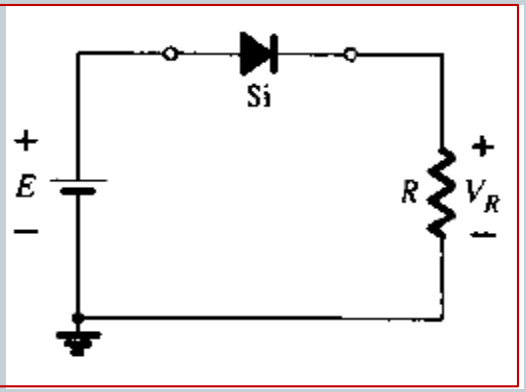
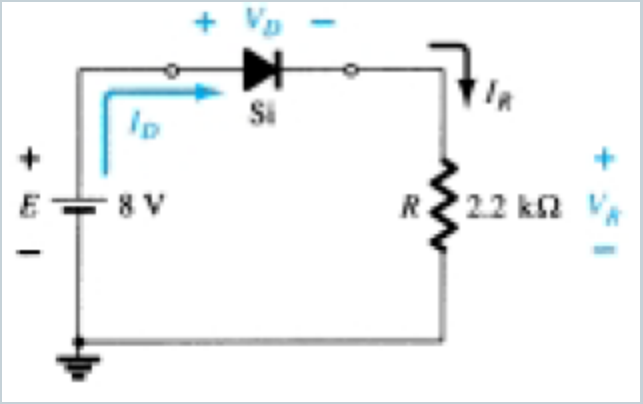
Diode Application

EEE 1221
ELECTRONICS

Series Diode Configuration with DC Inputs

$$V_D = V_T$$
$$V_R = E - V_T$$
$$V_R = I_D R = I_R R$$



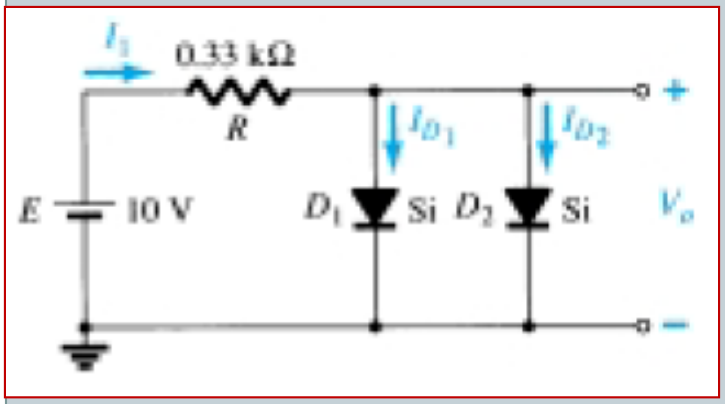


$$V_D = \mathbf{0.7\ V}$$

$$V_R = E - V_D = 8\ \text{V} - 0.7\ \text{V} = \mathbf{7.3\ V}$$

$$I_D = I_R = \frac{V_R}{R} = \frac{7.3\ \text{V}}{2.2\ \text{k}\Omega} \cong \mathbf{3.32\ mA}$$

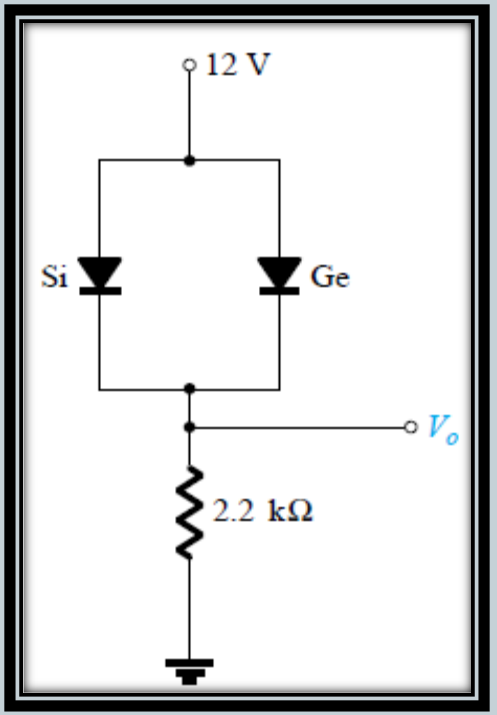
Parallel Diode Configuration with DC Inputs



$$I_1 = \frac{V_R}{R} = \frac{E - V_D}{R} = \frac{10\text{ V} - 0.7\text{ V}}{0.33\text{ k}\Omega} = \mathbf{28.18\text{ mA}}$$

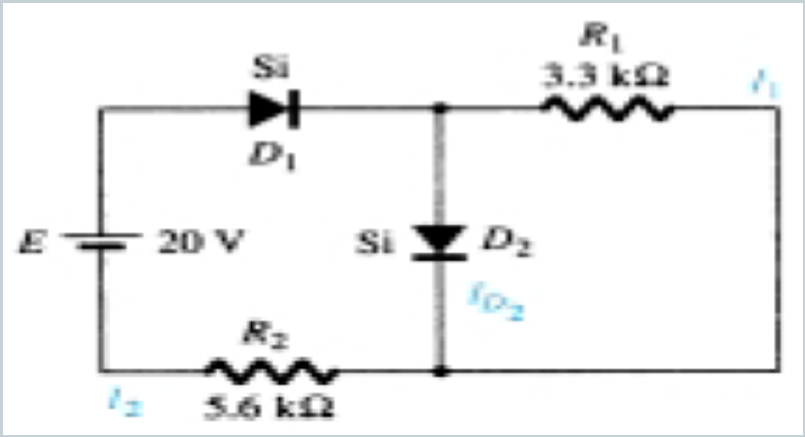
$$I_{D_1} = I_{D_2} = \frac{I_1}{2} = \frac{28.18\text{ mA}}{2} = \mathbf{14.09\text{ mA}}$$

Which Diode will turn on?



Series- Parallel Configuration

Find the Value of currents……



RECTIFIER

- An electronic device which converts the ac input voltage to a pulsating dc voltage.

Two types

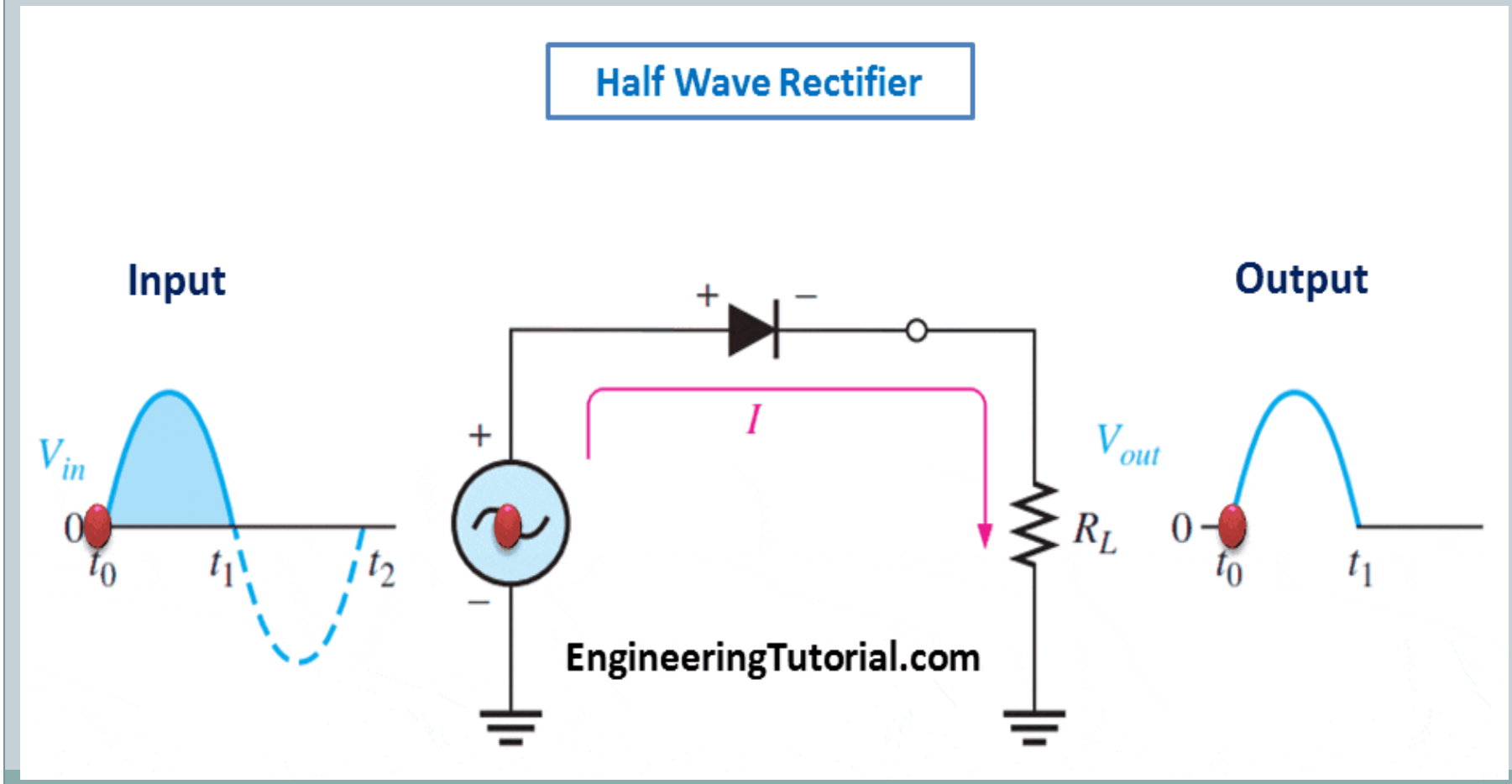
- Half wave rectifier
- Full wave rectifier

HALF WAVE RECTIFIER

- The process of removing one-half the input signal to establish a dc level is called *half-wave rectification*.
- During the positive half cycles diode turns into “on” state because of forward bias and conduct currents.
- During the negative half cycles diode turns into “off” state because of reverse bias so no current flows in that cycles.

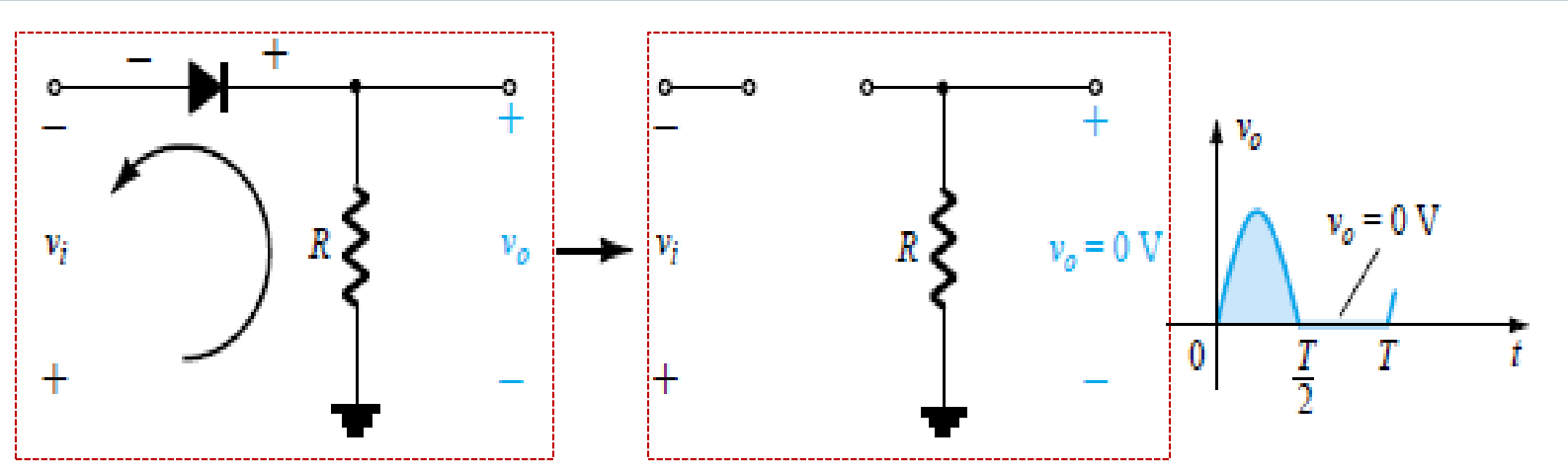
HALF WAVE RECTIFIER

❖ Positive half cycle



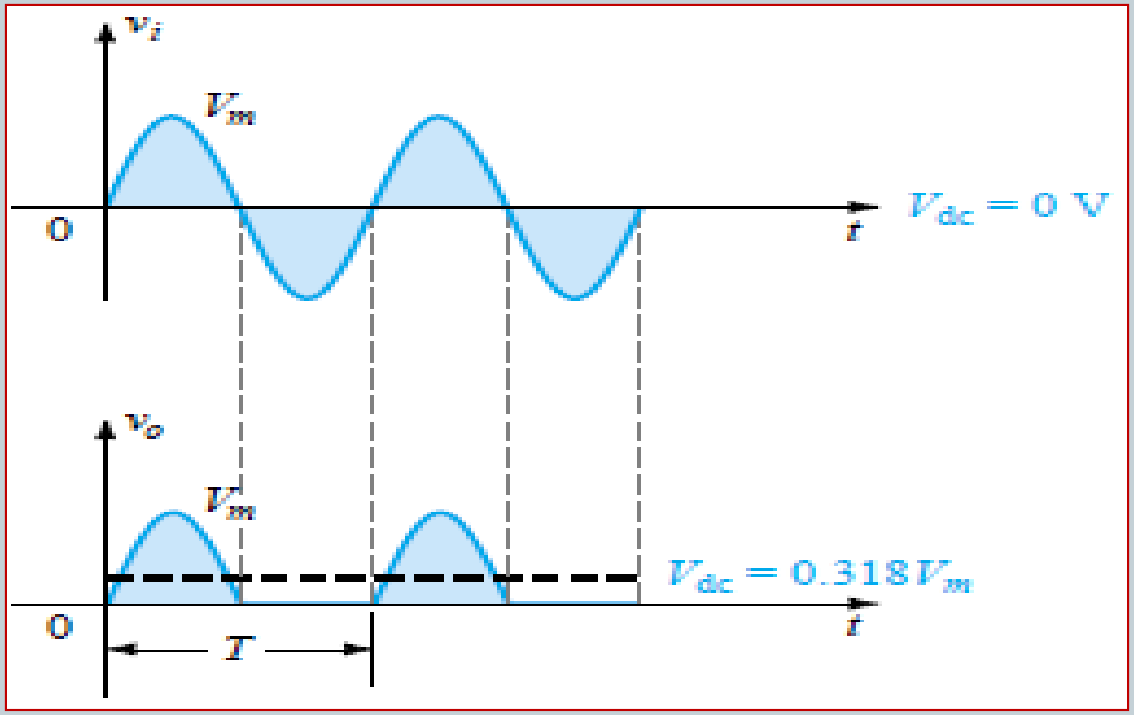
HALF WAVE RECTIFIER

- **Negative half cycle**



HALF WAVE RECTIFIER

❑ Input Output Waveform:

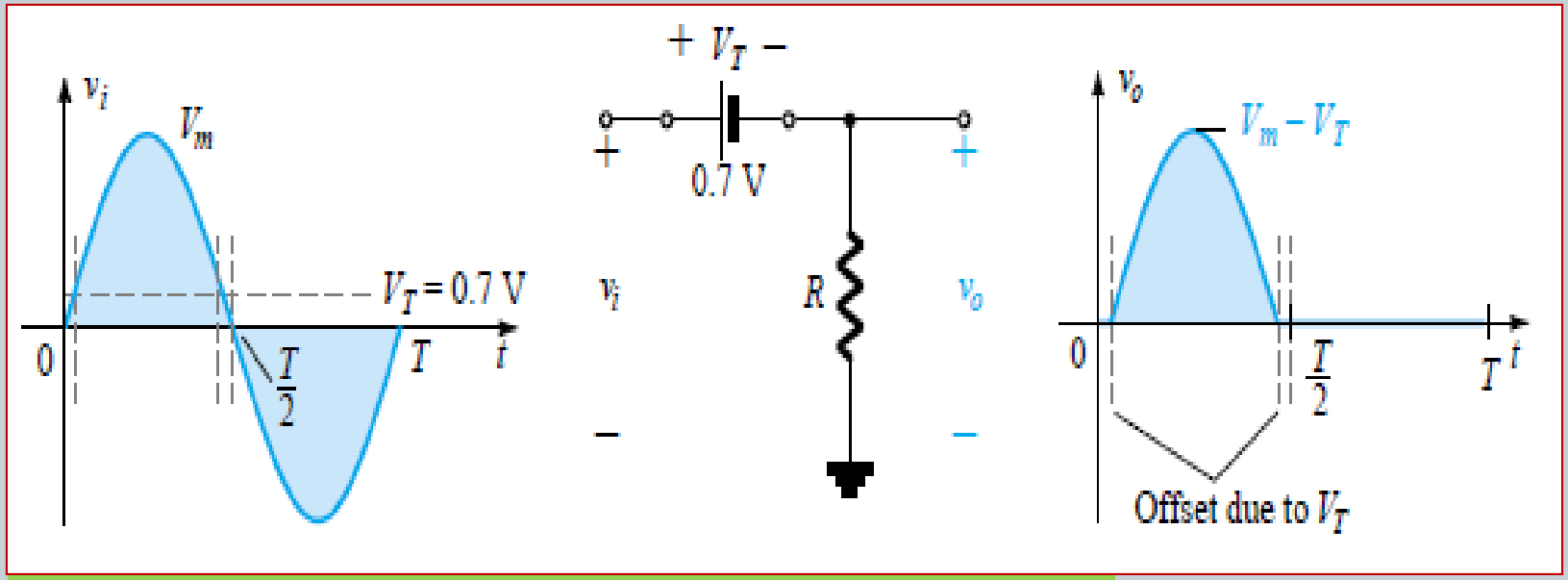


$V_o = V_{in} = V_m$

$V_{avg} = V_{dc} = .318V_m$

HALF WAVE RECTIFIER

- **Effect of Barrier Potential:**



$$V_{avg} = V_{dc} = 0.318\,(V_m - V_T)$$

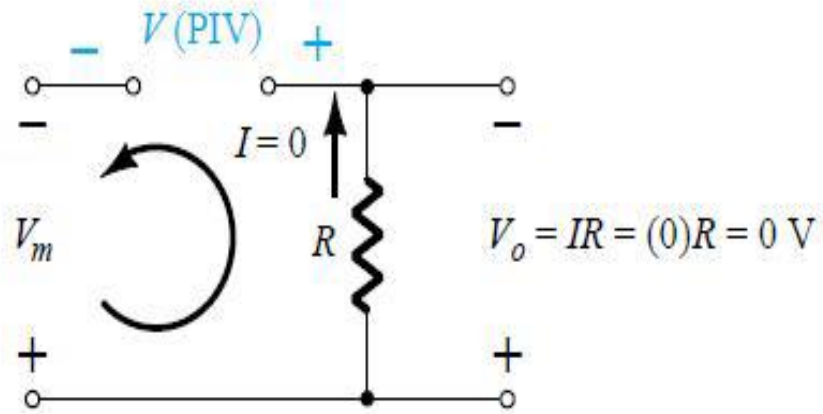
HALF WAVE RECTIFIER

- **Peak Inverse Voltage**

Applying Kirchhoff's voltage law

$$V_m = V(PIV) + V_o$$

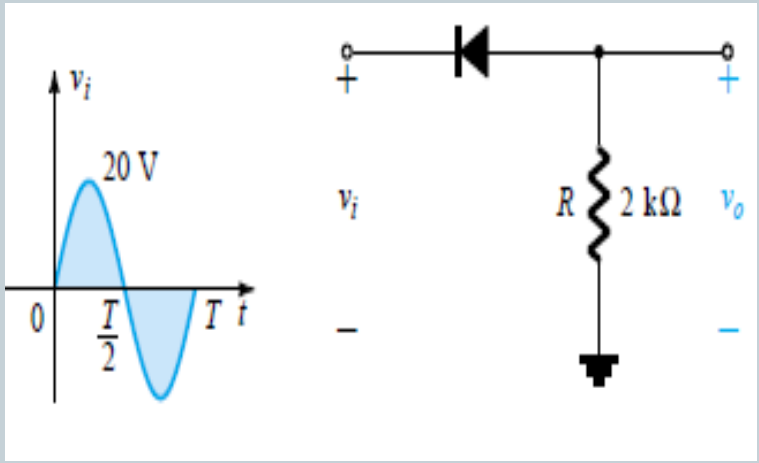
or, $$V_m - Vo = V(PIV)$$



PIV rating $\geqq V_m$ half-wave rectifier

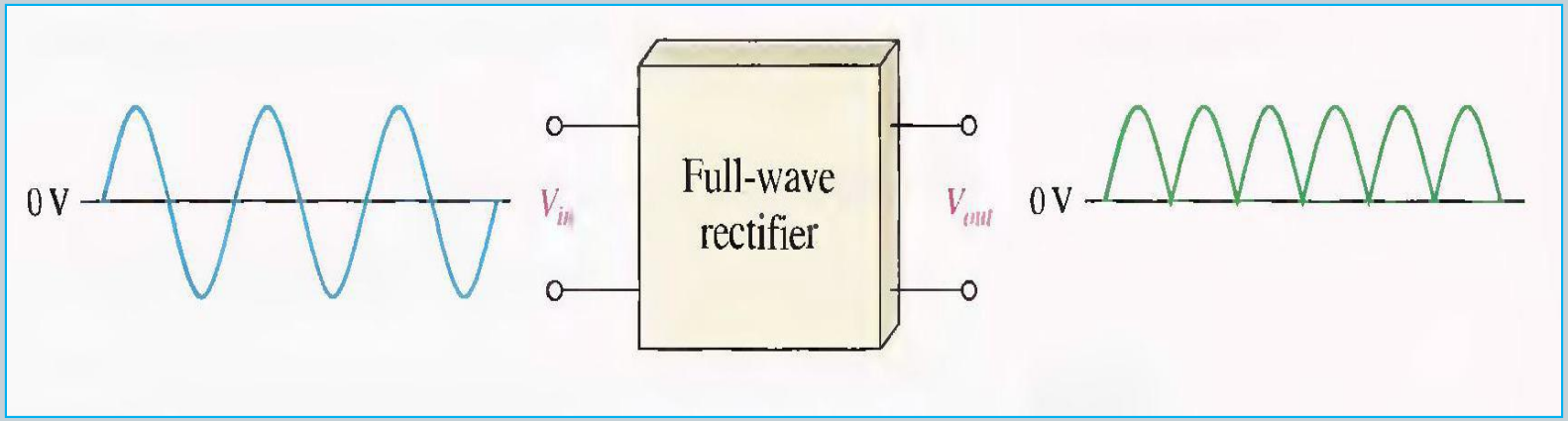
Math Problem

- (a) Sketch the output V_o and determine the dc level of the output for the network in Fig.
- (b) Repeat part (a) if the ideal diode is replaced by a silicon diode.
- (c) Repeat parts (a) and (b) if V_m is increased to 200 V and compare solutions.



FULL WAVE RACTIFIER

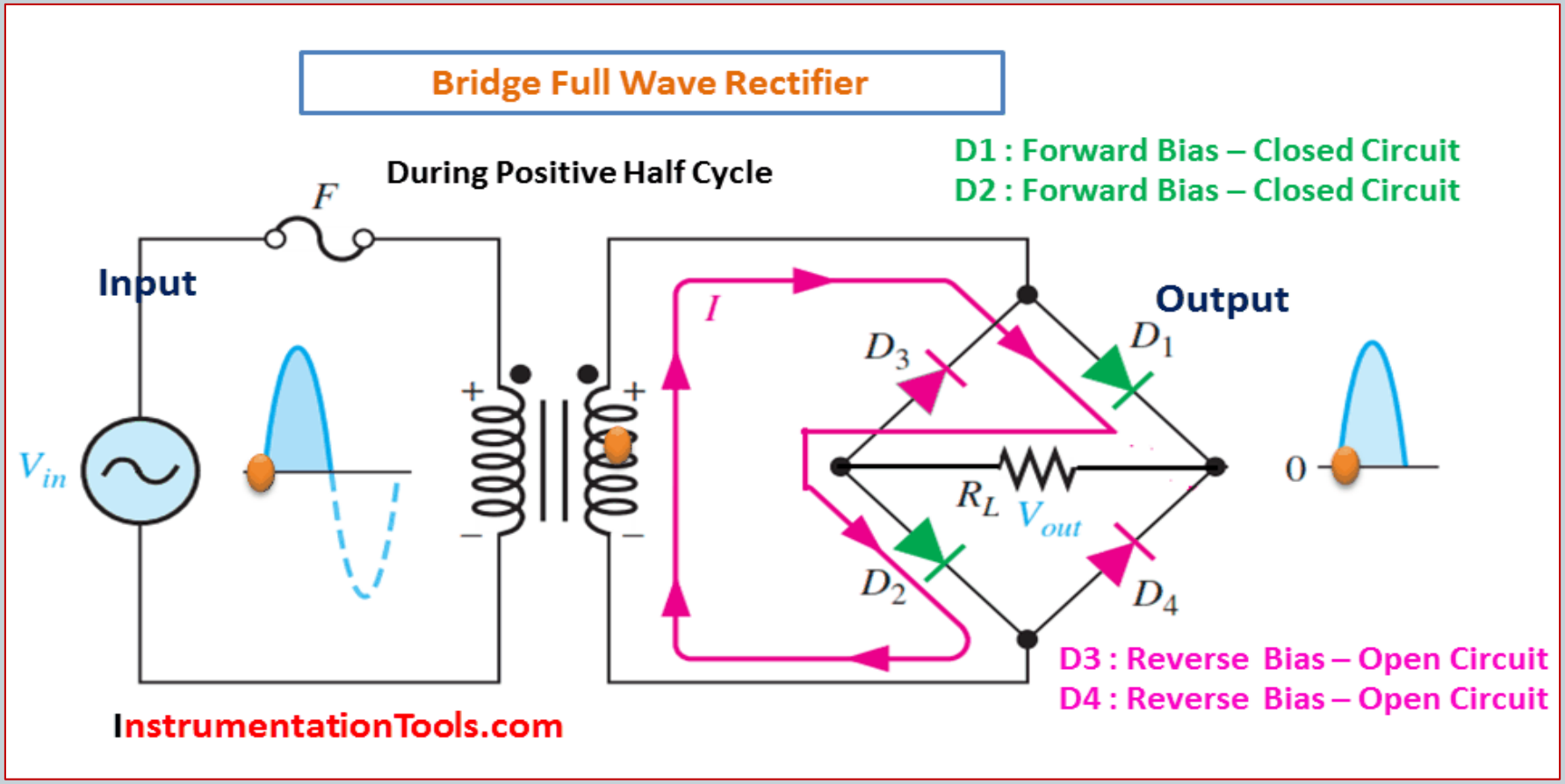
- The dc level obtained from a sinusoidal input can be improved 100% using a process called ***full-wave rectification***.



- Bridge Full Wave Rectifier
- Center Tapped Full Wave Rectifier

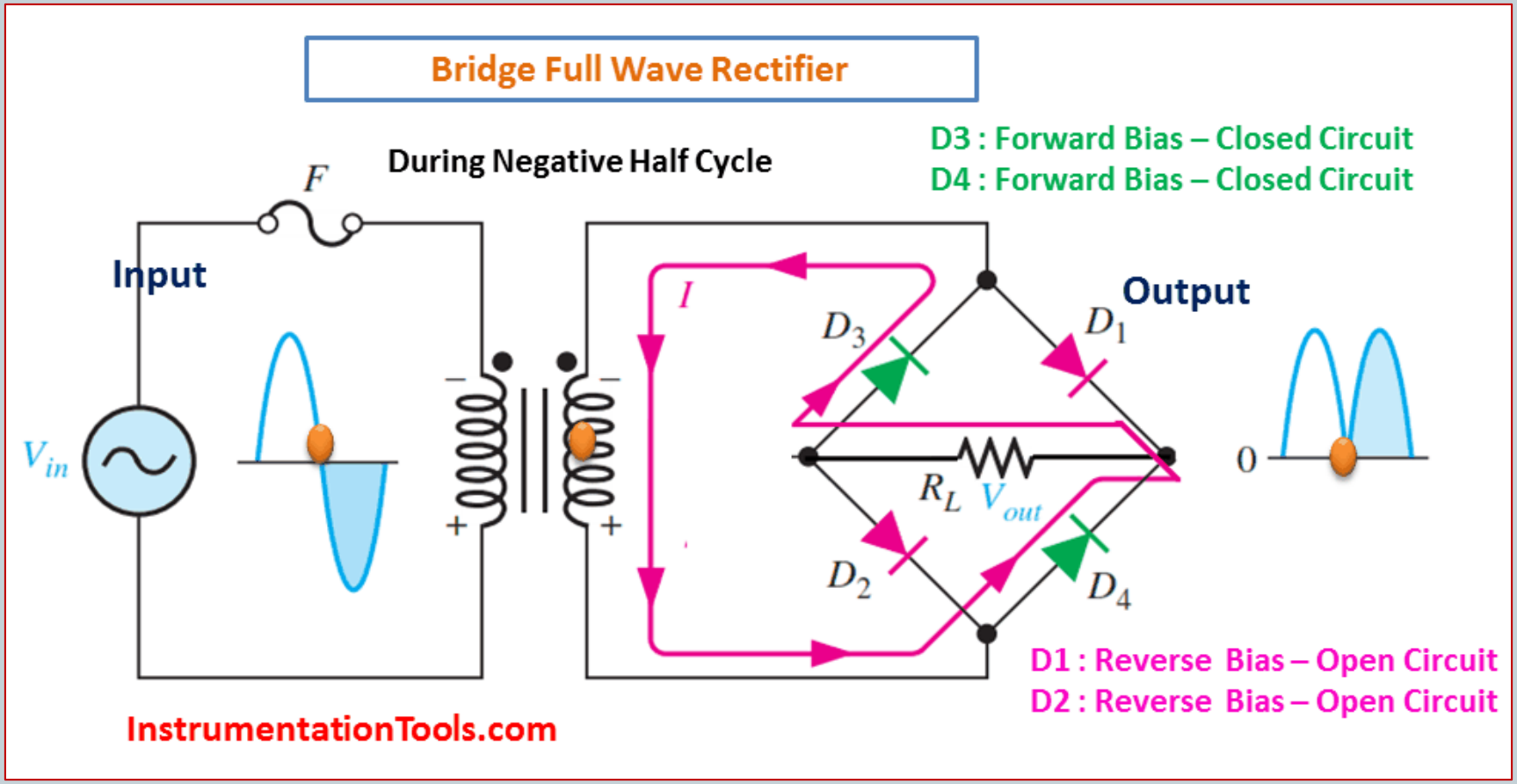
Bridge Network

➢ Positive half cycle



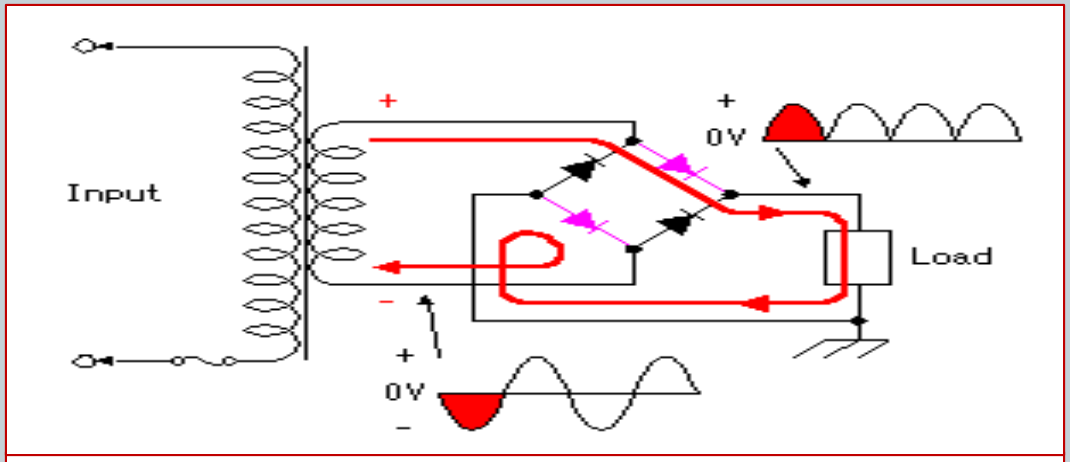
Bridge Network

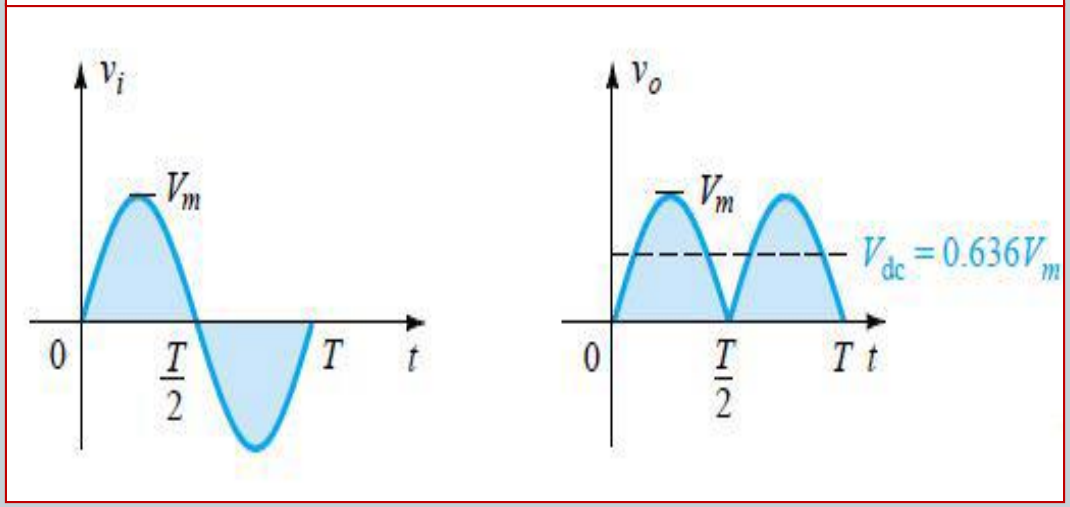
➢ Negative half cycle



Bridge Network

Input Output Waveform:



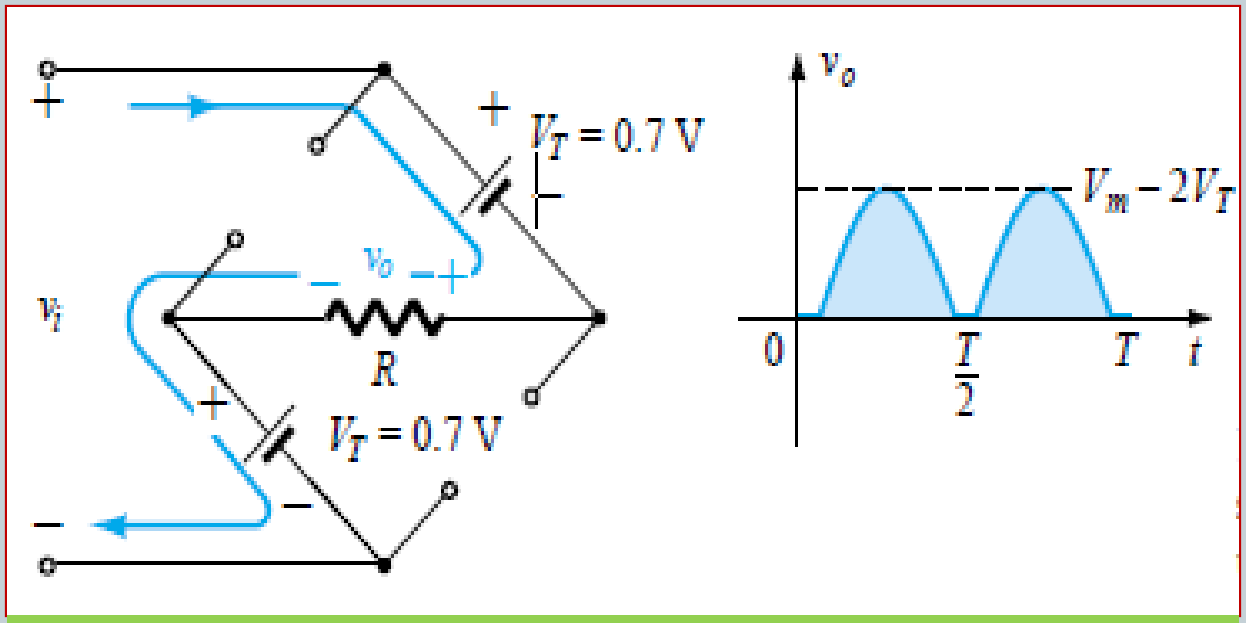


$$V_{out} = V_{in}$$

$$V_{avg} = V_{dc} = 0.636\ V_o$$

Bridge Network

- **Effect of Barrier Potential:**



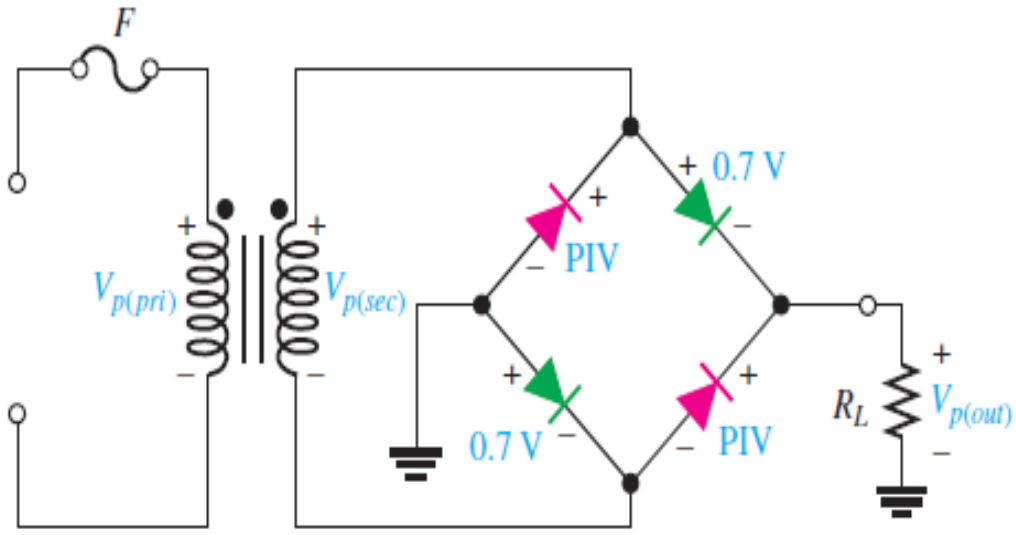
$$V_{avg} = V_{dc} = 0.636\,(V_m - 2V_T)$$

Bridge Network

- **Peak Inverse Voltage:**

$$PIV = V_p(out) + V_T$$

$$= V_m + V_T$$



(b) For the practical diode model (forward-biased diodes D_1 and D_2 are shown in green), PIV = $V_{p(out)}$ + 0.7 V.

Math Problem

Determine the peak output voltage for the bridge rectifier in Figure 2–41. Assuming the practical model, what PIV rating is required for the diodes? The transformer is specified to have a 12 V rms secondary voltage for the standard 120 V across the primary.

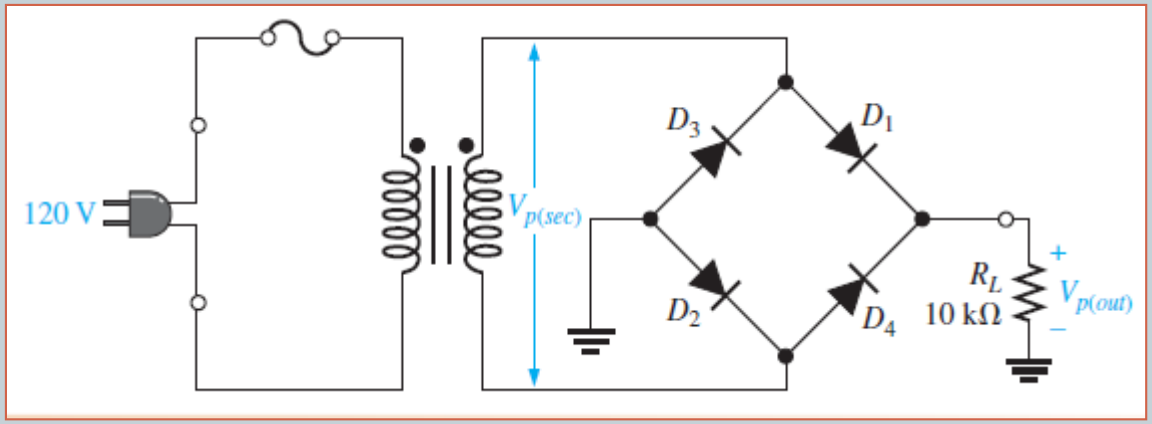
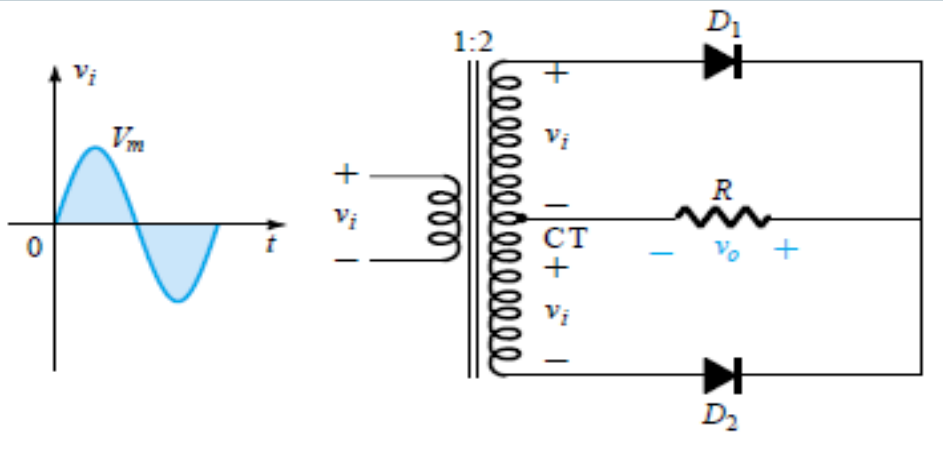


FIGURE 2–41

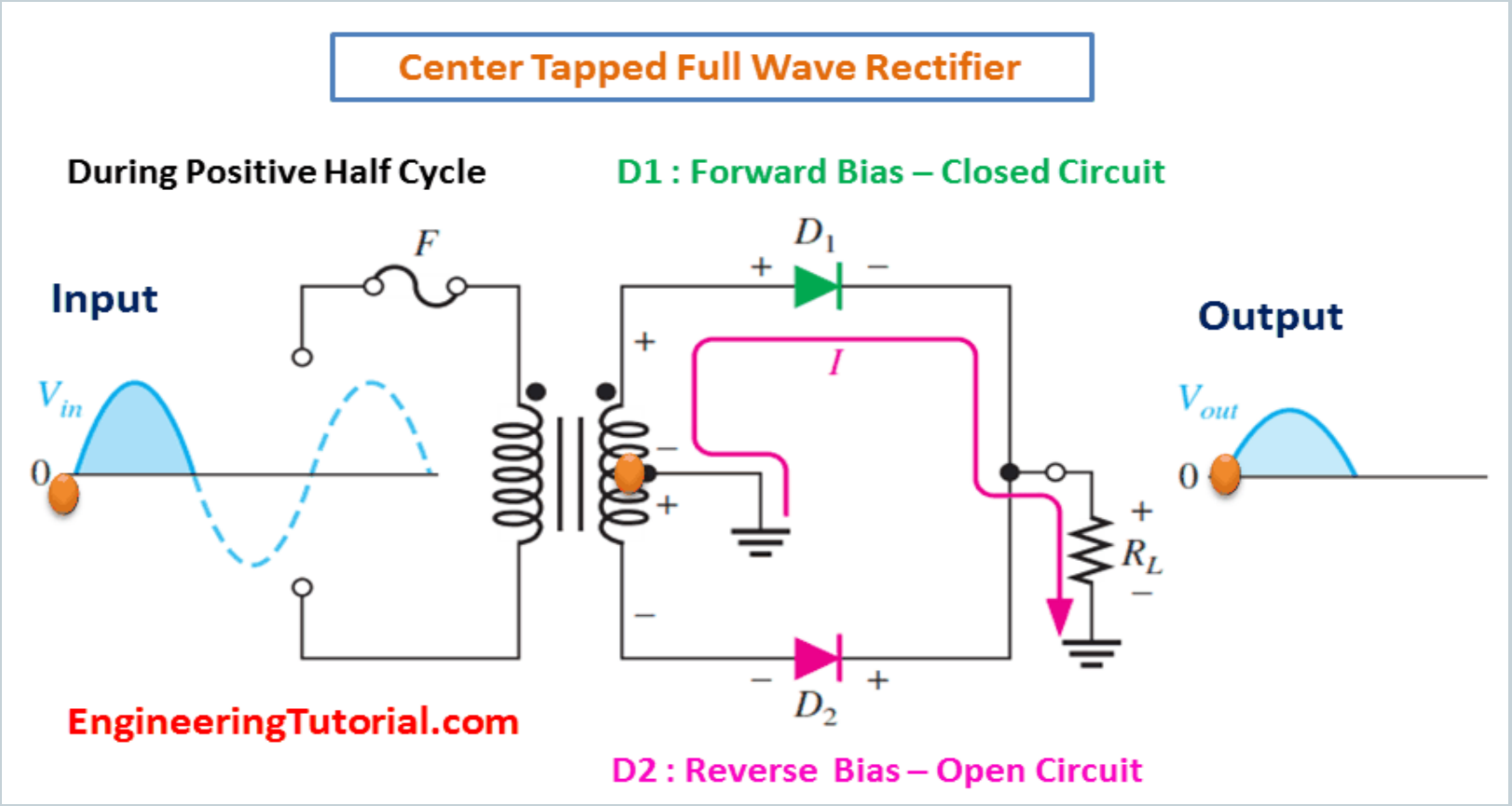
Center Tapped Full Wave Rectifier

- A second popular full-wave rectifier appears in Fig. with only two diodes but requiring a center-tapped (CT) transformer to establish the input signal across each section of the secondary of the transformer.



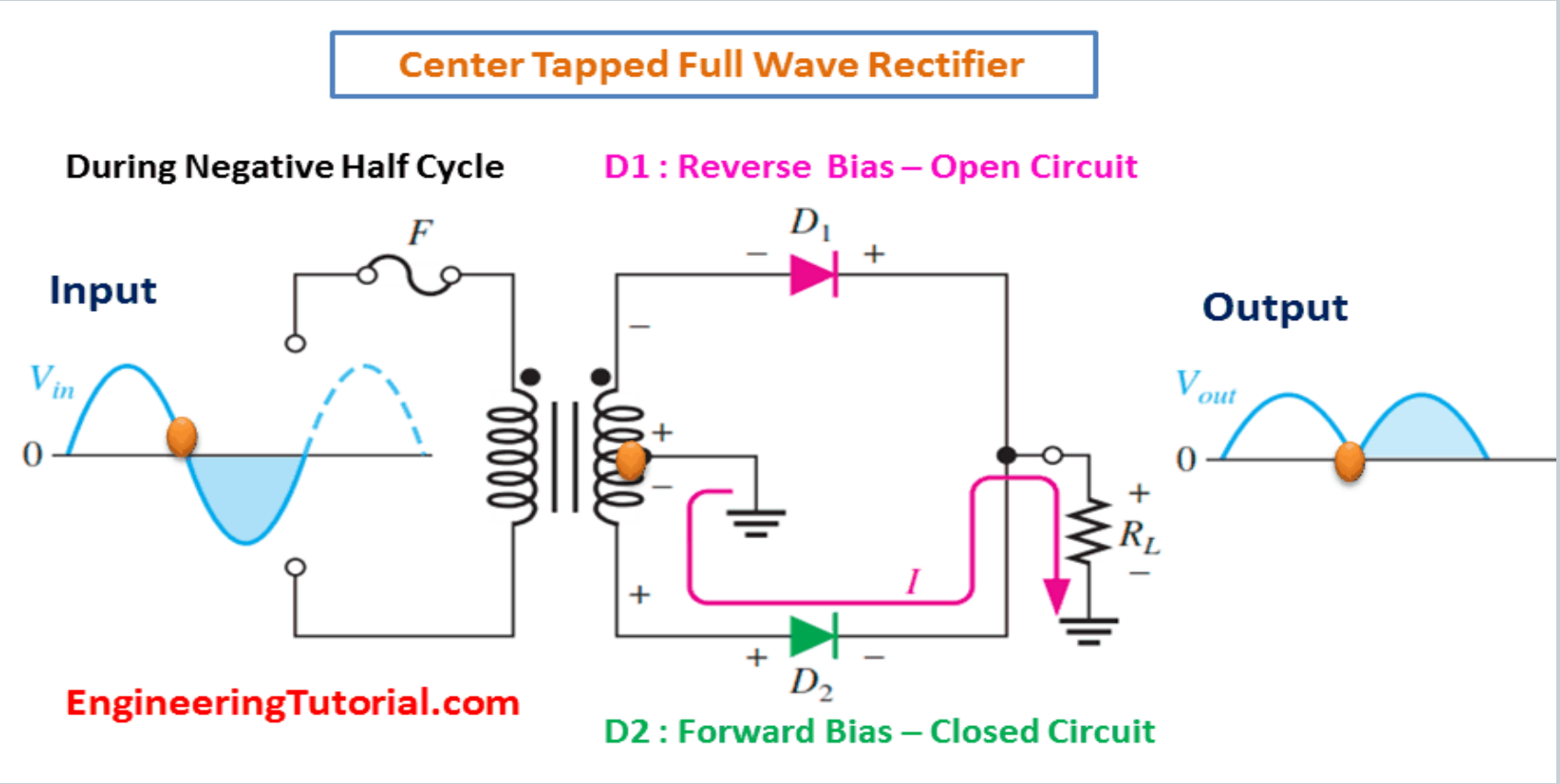
Center Tapped Full Wave Rectifier

➢ Positive half cycle



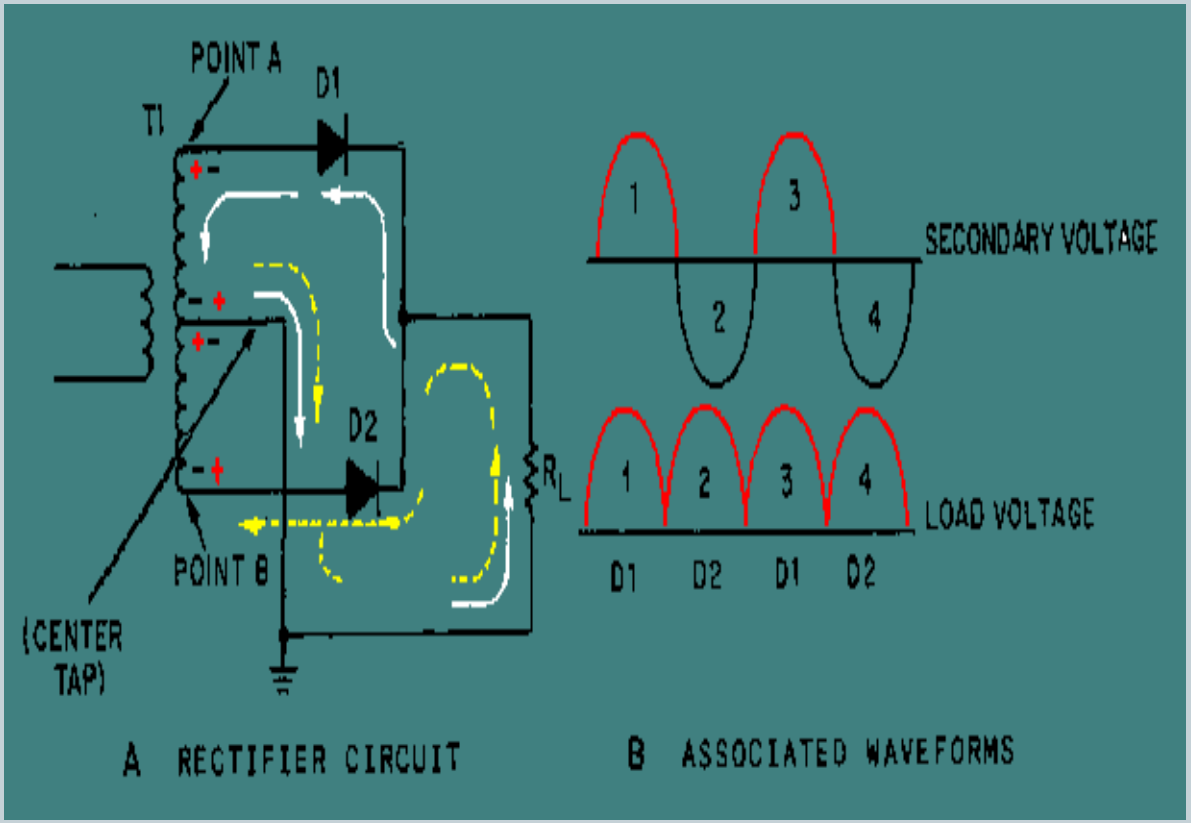
Center Tapped Full Wave Rectifier

➢ Negative half cycle



Center Tapped Full Wave Rectifier

- **Input- Output Waveform:**



Turn Ratio (1:2)

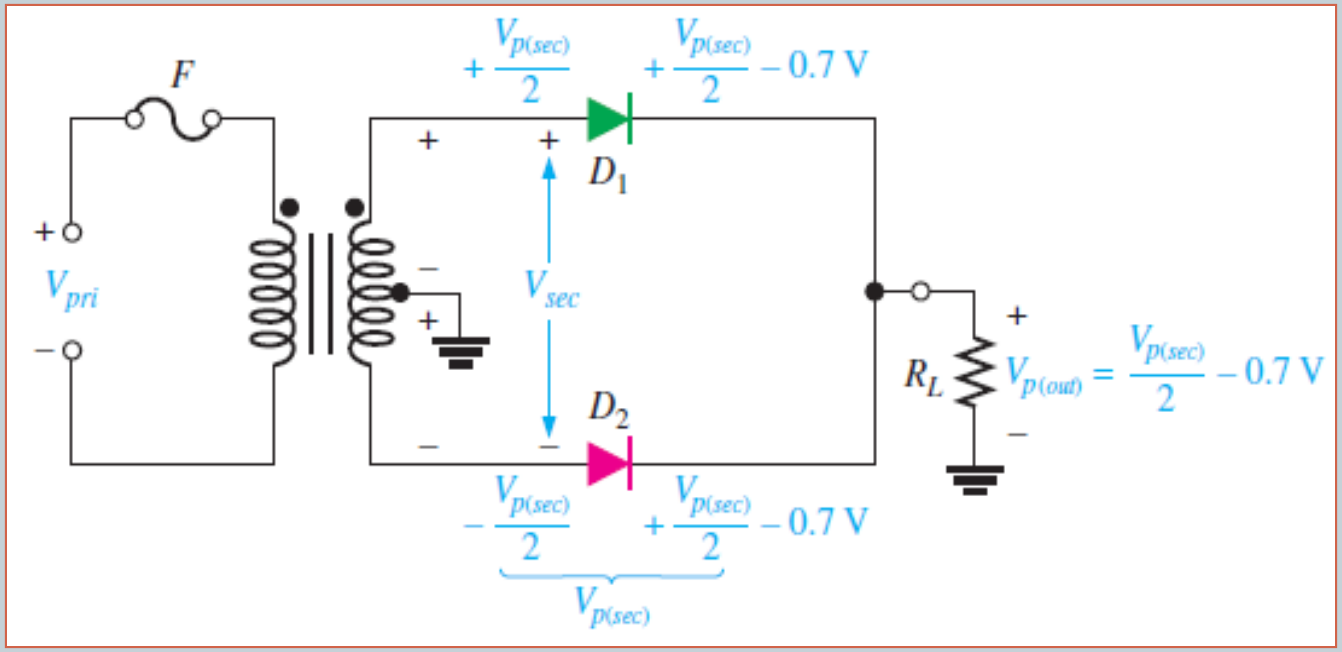
$V_o = V_{sec} / 2$

$V_{avg} = V_{dc}$

$= 0.636 V_o$

Center Tapped Full Wave Rectifier

- **Peak Inverse Voltage**

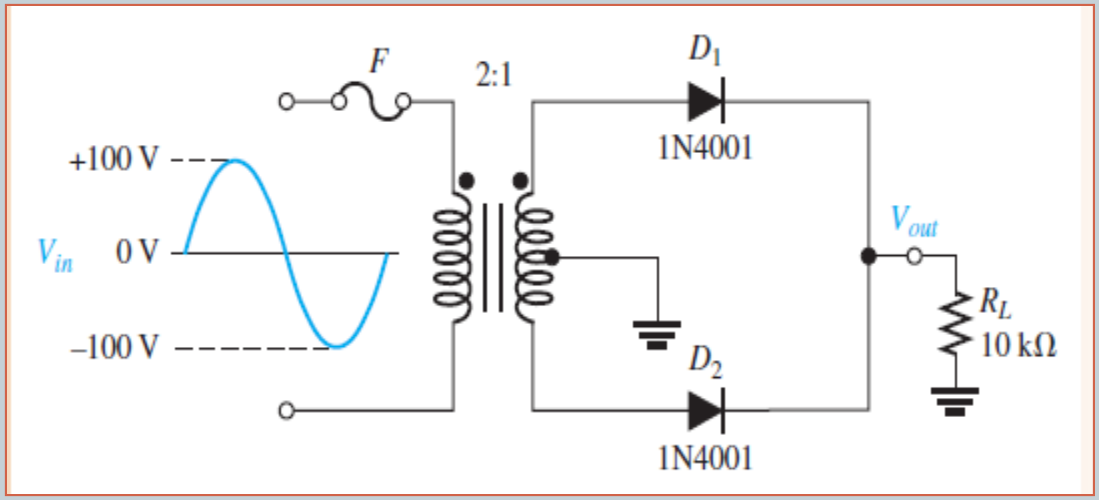


PIV = V_{sec} - V_T

Math Problem

(a) Show the voltage waveforms across each half of the secondary winding and across R_L when a 100 V peak sine wave is applied to the primary winding in Figure 2–36.

(b) What minimum PIV rating must the diodes have?

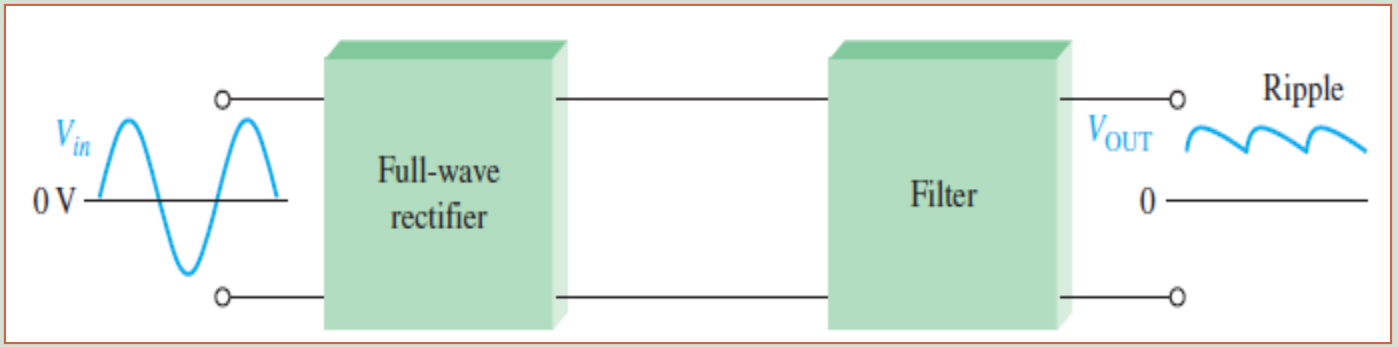


WHICH ONE IS BETTER?

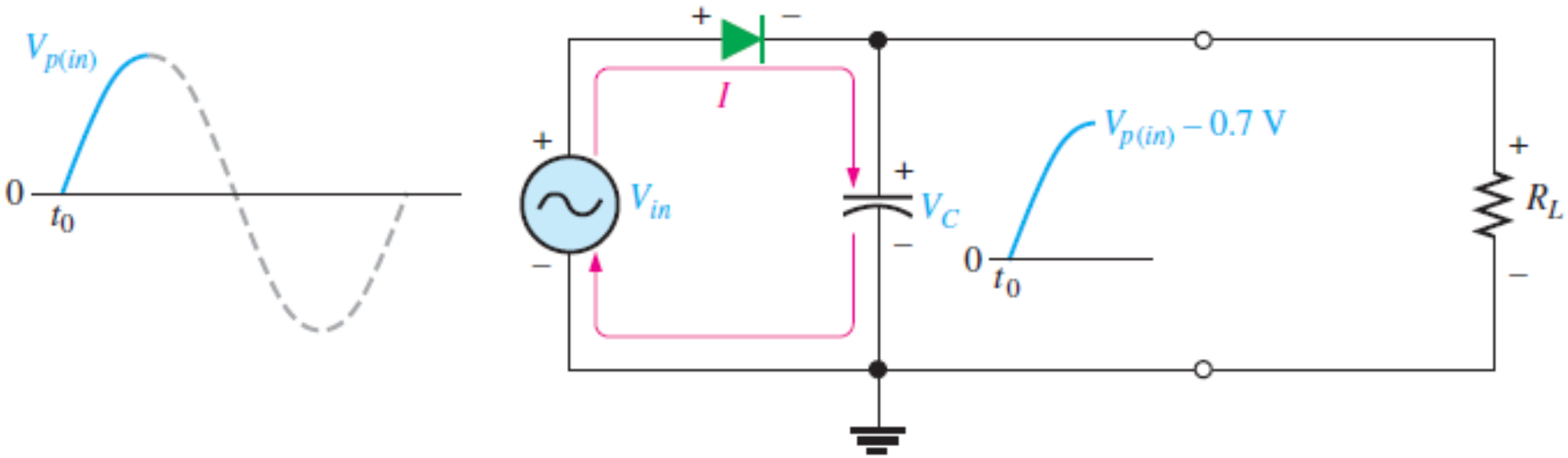
- Center tap rectification?
- Bridge rectification?

Filter

- A power supply filter ideally eliminates the fluctuations in the output voltage of half wave or full-wave rectifier and produces a constant-level dc voltage.

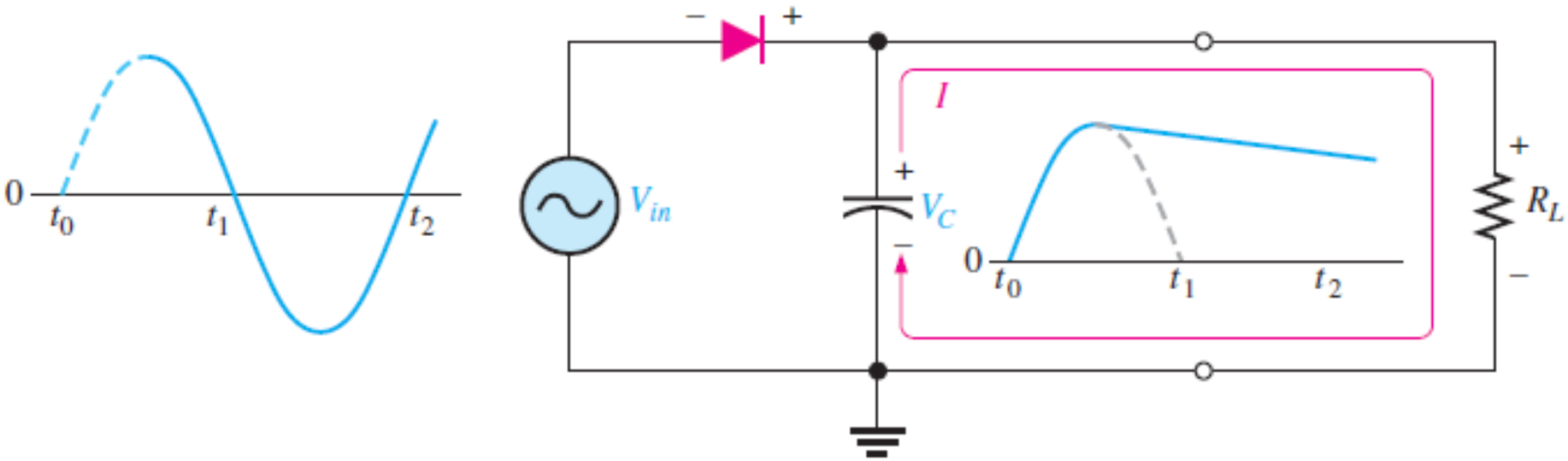


Capacitor Input Filter



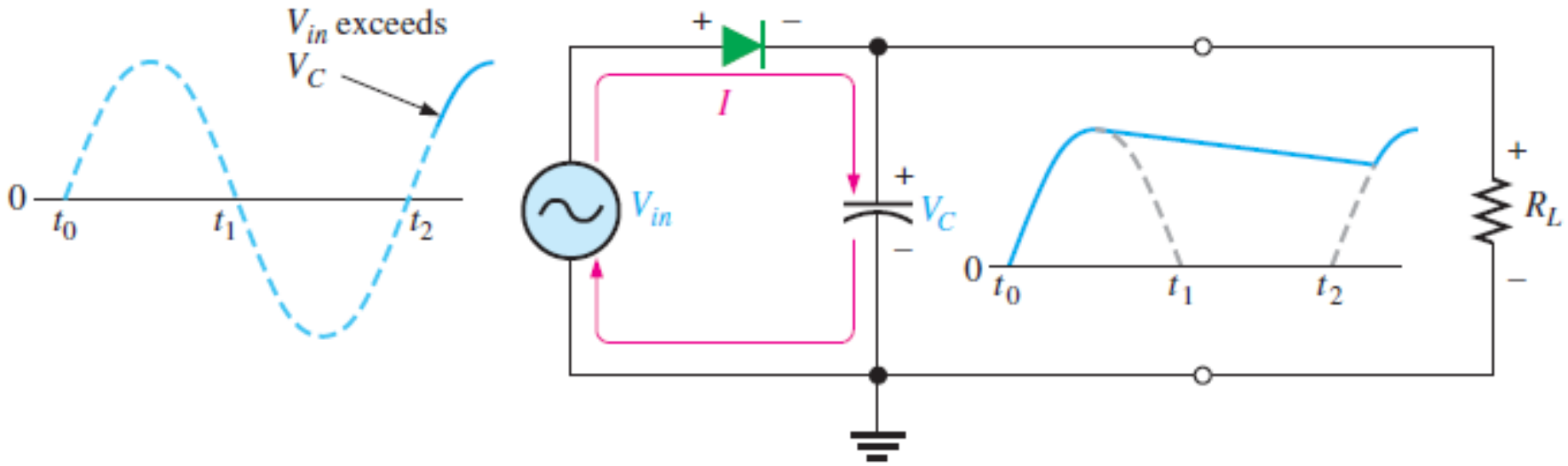
(a) Initial charging of the capacitor (diode is forward-biased) happens only once when power is turned on.

Capacitor Input Filter



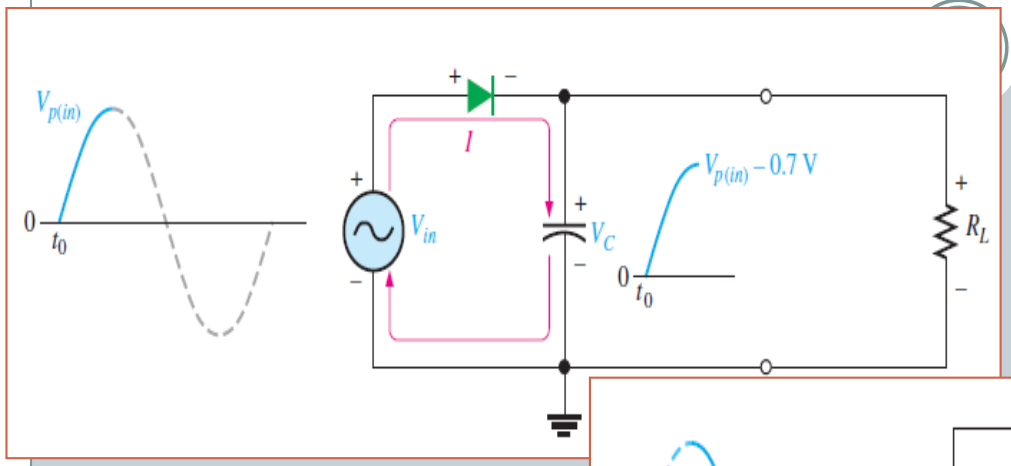
(b) The capacitor discharges through R_L after peak of positive alternation when the diode is reverse-biased. This discharging occurs during the portion of the input voltage indicated by the solid dark blue curve.

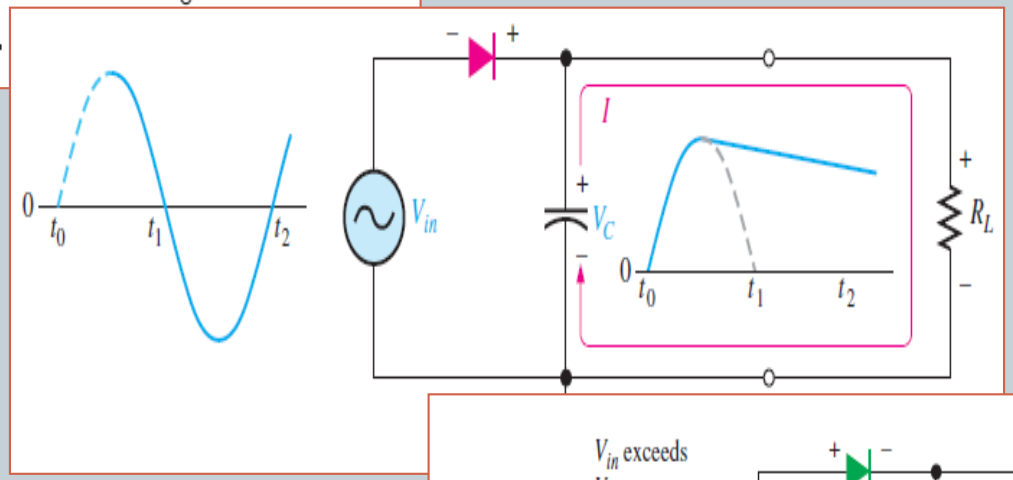
Capacitor Input Filter

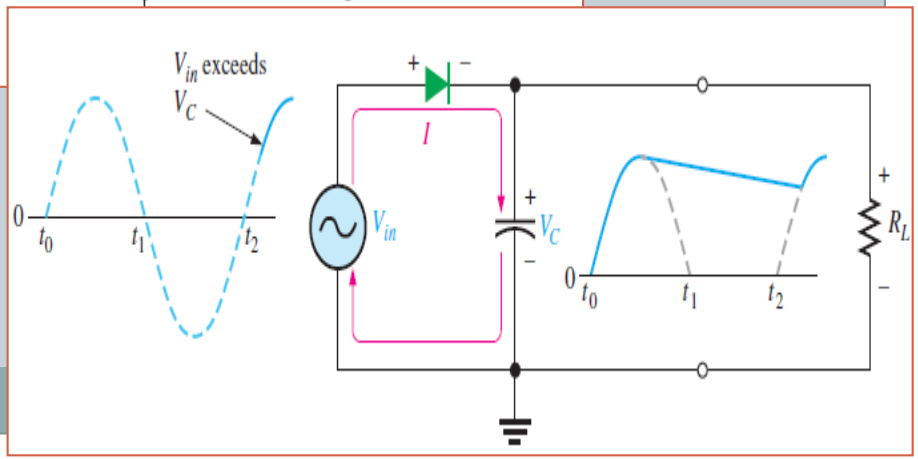


(c) The capacitor charges back to peak of input when the diode becomes forward-biased. This charging occurs during the portion of the input voltage indicated by the solid dark blue curve.

Capacitor Input Filter

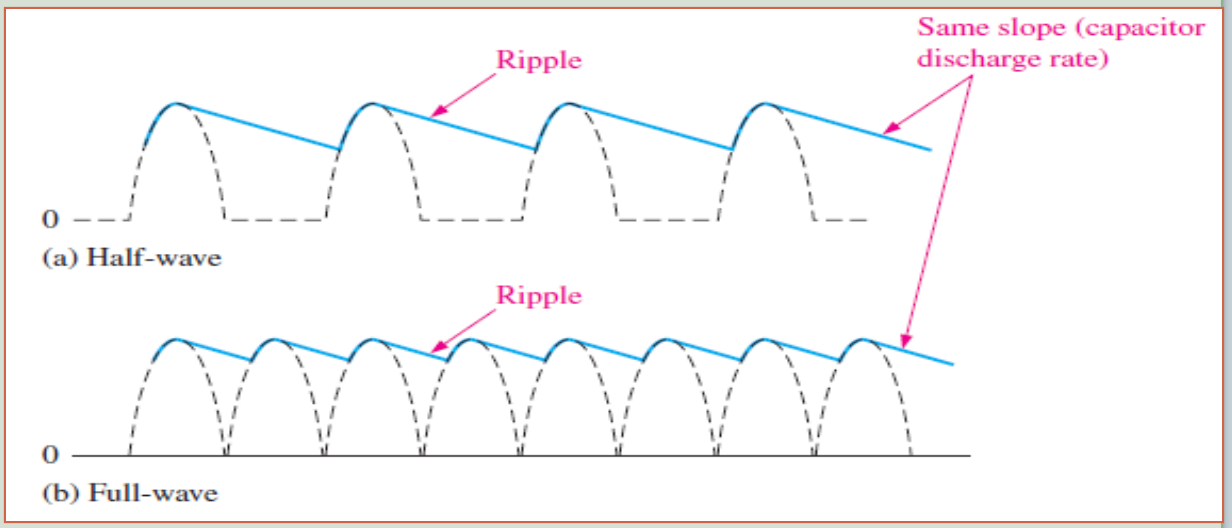






Ripple Voltage

- The variation in the capacitor voltage due to the charging and discharging is called the **ripple voltage.**

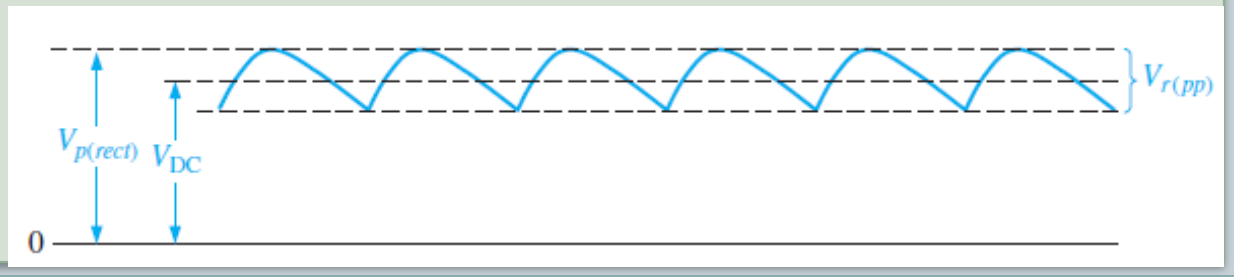


Ripple Factor

$$r = \frac{V_{r(pp)}}{V_{DC}}$$

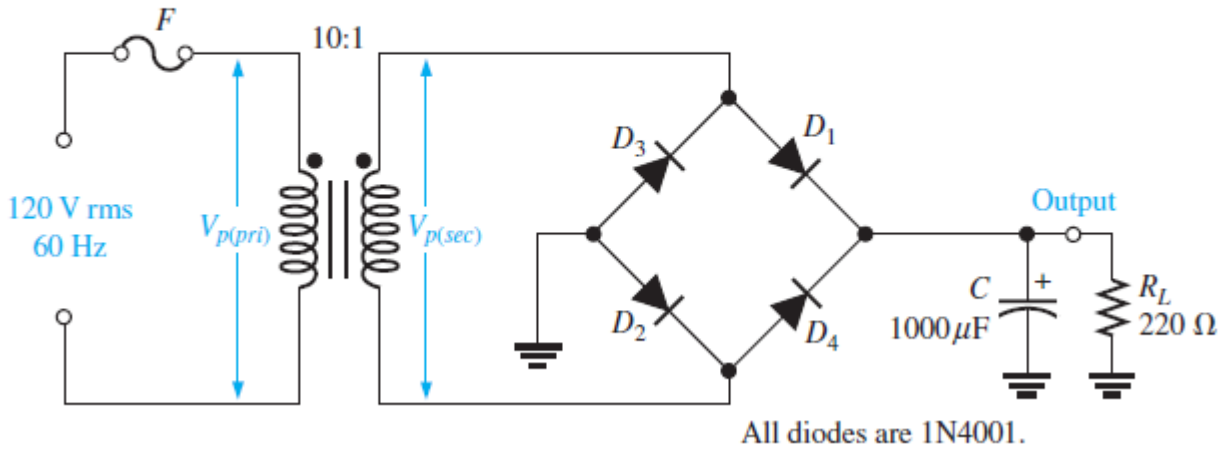
$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$

$$V_{DC} \cong \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$



Math Problem

Determine the ripple factor for the filtered bridge rectifier with a load as indicated in Figure 2–48.



All diodes are 1N4001.

$$r = \frac{V_{r(pp)}}{V_{DC}}$$

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$

$$V_{DC} \cong \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)} = \left(\frac{1}{(120\text{ Hz})(220\ \Omega)(1000\ \mu\text{F})}\right)15.6\text{ V} = 0.591\text{ V}$$

$$V_{DC} = \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)} = \left(1 - \frac{1}{(240\text{ Hz})(220\ \Omega)(1000\ \mu\text{F})}\right)15.6\text{ V} = 15.3\text{ V}$$

$$r = \frac{V_{r(pp)}}{V_{DC}} = \frac{0.591\text{ V}}{15.3\text{ V}} = \mathbf{0.039}$$

Self Topic

- Surge Current in the Capacitor Input Voltage
- Voltage Regulators

SELF-STUDY

Do All Mathematics Problem Of Example And Exercise From The Reference Book !!!!

Reference

- Half wave & Full wave
- https://electronicscoach.com/difference-between-centre-tapped-and-bridge-rectifier.html
- https://www.elprocus.com/full-wave-bridge-rectifier-versus-center-tapped-full-wave-rectifier/

THANK YOU!!!

ANY QUESTION ?