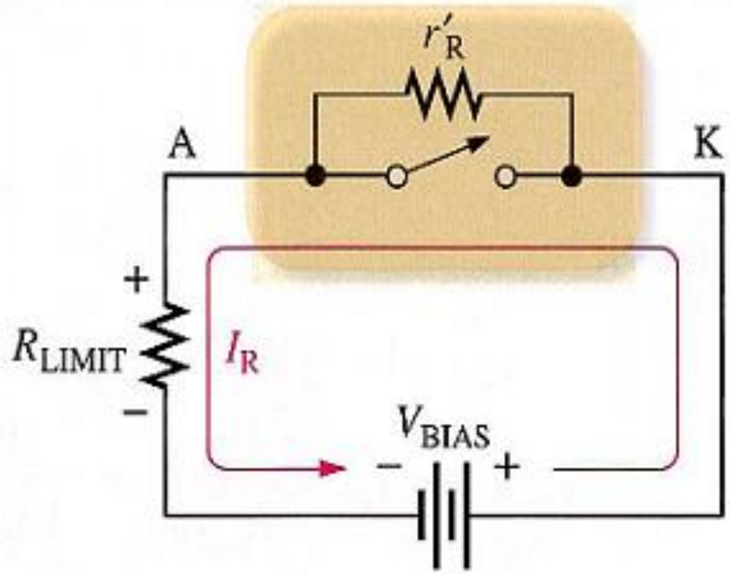
- Constants
  - Silicon Diode: $V_F = 0.7V$ ($V_F = V_{BIAS}$ if $V_{BIAS} < 0.7V$)
  - Germanium Diode: $V_F = 0.3V$ ($V_F = V_{BIAS}$ if $V_{BIAS} < 0.3V$)

Complete Diode Model

$$I_F = \frac{V_{BIAS} - 0,7\,V}{R_{LIMIT} + r'_d}$$

$$I_R = \frac{V_{BIAS}}{R_{LIMIT} + r'_R}$$



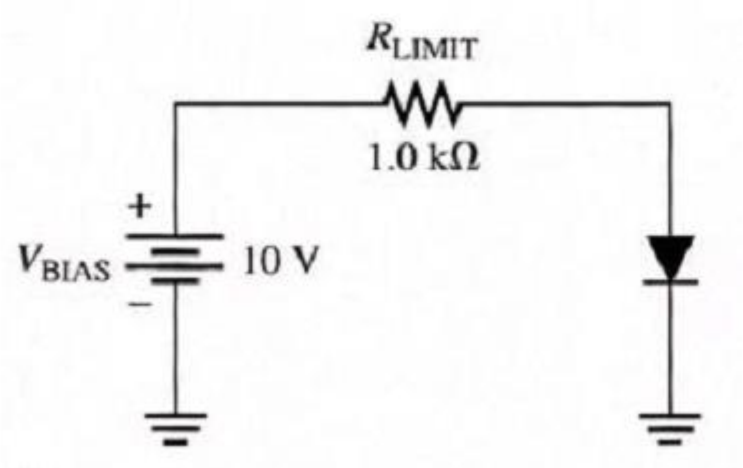


Forward bias

Reverse bias

Exercise 3

- Given circuit
  - Forward bias voltage $V_F = 0.7V$
  - Internal resistance $r'_d = 10\Omega$
- Determine V_F, I_F and V_{RLIMIT} for three diode models
  - Ideal diode model
  - Practical diode model
  - Complete diode model



Solution 3

- Ideal diode model

$$V_F = 0\,V$$

$$I_F = \frac{V_{BIAS}}{R_{LIMIT}} = \frac{10\,V}{1k\Omega} = 10\,mA$$

$$V_{R_{LIMIT}} = I_F \bullet R_{LIMIT} = (10\,mA) \bullet (1k\Omega) = 10\,V$$

- Practical diode model

$$V_F = 0{,}7\,V$$

$$I_F = \frac{V_{BIAS} - V_R}{R_{LIMIT}} = \frac{10\,V - 0{,}7\,V}{1k\Omega} = 9{,}3\,mA$$

$$V_{R_{LIMIT}} = I_F \bullet R_{LIMIT} = (9{,}3\,mA) \bullet (1k\Omega) = 9{,}3\,V$$

- Complete diode model

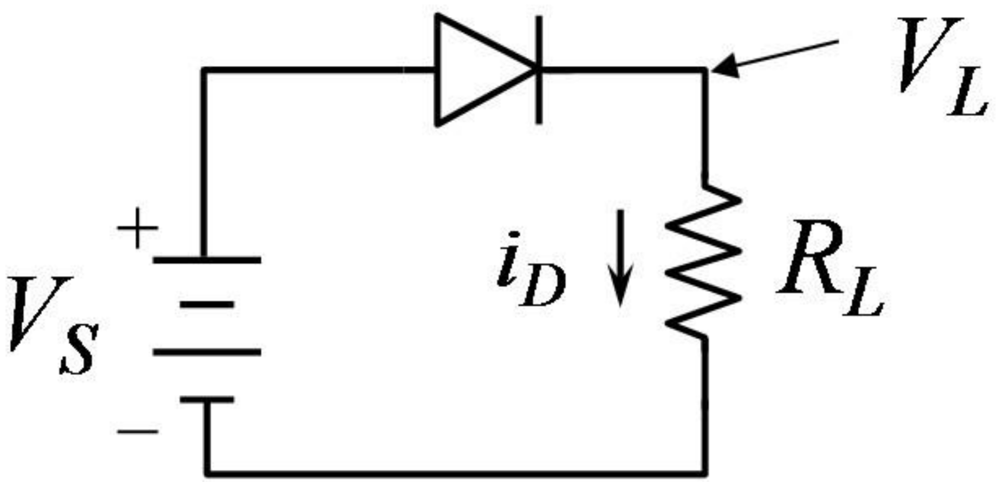
$$I_F = \frac{V_{BIAS} - 0{,}7}{R_{LIMIT} + r'_d} = \frac{10\,V - 0{,}7\,V}{1k\Omega + 10\,\Omega} = \frac{9{,}3\,V}{1010\,\Omega} = 0{,}00921\,A = 9{,}21mA$$

$$V_F = 0{,}7\,V + r'_d . I_F = 0{,}7\,V + (10\,\Omega) \bullet (9{,}21mA) = 792\,mV$$

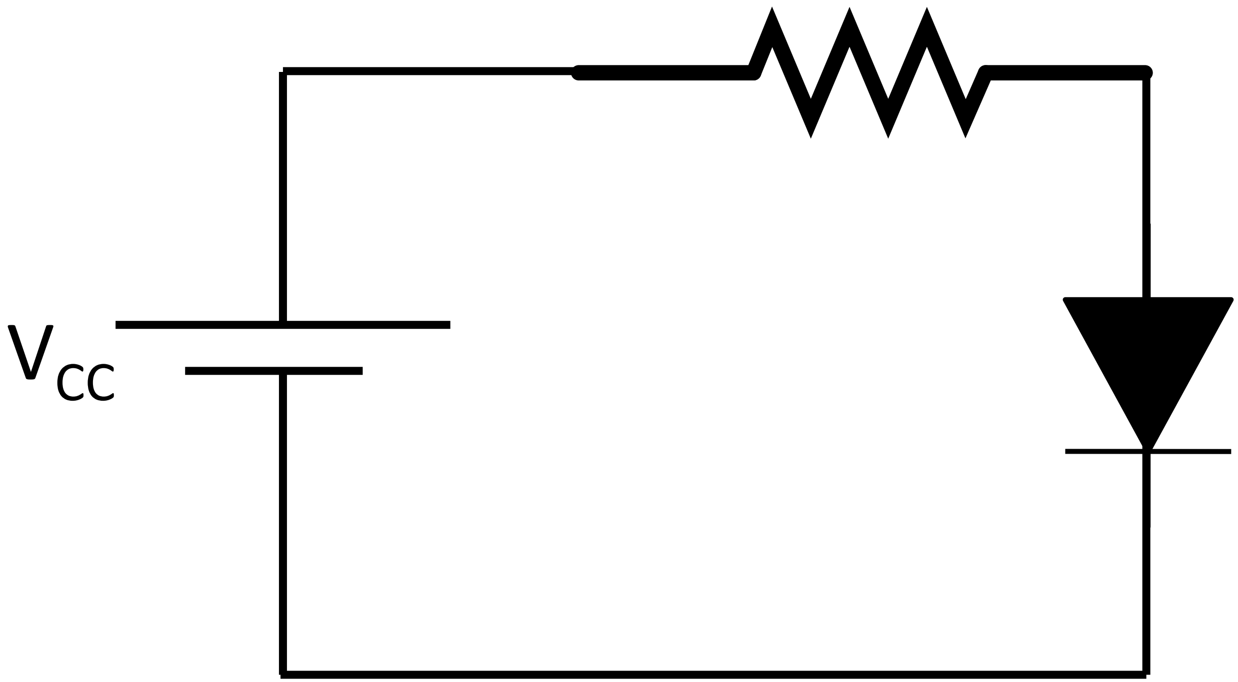
$$V_{R_{LIMIT}} = I_F \bullet R_{LIMIT} = (9{,}21mA) \bullet (1k\Omega) = 9{,}21V$$

Exercise

- Analyze the circuit by using the diode practical model.
- V_S = 5V and the current (i_D) in the circuit is 1mA.
- What is the value of R_L.

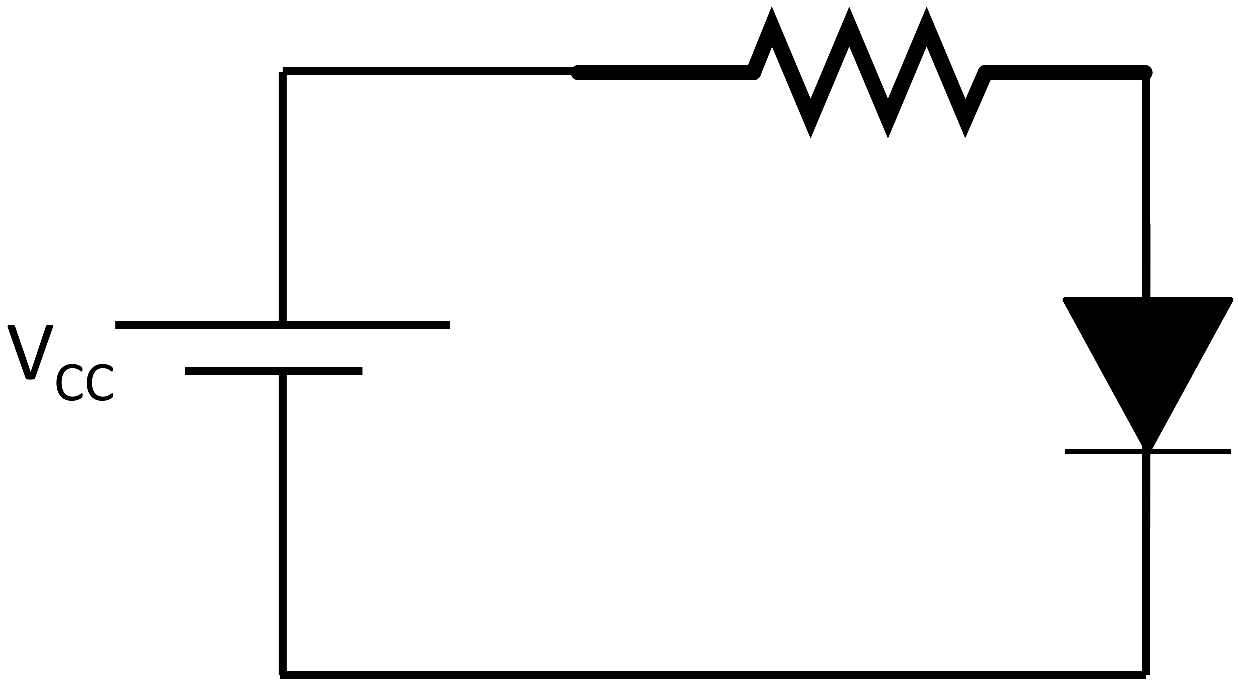


Exercise



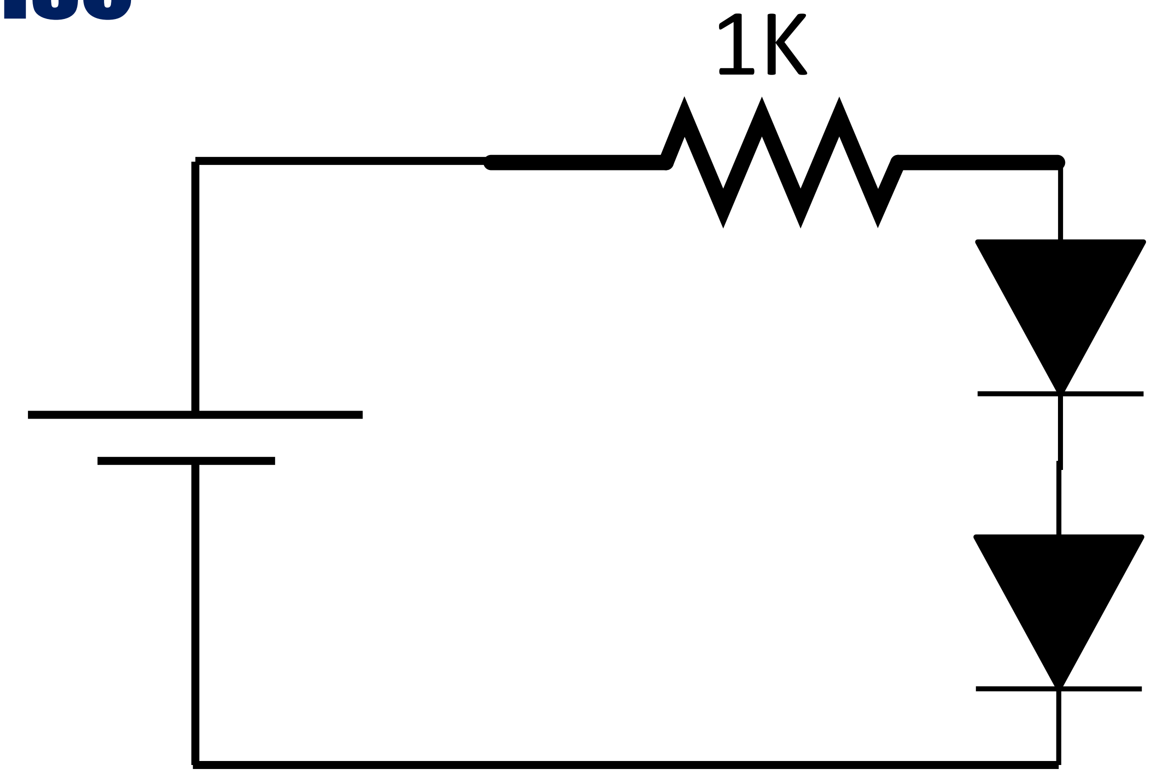
- When R = 230 Ohm, V = 0.68V
- When R = 150 Ohm, V = 0.69V
- Determine the internal resistance of the diode.
- V_{CC} = 5V for both cases

Exercise



- Determine the dropdown voltage of the diode and its internal resistance with V_{CC} = 12V, R = 220 Ohm and I = 51.63mA51.

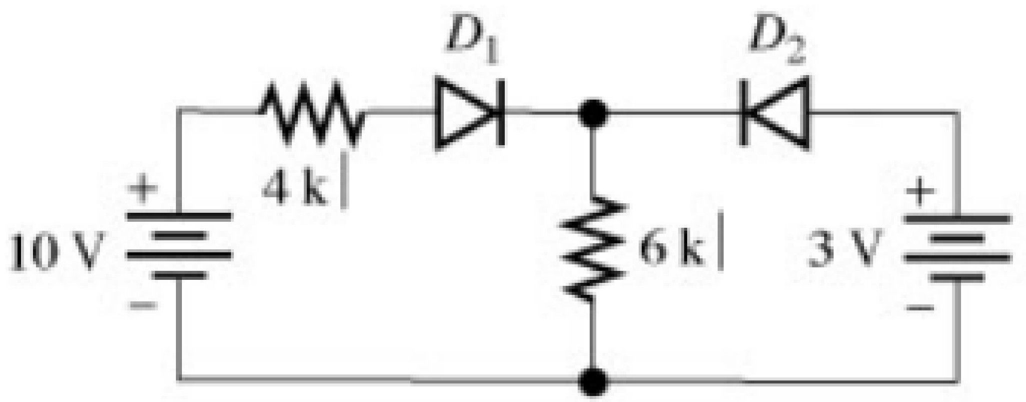
Exercise



- The voltage supply is 9V, the dropdown voltage of each diode is 0.7V. Determine the current in the circuit

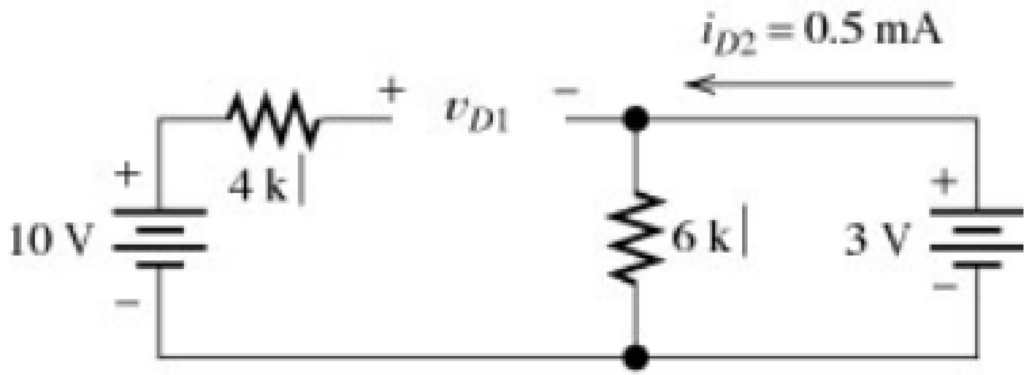
Exercise

- Analyze the circuit using ideal diode model

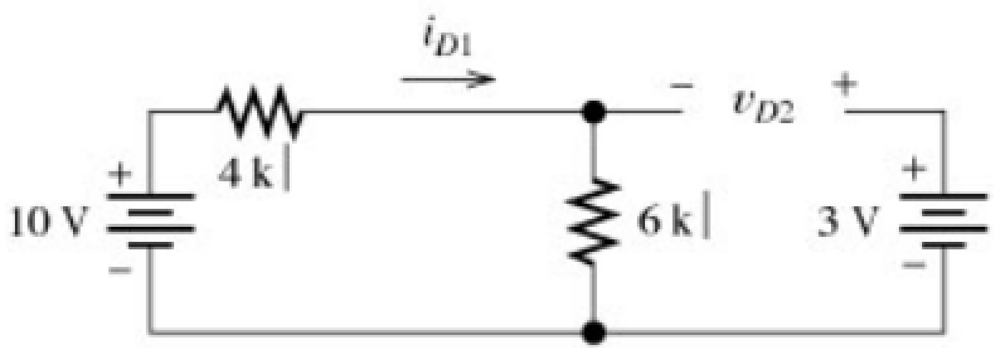


Answer

- Assume that D1 is OFF and D2 is ON

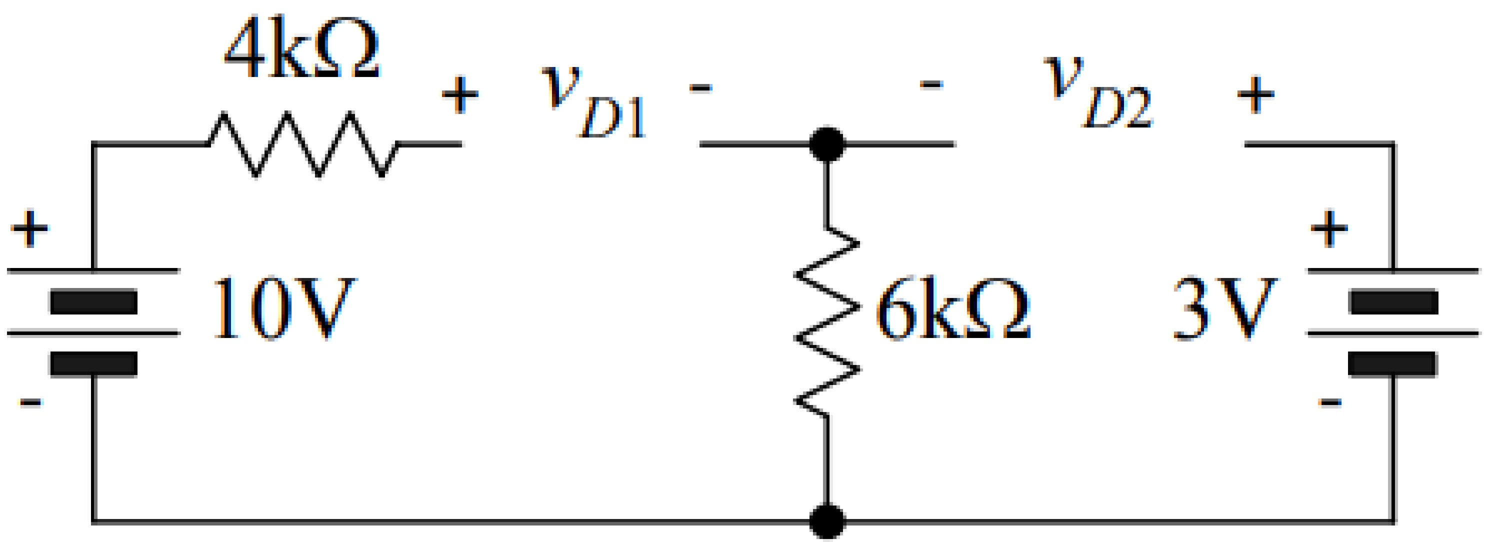


- Assume that D1 is ON and D2 is OFF



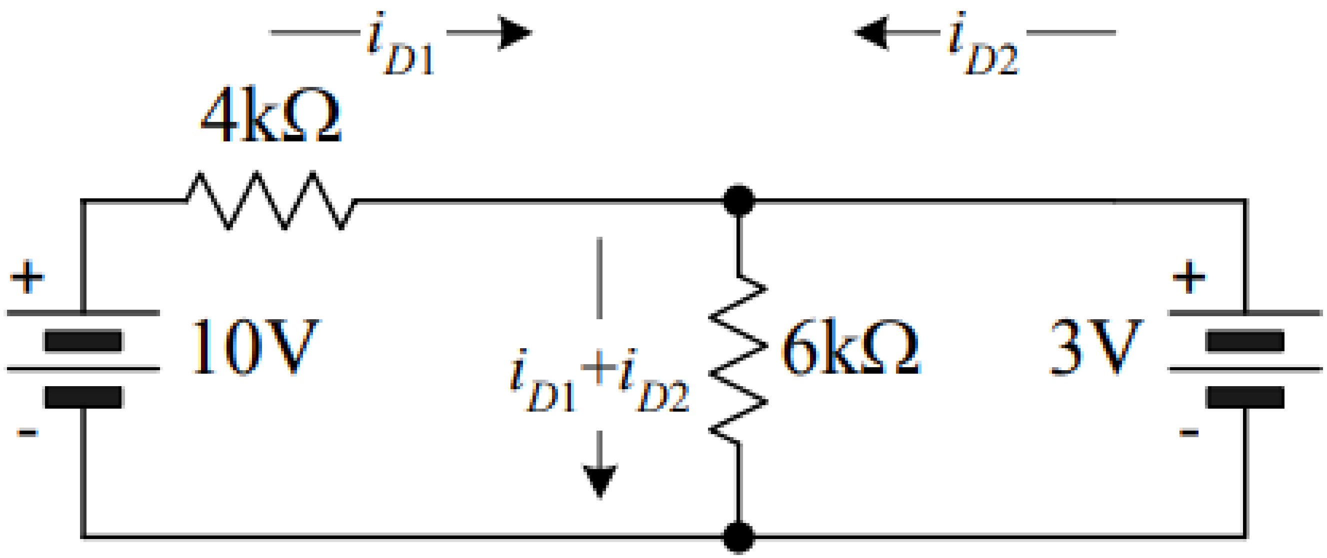
Exercise

- Explain that D1 and D2 are off is not a valid assumption



Exercise

- Show that D1 and D2 are on is not valid also



Answer

$$i_{D1} + i_{D2} = \frac{3\text{V}}{6\text{k}\Omega} = 0.5\text{mA}$$

$$i_{D1} = \frac{10\text{V} - 3\text{V}}{4\text{k}\Omega} = 1.75\text{mA}$$

$$i_{D2} = \left(i_{D1} + i_{D2}\right) - i_{D1} = 0.5 - 1.75 = -1.25\text{mA}$$

Midterm (60 mins – Closed Book)

- 29/03/2019 – From 8g30 – 303B4
- Multichoice + Written

- Chapter 1: Basic Electronic Components
  - Deterimine the resistor values (4-band colors, 5-band colors)
  - LEDs connectors (Serial + Parallel)

- Chapter 2: Diode
  - Diode Principles and Models
  - Applications using Diodes

- Chapter 3: BJT (npn)
  - Amplifier Coefficient, Applications
  - Cutoff, Saturation and Amplifier modes
  - Vbe = 0.7 (for default)