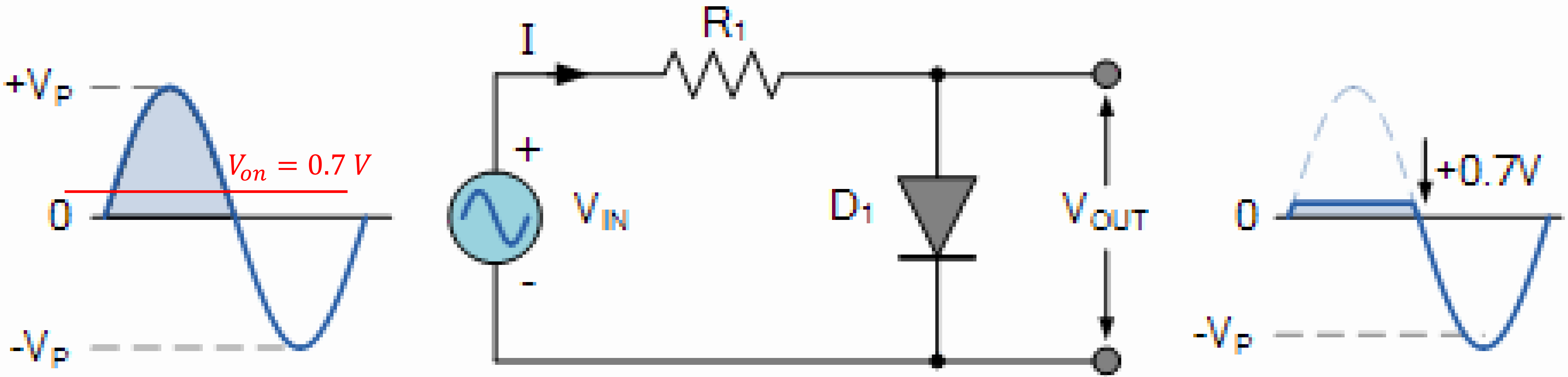
EXPLORE MORE

DIODE CLIPPING CIRCUITS for Alternating Voltage

Assume: Silicon diodes with $V_{ON} = 0.7V$

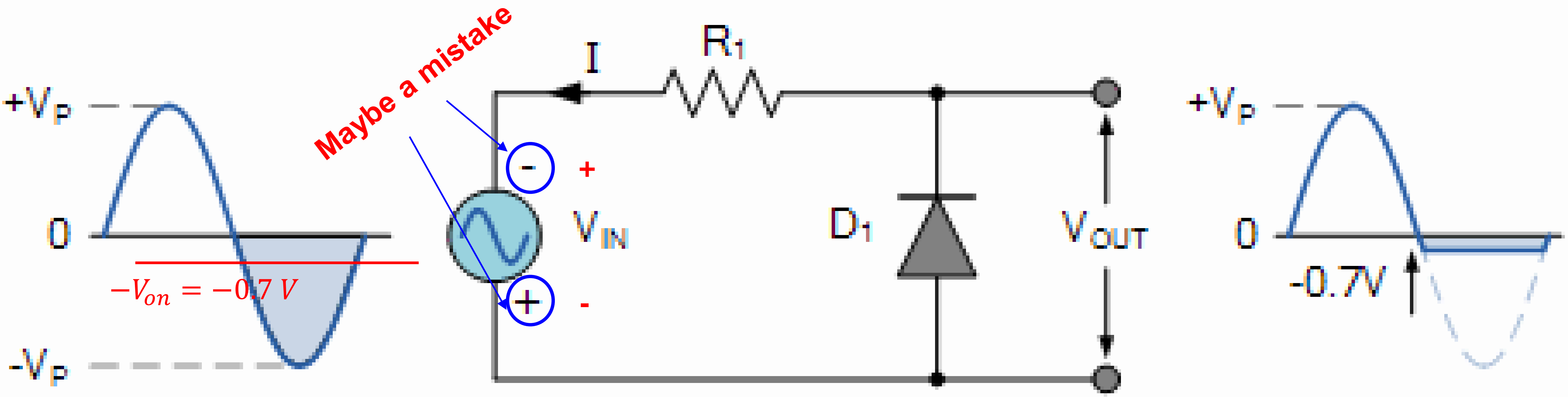
Positive Diode Clipping Circuit



Case 1: when V_{in} is larger than V_{on}, the diode is turned on, $V_{out} = 0.7$ V

Case 2: when V_{in} is smaller than V_{on}, the diode is turned off, $V_{out} = V_{in}$

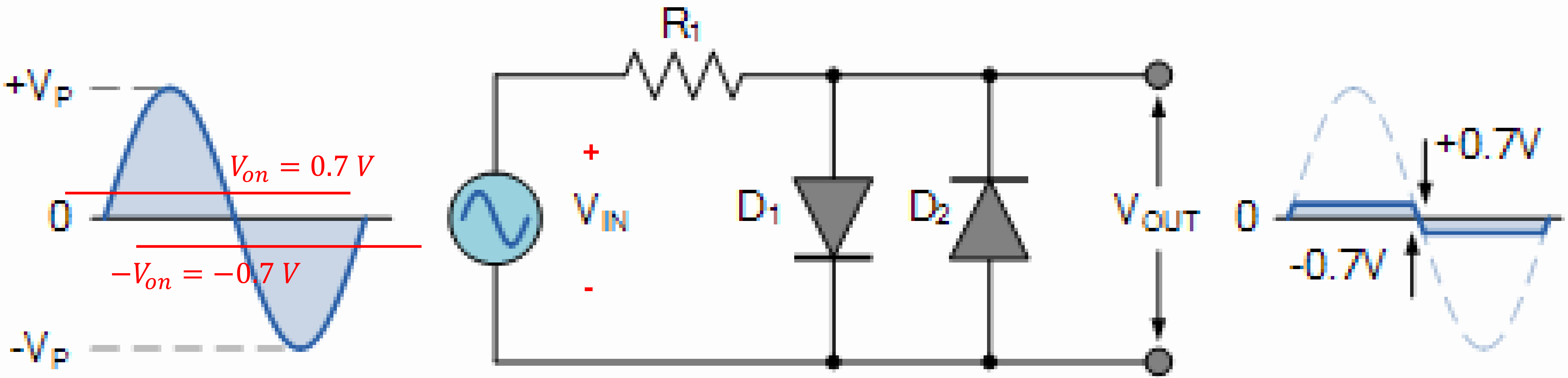
Negative Diode Clipping Circuit



Case 1: when V_{in} is larger than $-V_{on}$, the diode is turned off, $V_{out} = V_{in}$

Case 2: when V_{in} is smaller than $-V_{on}$, the diode is turned on, $V_{out} = -0.7$ V

Clipping Both Half Cycles

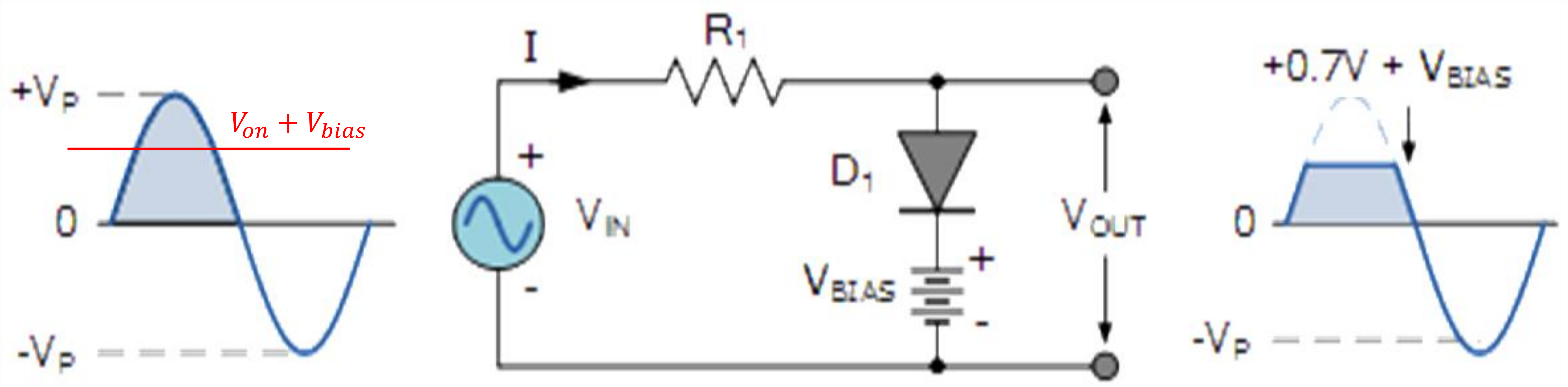


Case 1: when Vin is larger than Von, diode D1 is turned on, Vout = 0.7 V

Case 2: when Vin is smaller than -Von, diode D2 is turned on, Vout = -0.7V

Case 3: when Vin is within –Von and Von, both diodes are turned off, Vout = Vin

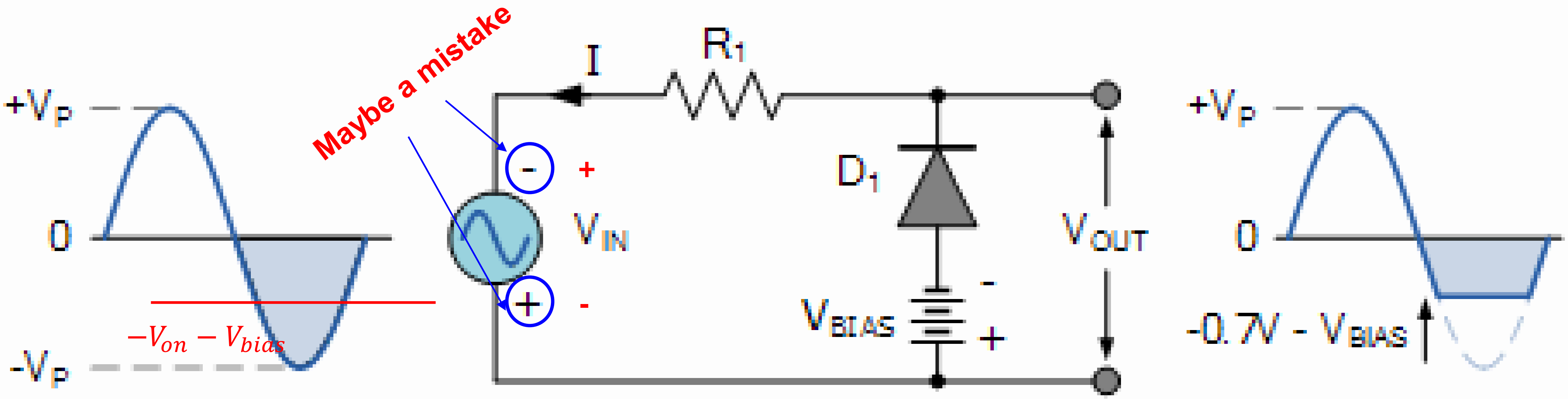
Positive Bias Diode Clipping



Case 1: When $V_{in} > V_{on} + V_{bias}$, the diode is on, so $V_{out} = V_{on} + V_{bias}$

Case 2: Otherwise, $V_{out} = V_{in}$

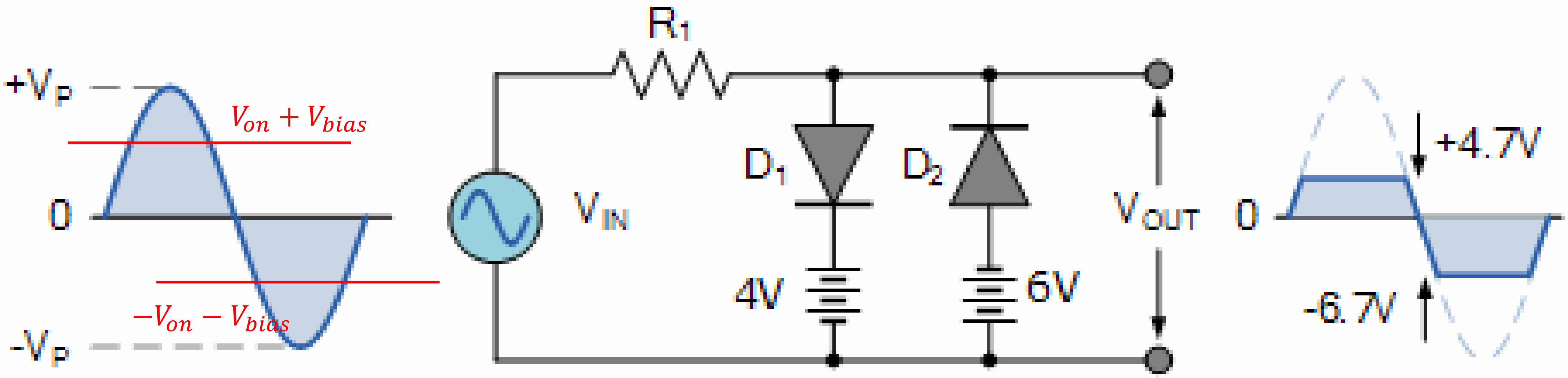
Negative Bias Diode Clipping



Case 1: When $V_{in} < -V_{on} - V_{bias}$, the diode is on, so $V_{out} = -V_{on} - V_{bias}$

Case 2: Otherwise, $V_{out} = V_{in}$

Diode Clipping – Different Bias Level

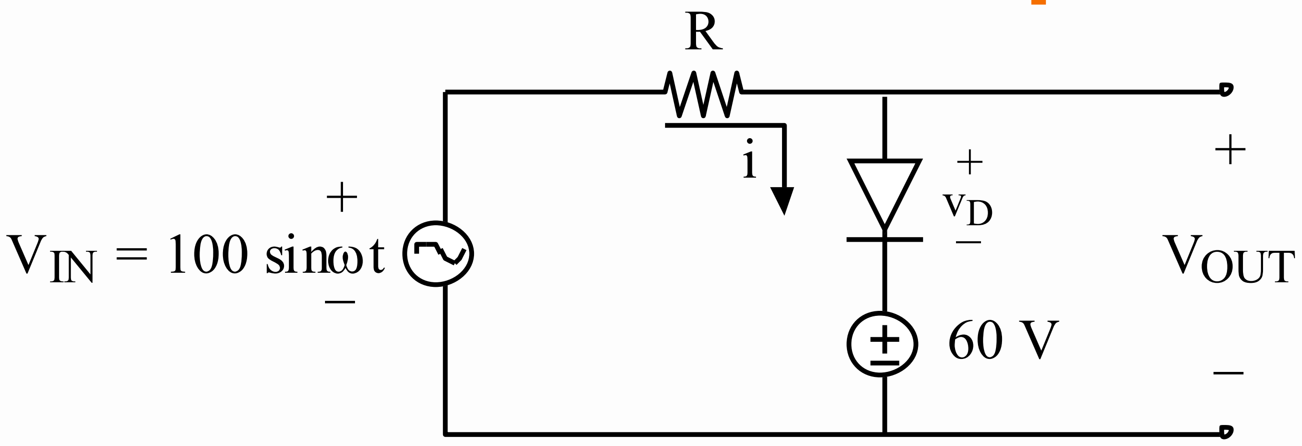


Case 1: When $V_{in} > V_{on} + 4$, diode D1 is on, so $V_{out} = V_{on} + 4$

Case 2: When $V_{in} < -V_{on} - 6$, diode D2 is on, so $V_{out} = -V_{on} - 6$

Case 3: Otherwise, $V_{out} = V_{in}$

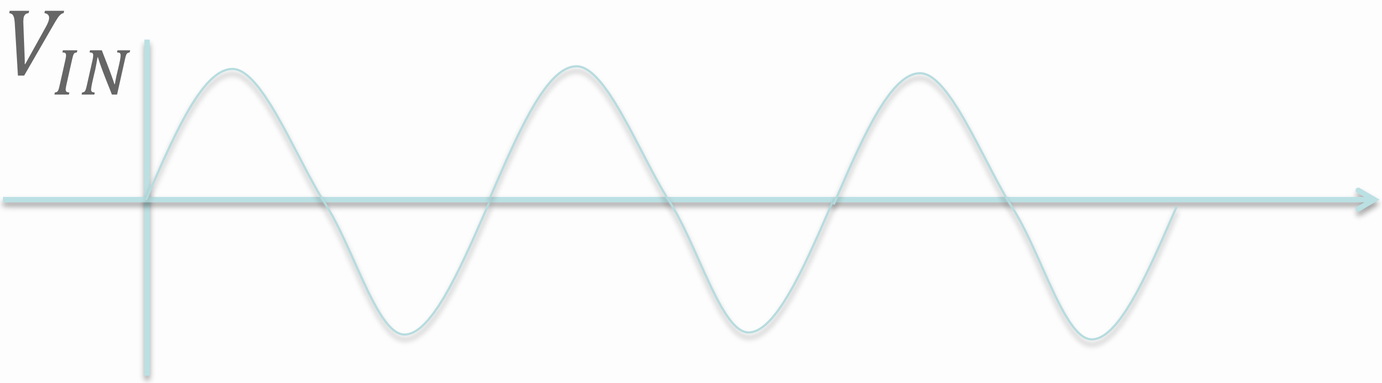
A voltage-clipping circuit sets maximum or minimum output voltage



Kirchhoff voltage law

KVL:

$V_{OUT} = 60 + v_D$



L18Q9: If the input voltage waveform is shown, what is the output waveform, assuming an ideal diode model (V_{ON} = 0 V)?

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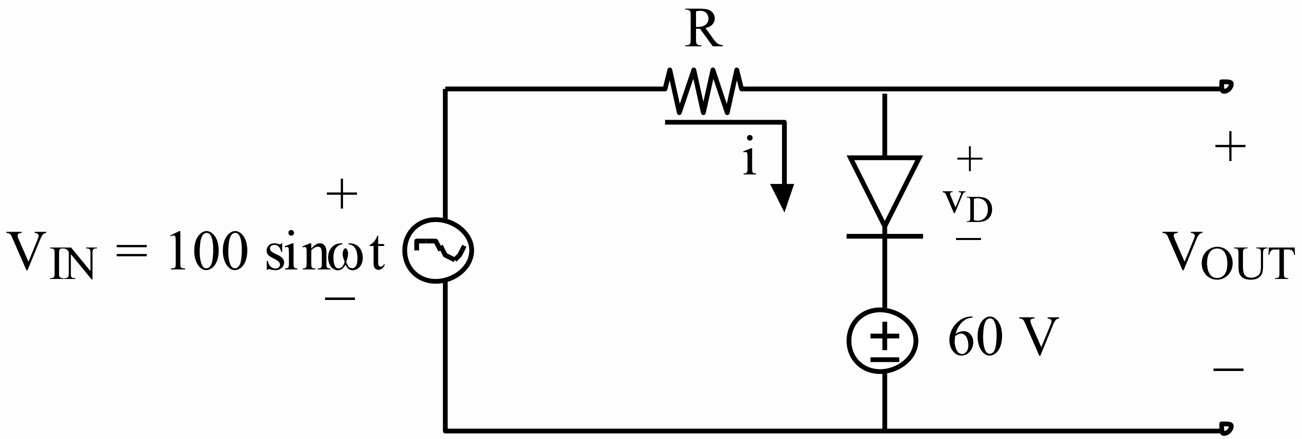
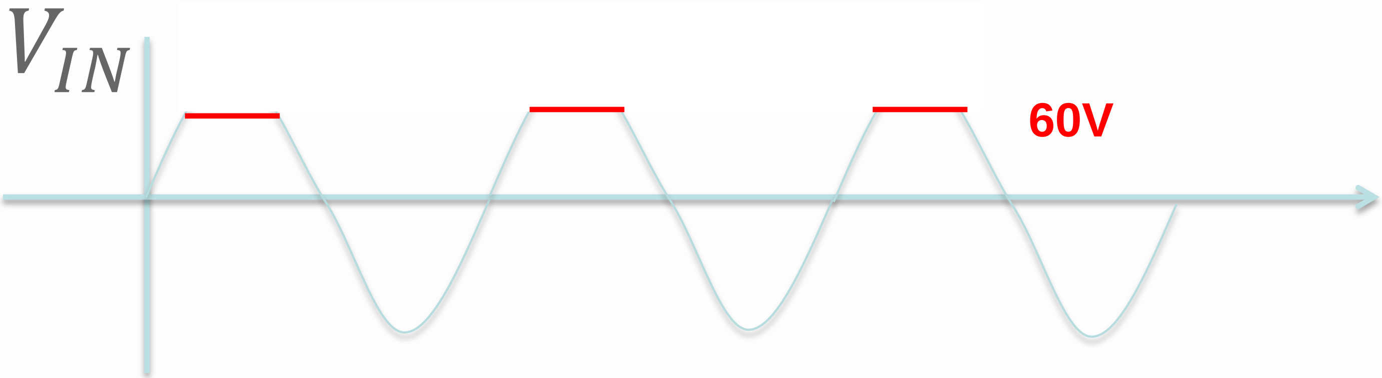


KVL:

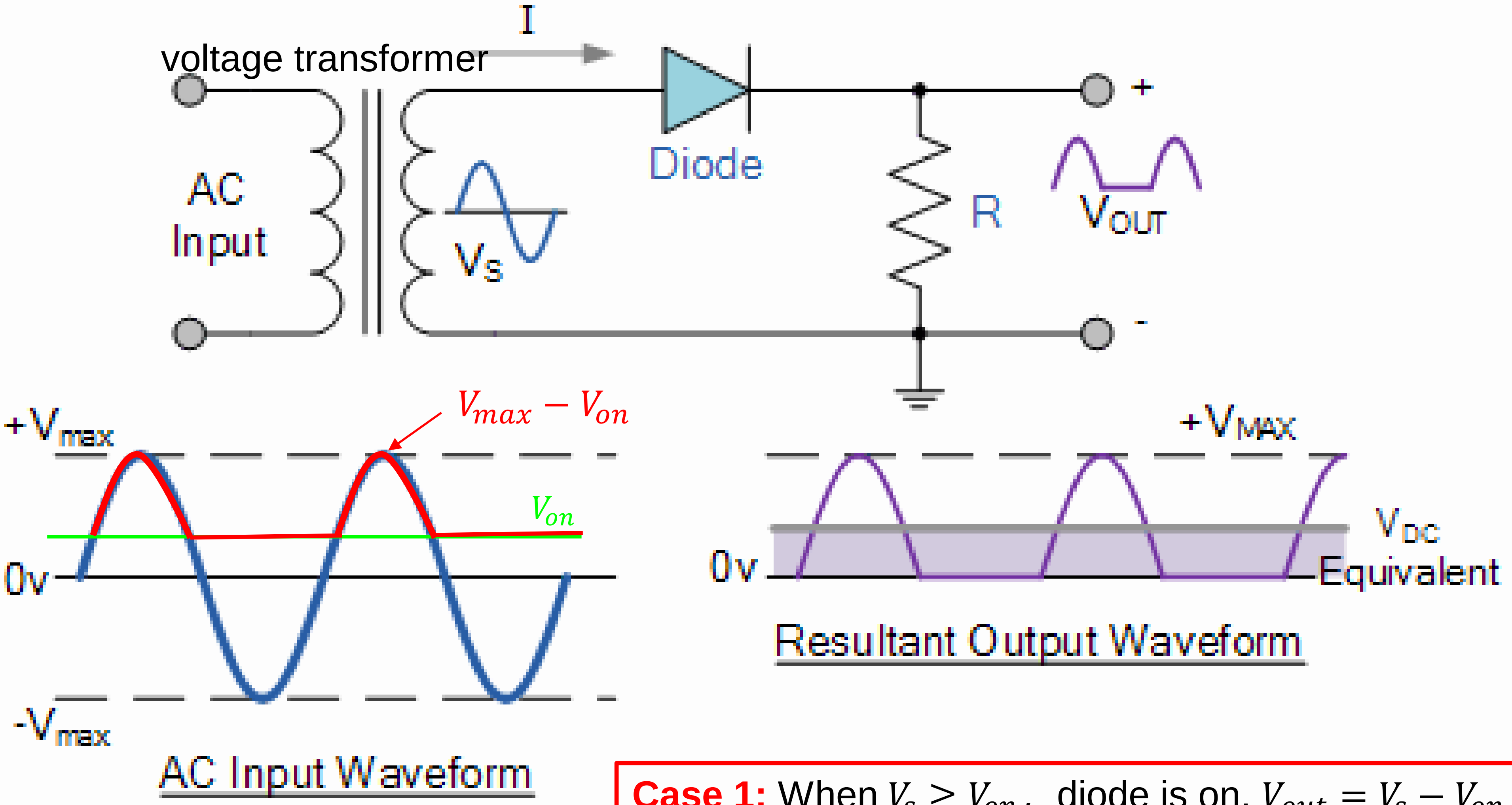
$V_{OUT} = 60 + v_D$



EXPLORE MORE

Voltage Rectification with diode circuits

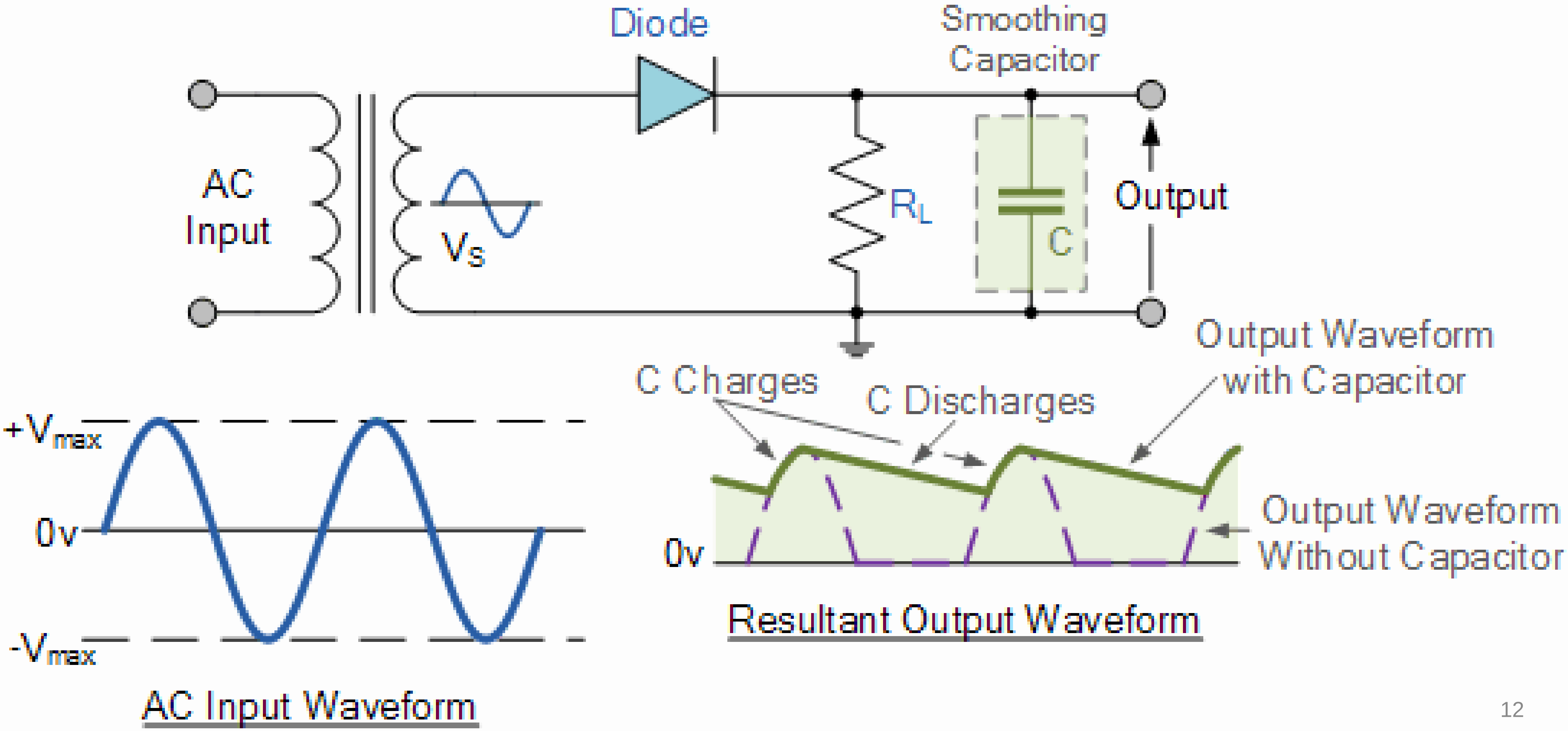
Half-Wave Rectifier Circuit



Case 1: When $V_s \geq V_{on}$, diode is on, $V_{out} = V_s - V_{on}$

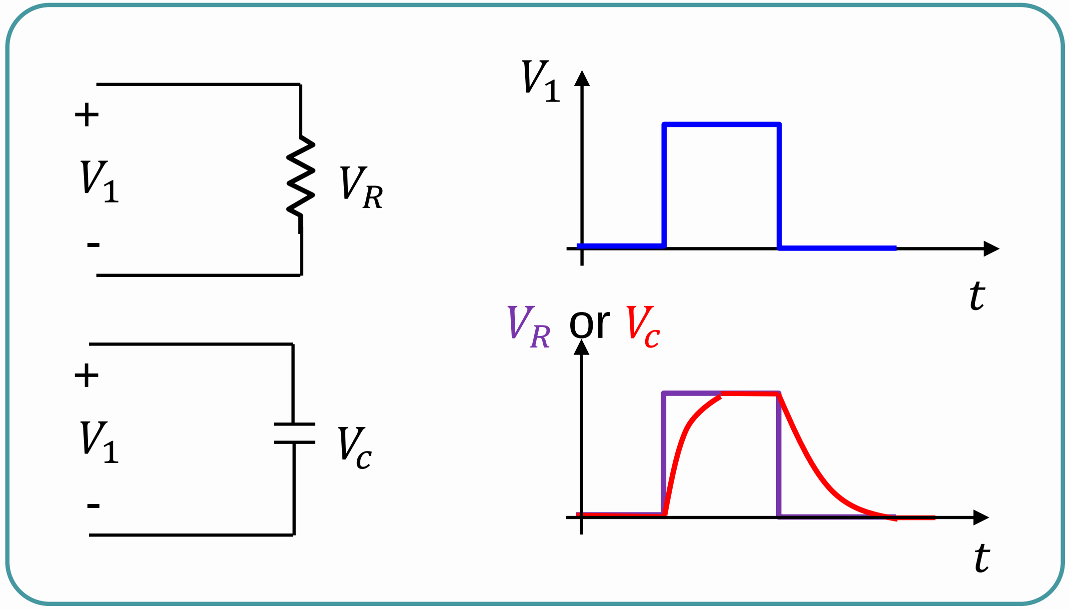
Case 2: When $V_s < V_{on}$, diode is off, $I = 0, V_{out} = I \times R = 0$

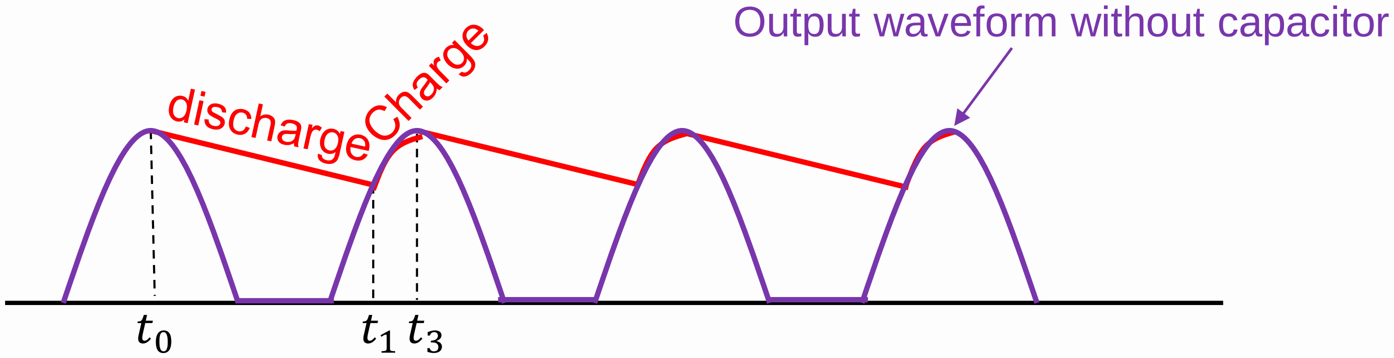
Half-Wave Rectifier-Smoothing Capacitor

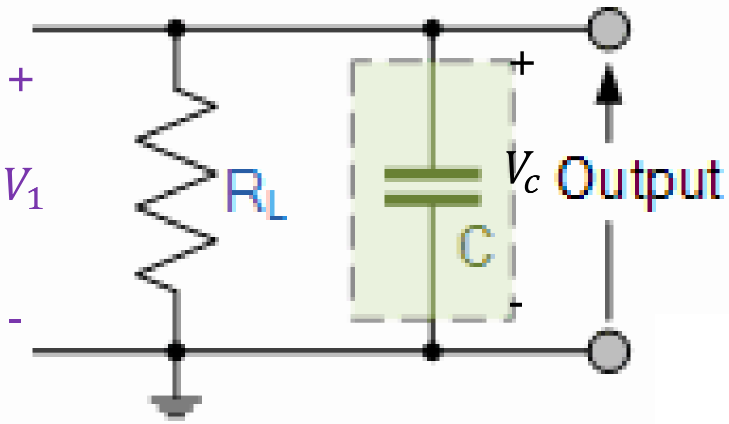


Supplementary Note for capacitor

Capacitor is different from resistor. Modifying the well-established state needs some time delay







1. At $t = t_0$, $V_1 = V_c$, the circuit reaches a balance

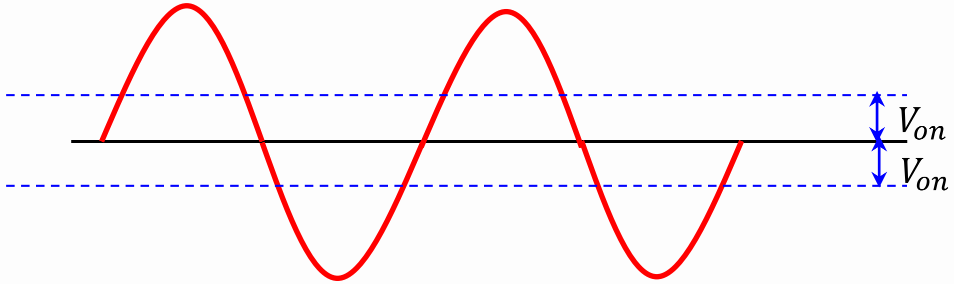
2. After $t = t_0$, $V_1 < V_c$, so the capacitor discharges, This discharge needs some time delay.

3. At $t = t_1$, $V_1 = V_c$, the circuit reaches a balance

4. After $t = t_1$, $V_1 > V_c$, so the capacitor charges (actually also needs time delay, here UIUC ignores)

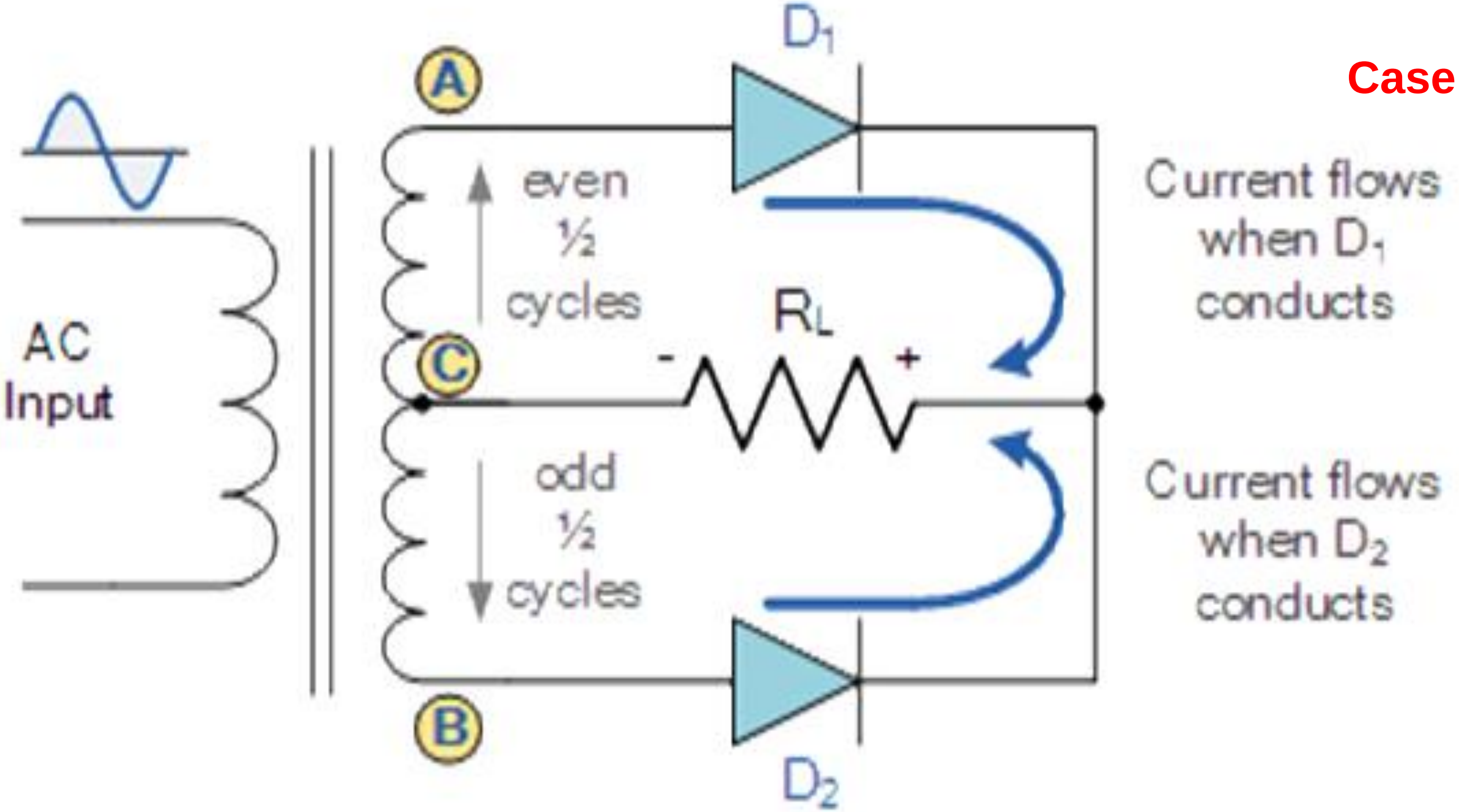
Full-Wave Rectifier Circuit

Case 1: when $V_s \geq V_{on}$, D1 is on, $V_{out} = V_s - V_{on}$

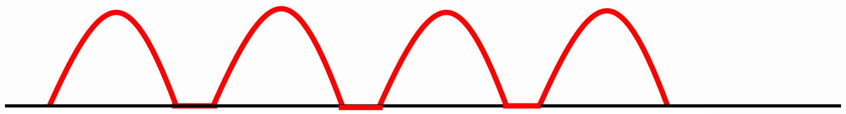


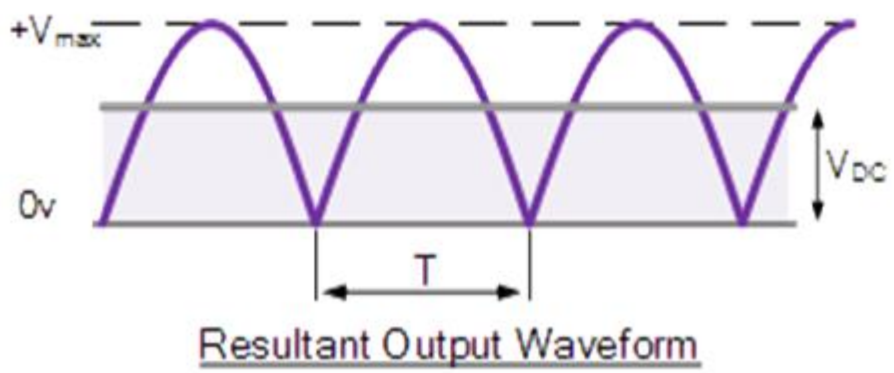
Case 2: when $V_s \leq -V_{on}$, D2 is on, $V_{out} = |V_s| - V_{on}$

Case 3: otherwise, D1&D2 are off, $V_{out} = 0$

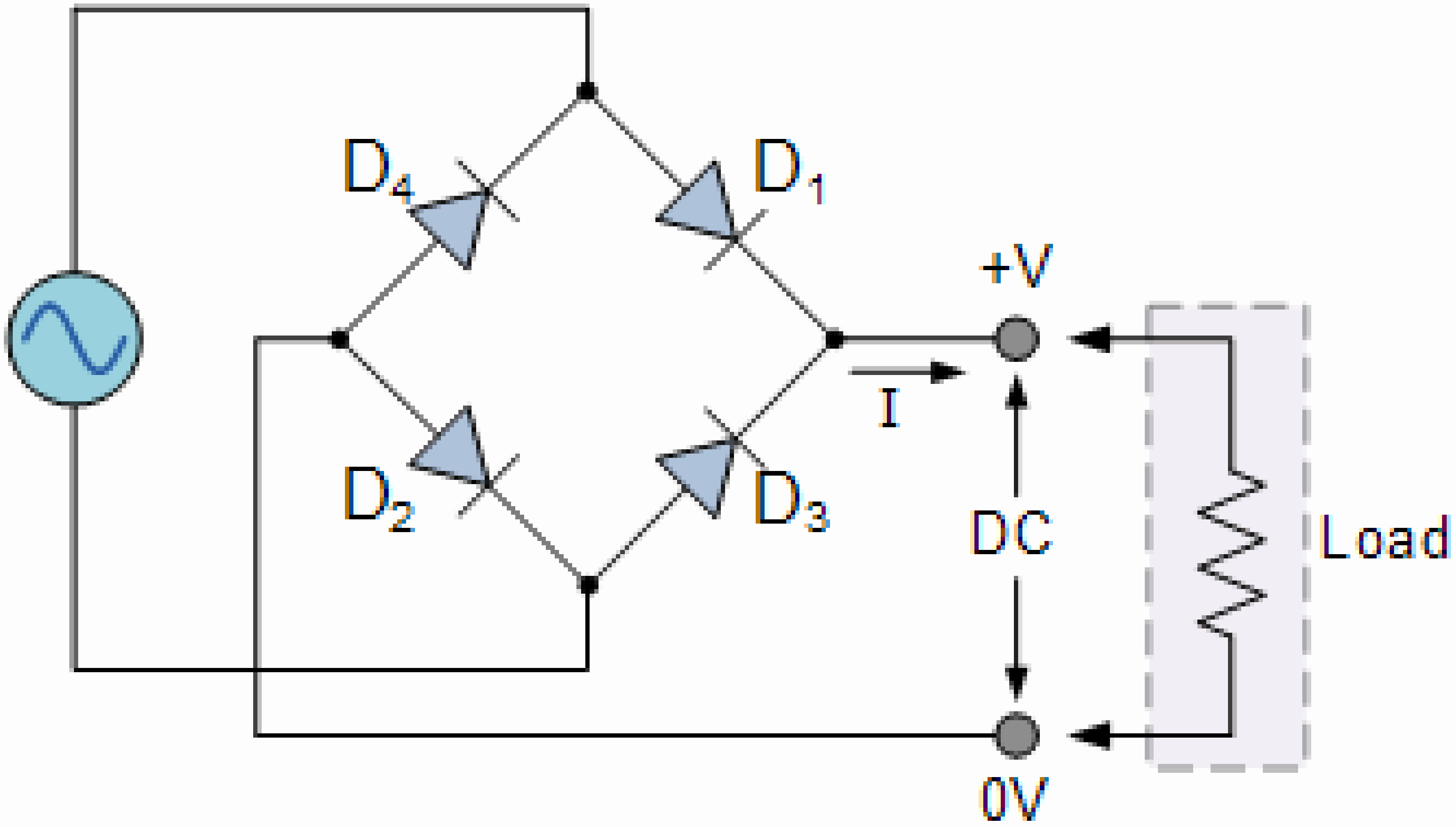


Output voltage

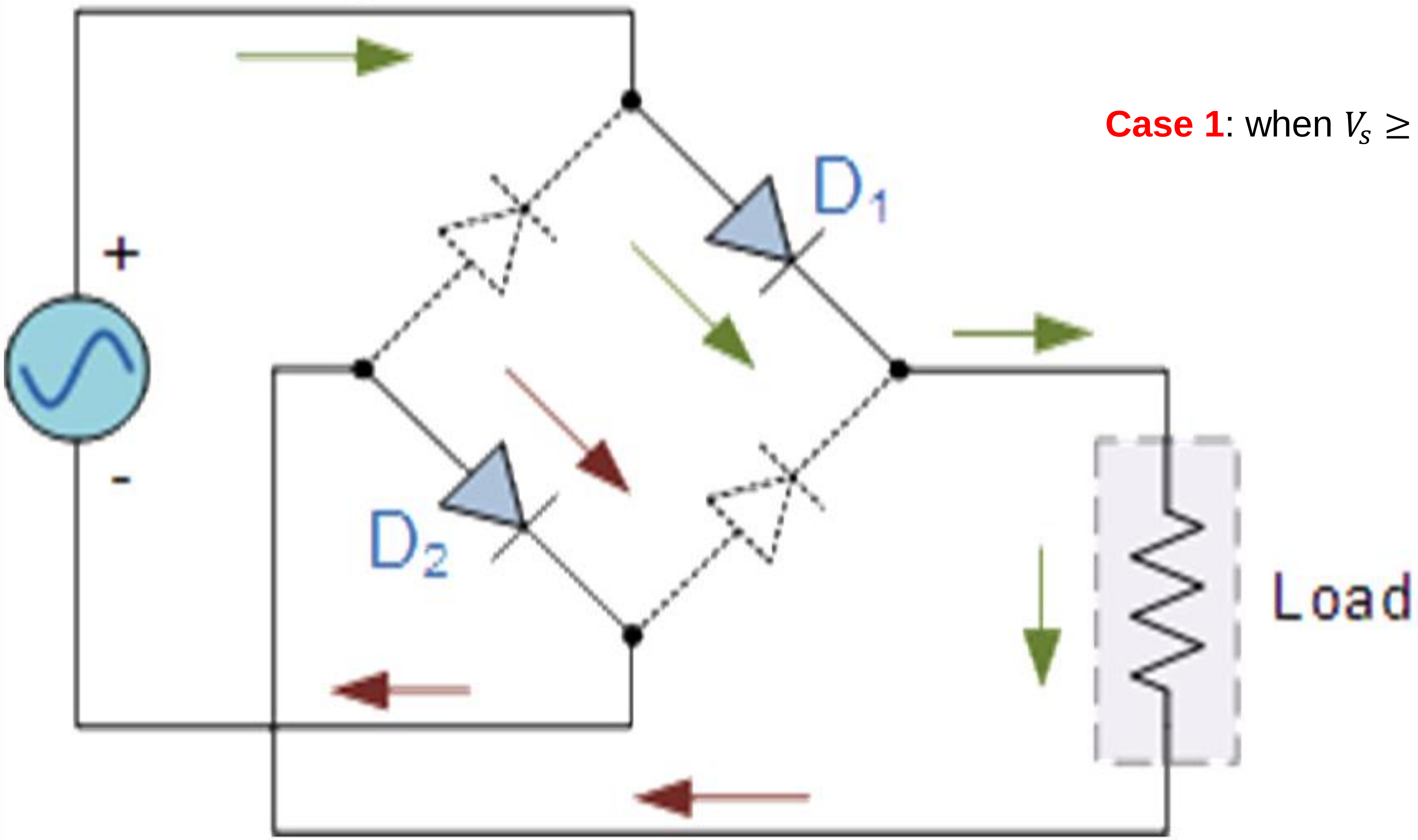




Full-Wave Diode Bridge Rectifier

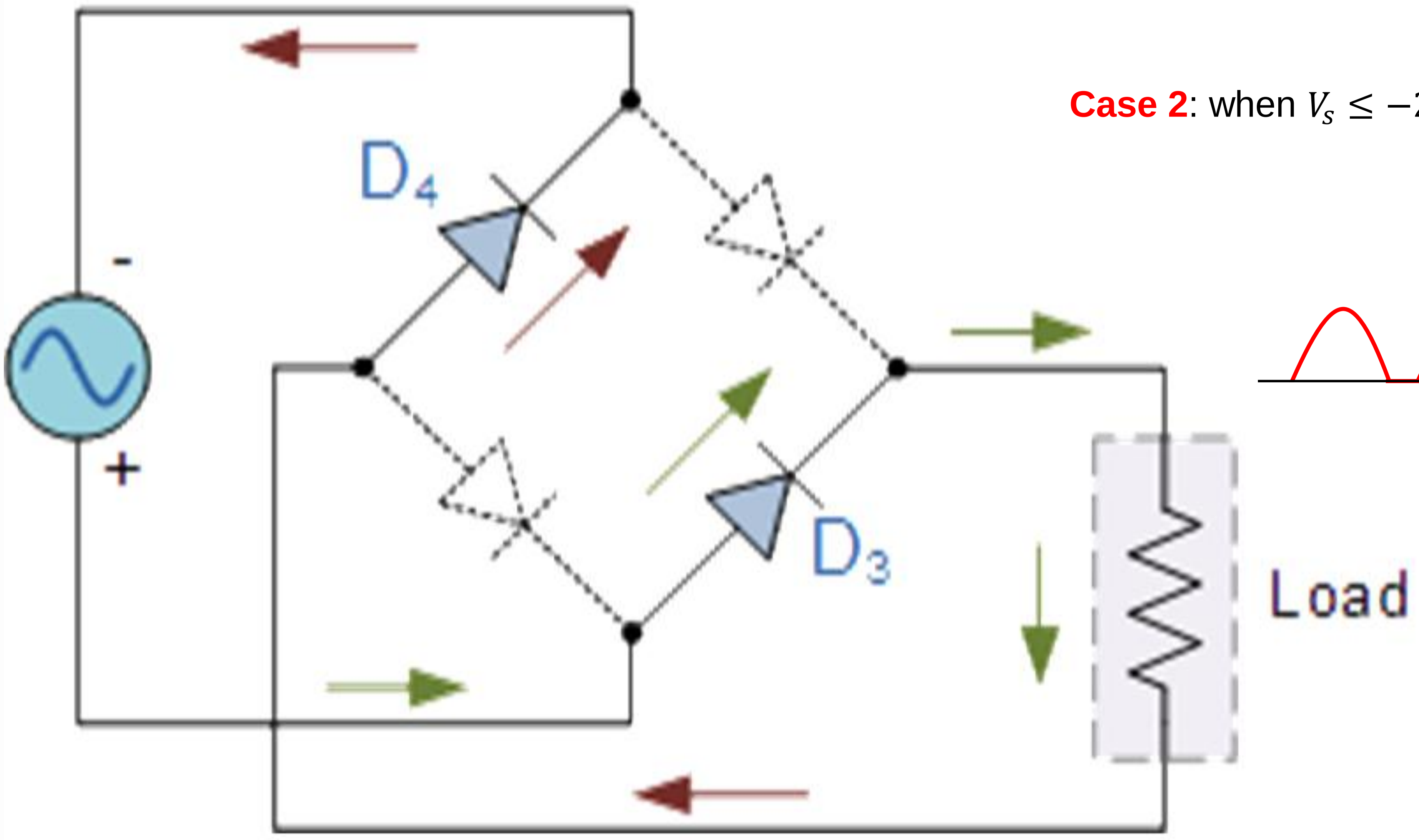


Diode Bridge – Positive Half-cycle



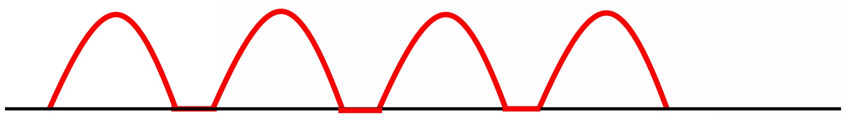
Case 1: when $V_s \geq 2 \times V_{on}$, $V_{out} = V_s - 2 \times V_{on}$

Diode Bridge – Negative Half-cycle

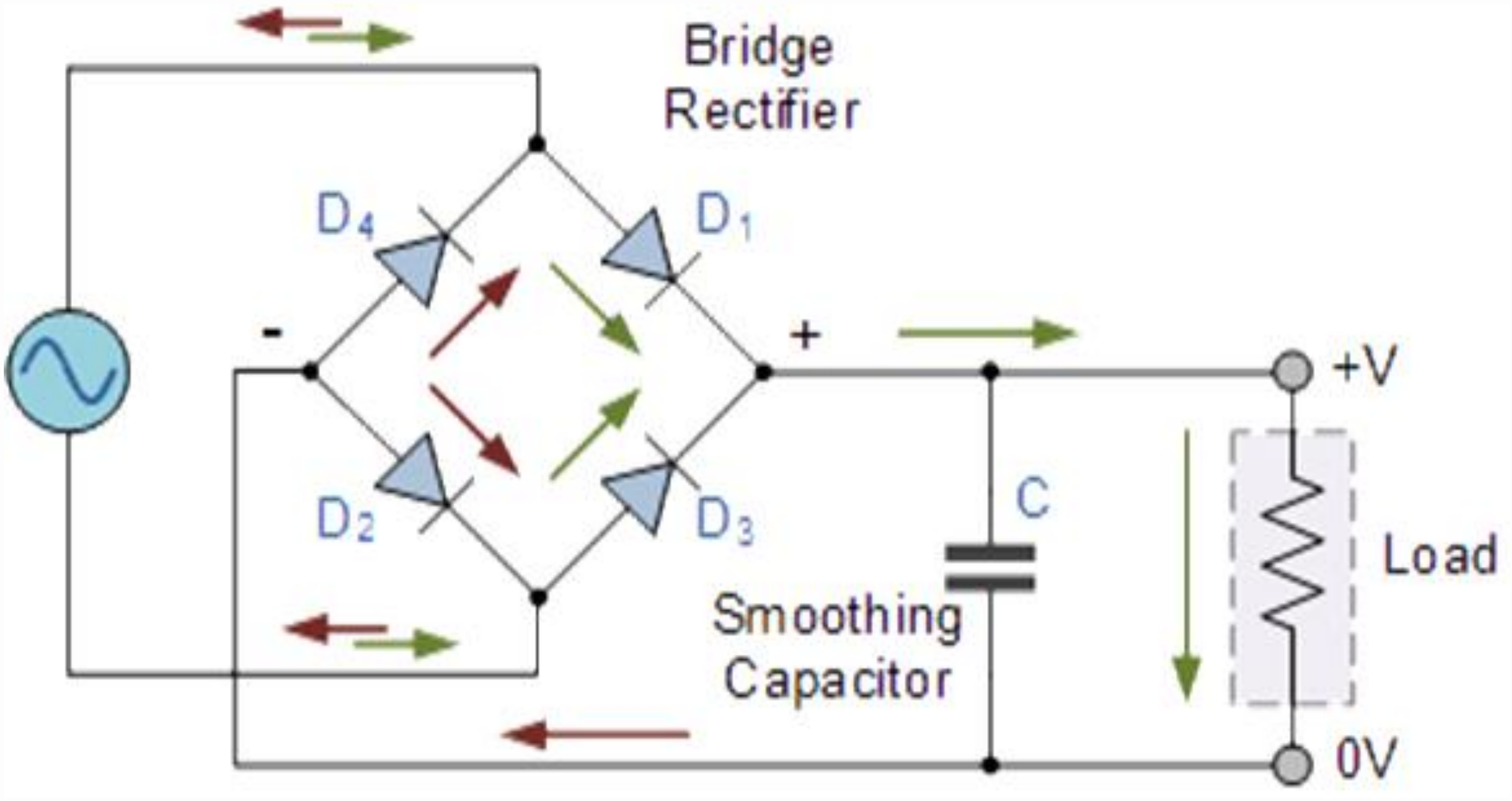


Case 2: when $V_s \leq -2 \times V_{on}$, $V_{out} = |V_s| - 2 \times V_{on}$

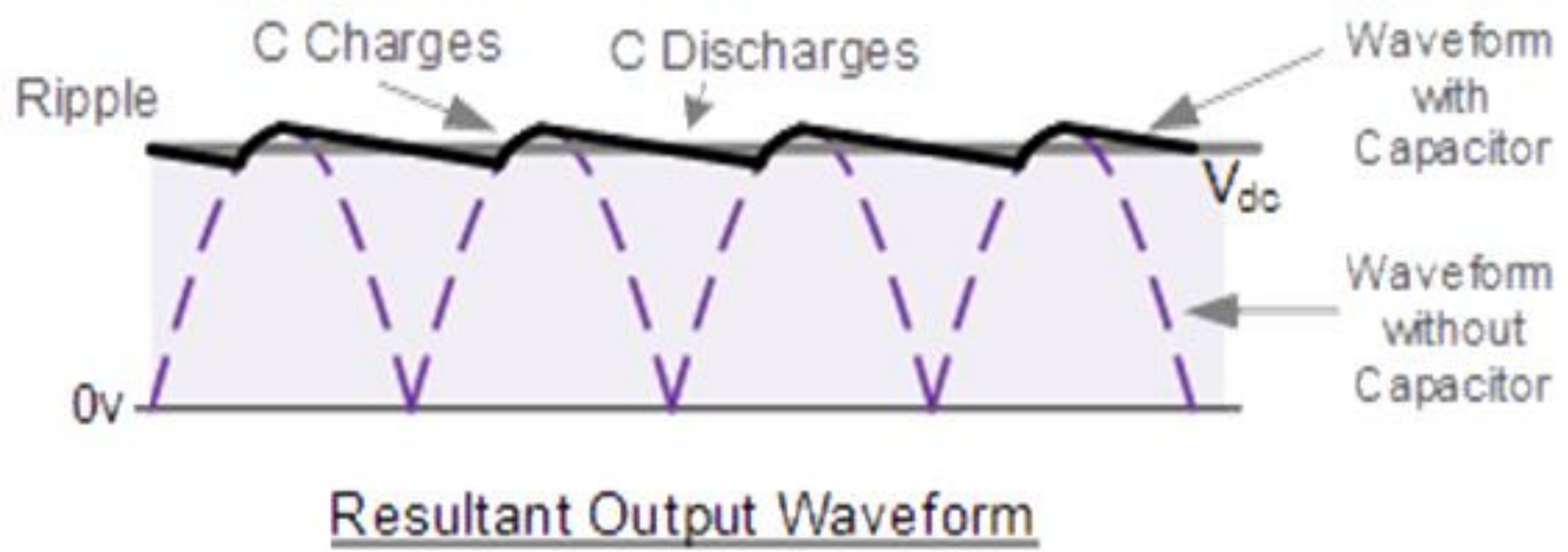
Output voltage



Diode Bridge with Smoothing Capacitor

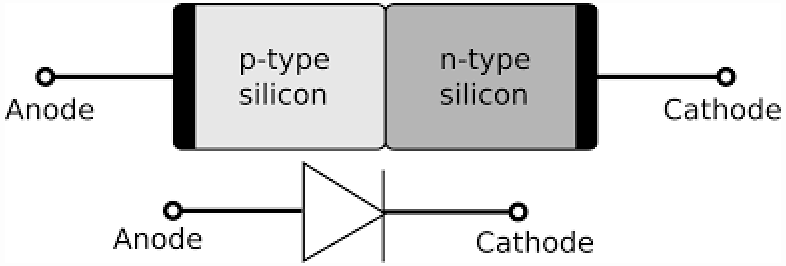


Waveform


C Charges
C Discharges
Ripple
Waveform with Capacitor
V_{dc}
Waveform without Capacitor
0v
Resultant Output Waveform

EXPLORE MORE

Physical considerations on semiconductor diodes



L18 Learning Objectives

a. Solve circuit analysis problems involving sources, resistances, and diodes
b. Estimate power dissipation in diode circuits
c. Select appropriate current-limiting resistors
d. Determine voltage limits and waveforms at outputs of diode voltage-clipping circuits

Lecture 19: Exercises, Start Lecture 20!

- We will use this lecture to catch up, if needed
- We will do multiple exercises
- Slides may be distributed in lecture