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# Introduction to Electronics

*An introduction to electronic components and a study of circuits containing such devices.*

**TECH**



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# Full-Wave Rectifiers

*Introduce diode full-wave rectifiers*

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# Previous Lesson

- Introduced diode half-wave rectifiers
- Analyzed behavior of half-wave rectifier circuit constructed with ideal and non-ideal diodes

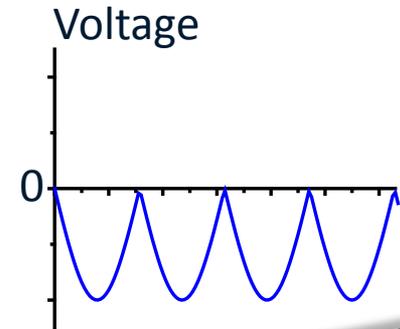
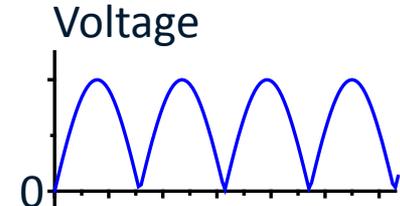
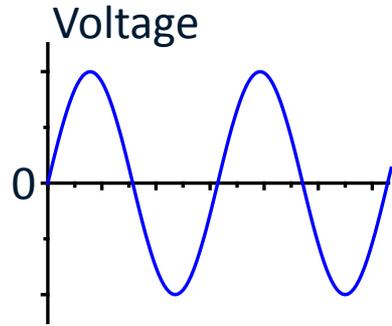
# Lesson Objectives

- Introduce full-wave rectifiers
- Examine their behavior for sinusoidal inputs
- Analyze diode full-wave rectifier circuit

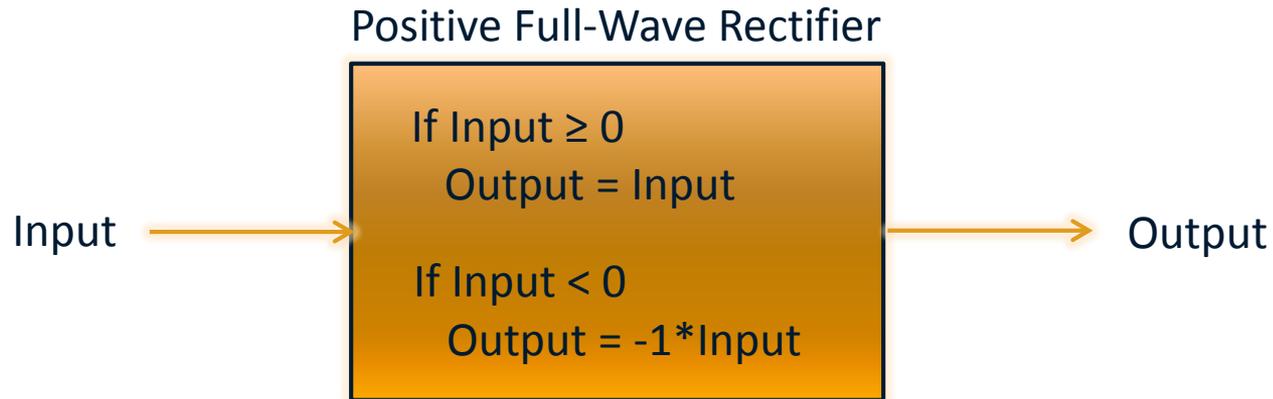
# Rectifier

- A non-linear device that modifies an input voltage such that the output voltage is greater than or less than a threshold value

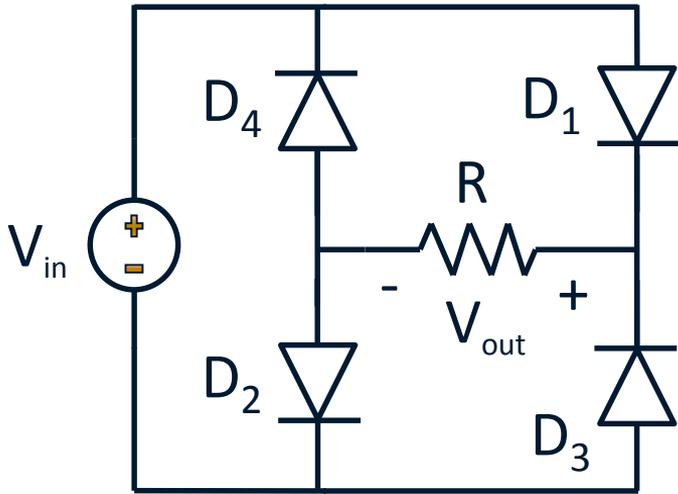
# Sinusoidal Input Voltages



# Full-Wave Rectifier



# Full-Wave Rectifier Circuit



Ideal Diodes

$V_{in}$  positive



$V_{in}$  negative



# $V_{out}$ Equation

- ⊙ A full-wave rectifier is also known as an absolute value circuit

$$V_{out} = \begin{cases} V_{in} & V_{in} \geq 0 \\ -V_{in} & V_{in} < 0 \end{cases}$$

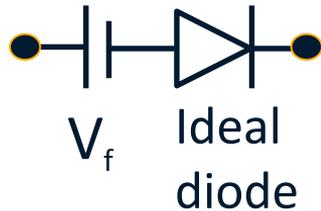
$D_1$  and  $D_2$  on  
 $D_3$  and  $D_4$  off

$D_1$  and  $D_2$  off  
 $D_3$  and  $D_4$  on

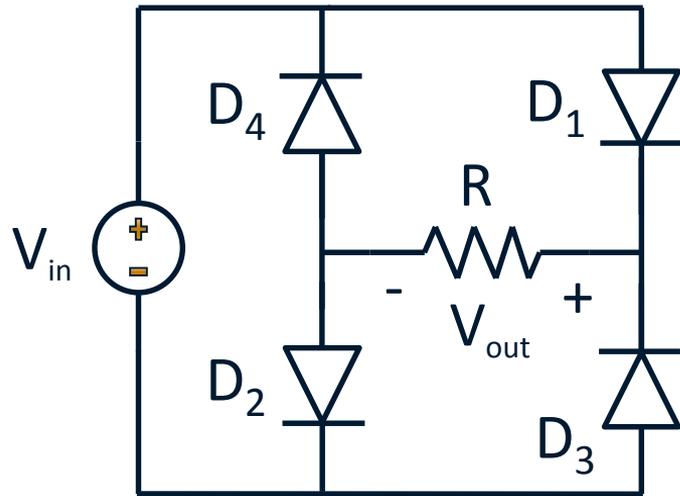
$$V_{out} = |V_{in}|$$

# Non-Ideal Diode

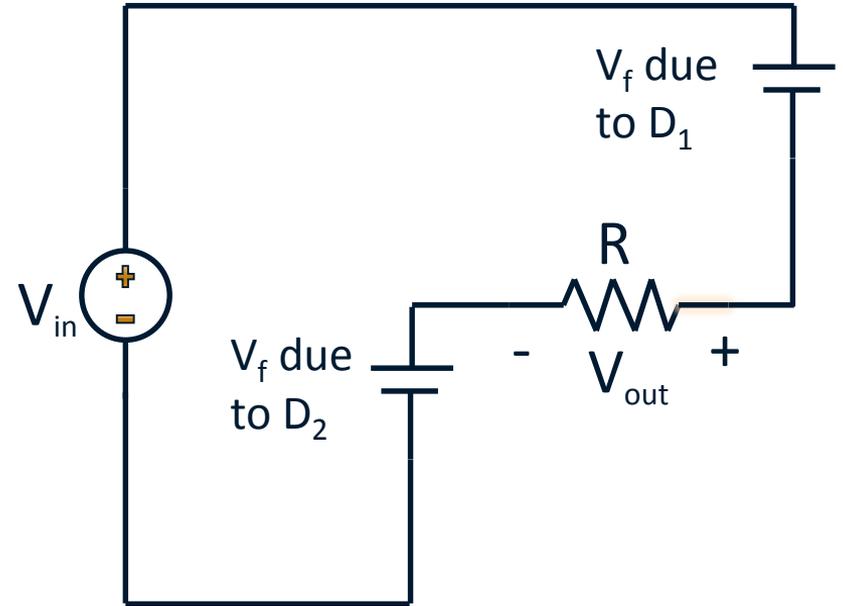
- How does a non-ideal diode change the behavior of the circuit?
- Include the forward voltage drop  $V_f$  by modeling the diode as an ideal diode in series with a voltage source



# Non-Ideal Diode Circuit



$D_1$  and  $D_2$  on  
 $D_3$  and  $D_4$  off



# Circuit for $D_1$ and $D_2$ On



$V_f$  due to  $D_2$      $V_f$  due to  $D_1$

$$V_{in} > 2V_f$$

# Circuit for $D_3$ and $D_4$ On

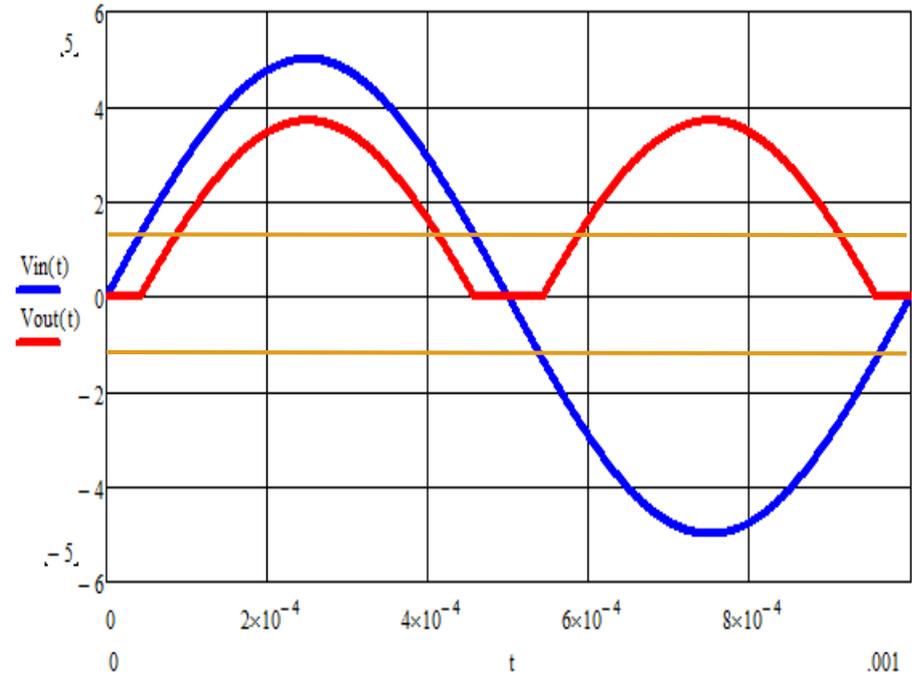


$V_f$  due to  $D_3$        $V_f$  due to  $D_4$

$$V_{in} < -2V_f$$

# $V_{out}$ Equation

$$V_{out} = \begin{cases} V_{in} - 2V_f & V_{in} > 2V_f \\ -V_{in} - 2V_f & V_{in} < -2V_f \\ 0 & \text{Otherwise} \end{cases}$$



# Other Possible Configurations

- How does the output voltage change if the directions of all diodes are reversed?
- How does the output voltage change if the direction of any one diode is reversed?

# Summary

- Full-Wave Rectifiers

# Next Lesson

- Voltage Transfer Characteristics