Electronics Fundamentals

CTE 204

Lecture 11

- Full-Wave Rectifier (Bridge Rectifier) -

(2024 - 2025)

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Full-Wave Bridge Rectifier

- The full-wave bridge rectifier uses four diodes, as shown in the Figure below.
- The input cycle is positive, diodes D_1 and D_2 are forward-biased and conduct current in the direction shown.
- A voltage is developed across RL that looks like the positive half of the input cycle.
- During this time, diodes D_3 and D_4 are reverse-biased.

Positive cycle

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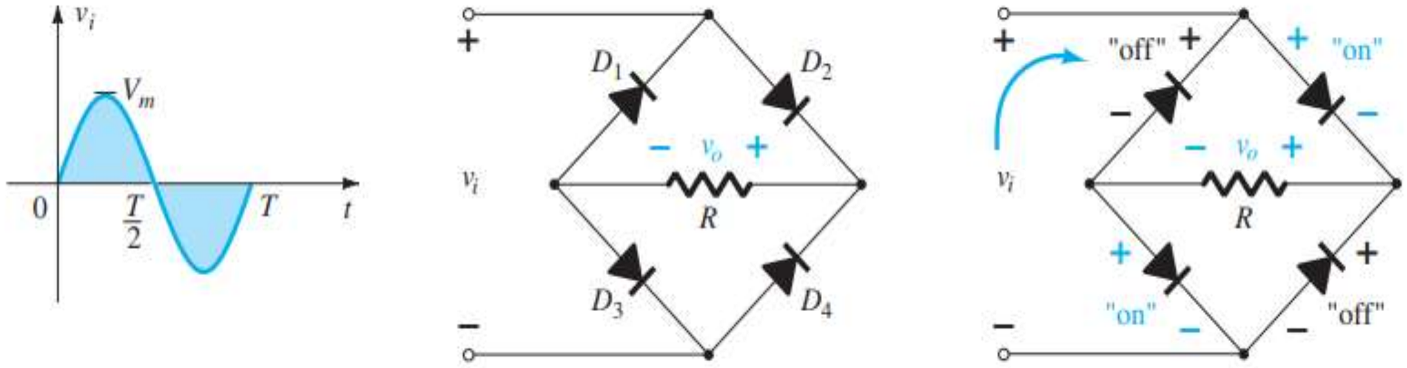
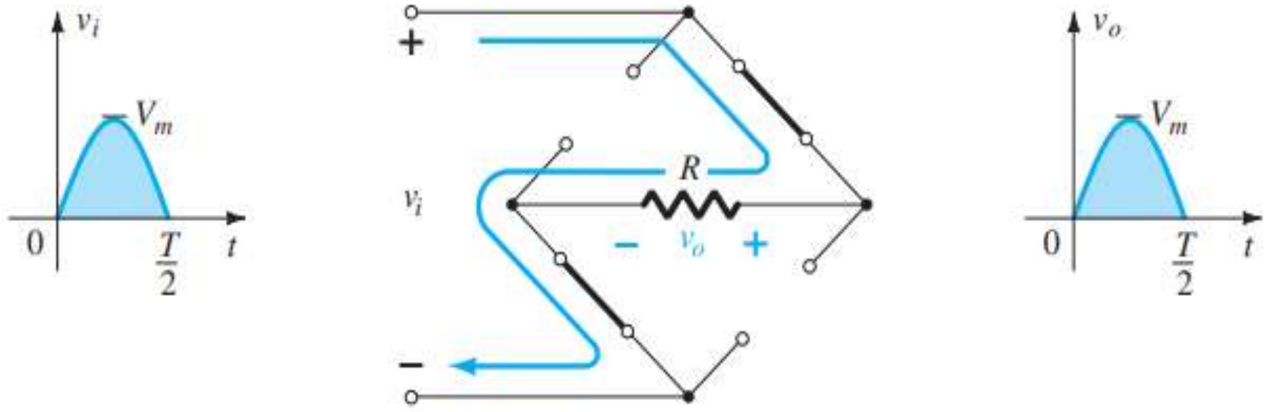




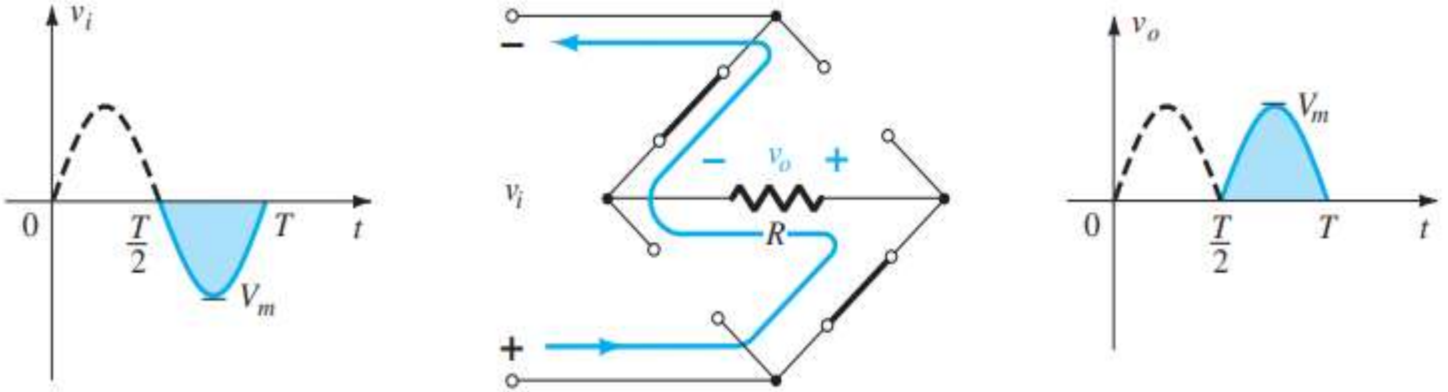
Full-Wave Bridge Rectifier

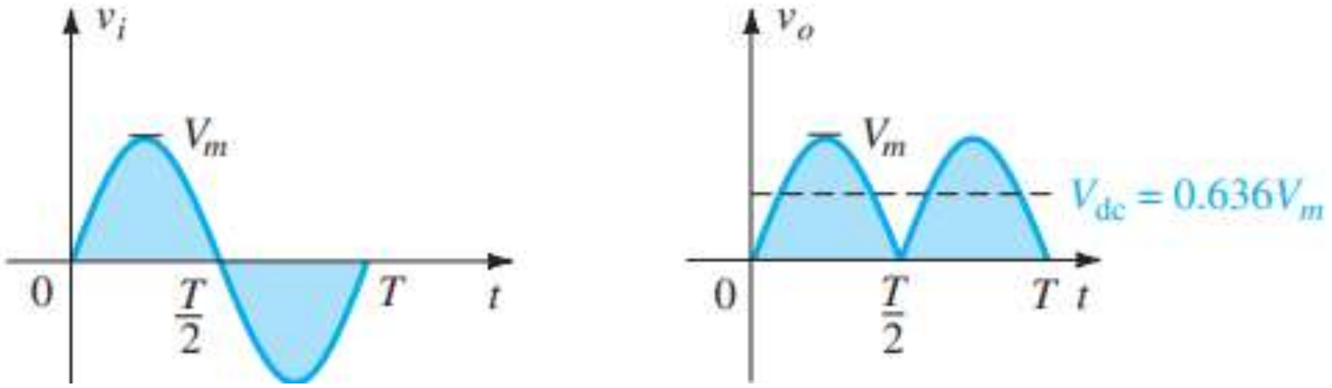
- The input cycle is negative, diodes D_3 and D_4 are forward-biased and conduct current in the same direction through as during the positive half-cycle.

- During the negative half-cycle, D_1 and D_2 are reverse-biased.

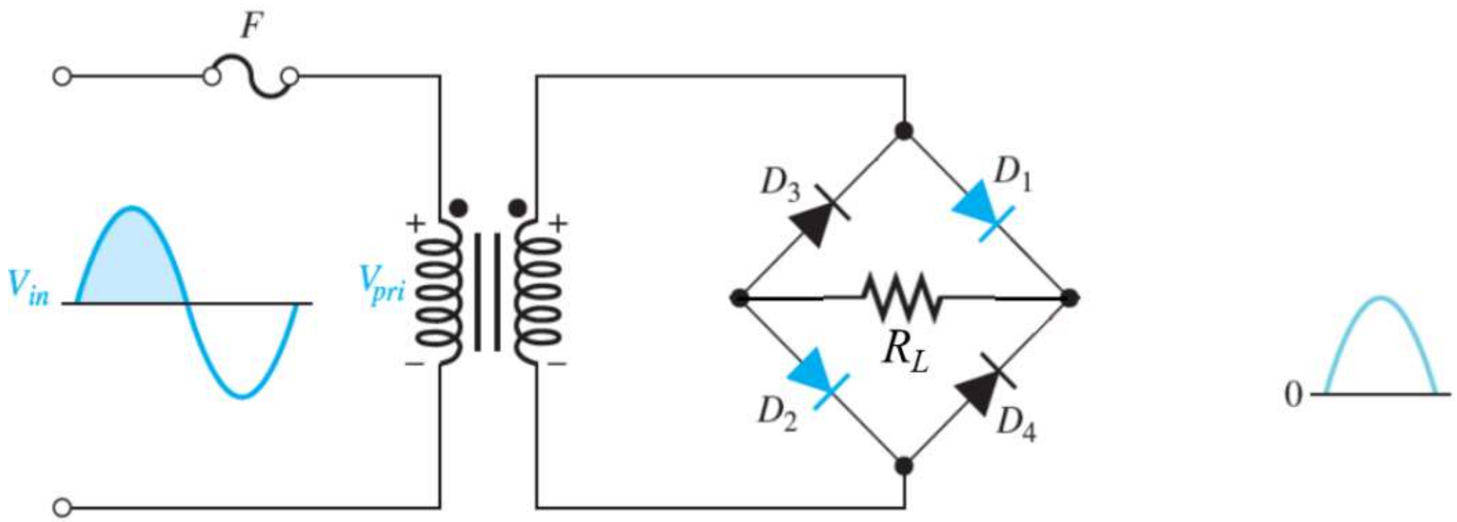
- A full-wave rectified output voltage appears across RL as a result of this action.

Negative cycle



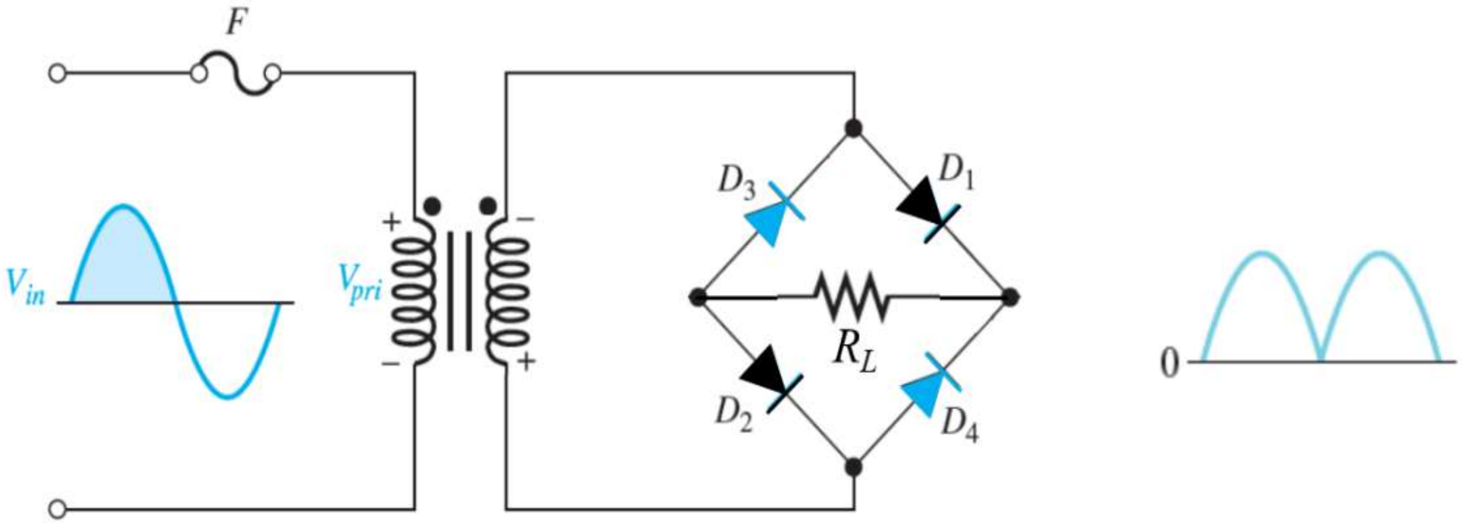


Positive - Negative cycle



Positive cycle

Negative cycle

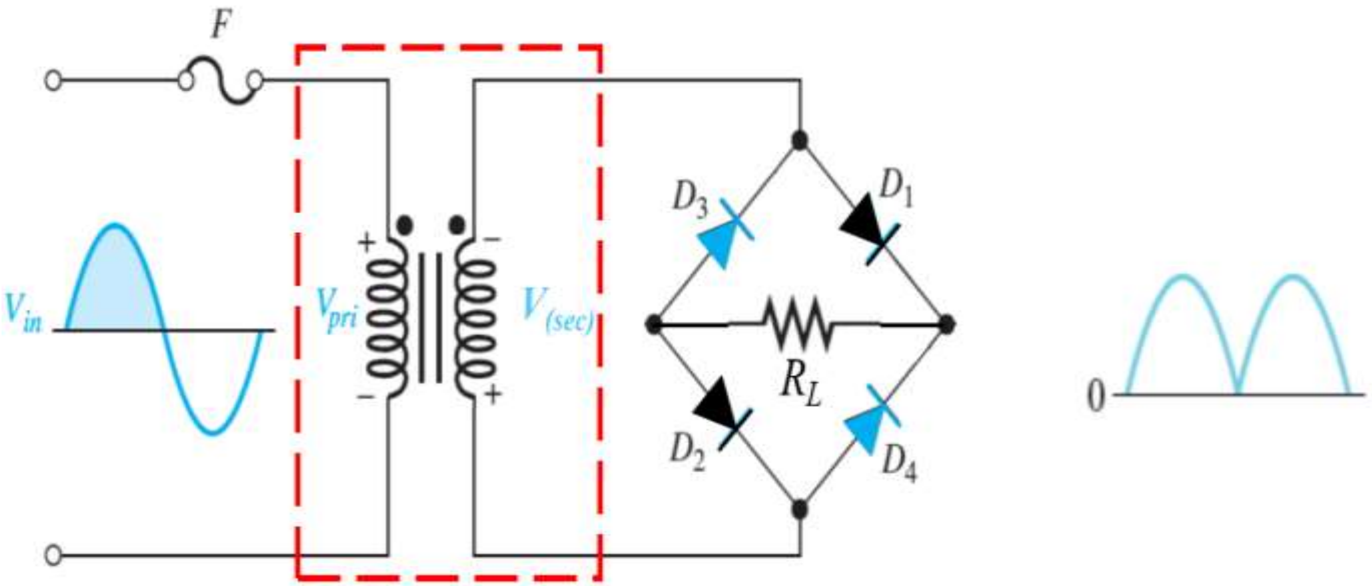


The bridge output voltage from the transformer:

The secondary voltage is equal to the primary voltage times the turns ratio as stated by the equation:

$$V_{p(sec)} = V_{p(out)}$$

$$V_{p(sec)} = V_{p(out)} = nV_{p(pri)}$$

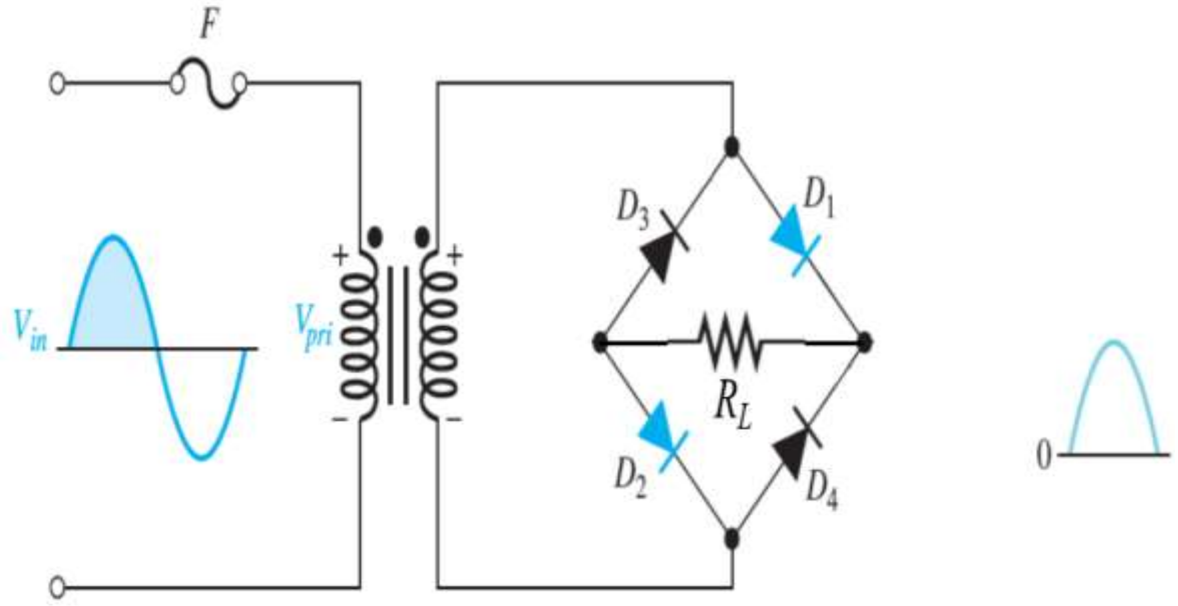


The positive half-cycle:

- D_1 and D_2 are forward-Biased
- D_3 and D_4 are reversed-Biased
- PIV is equal to the $V_{p(sec)}$

  which is equal to the $V_{p(out)}$

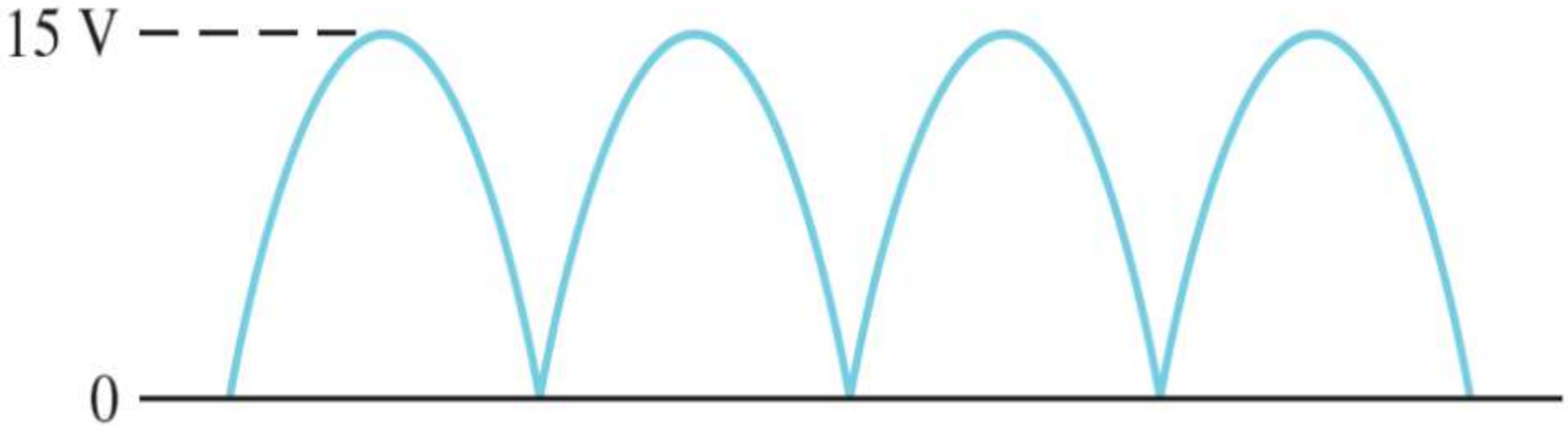
$$PIV = V_{p(sec)} = V_{p(out)}$$



Example

Find the average value of the full-wave rectified output voltage in the Figure below.

Sol:

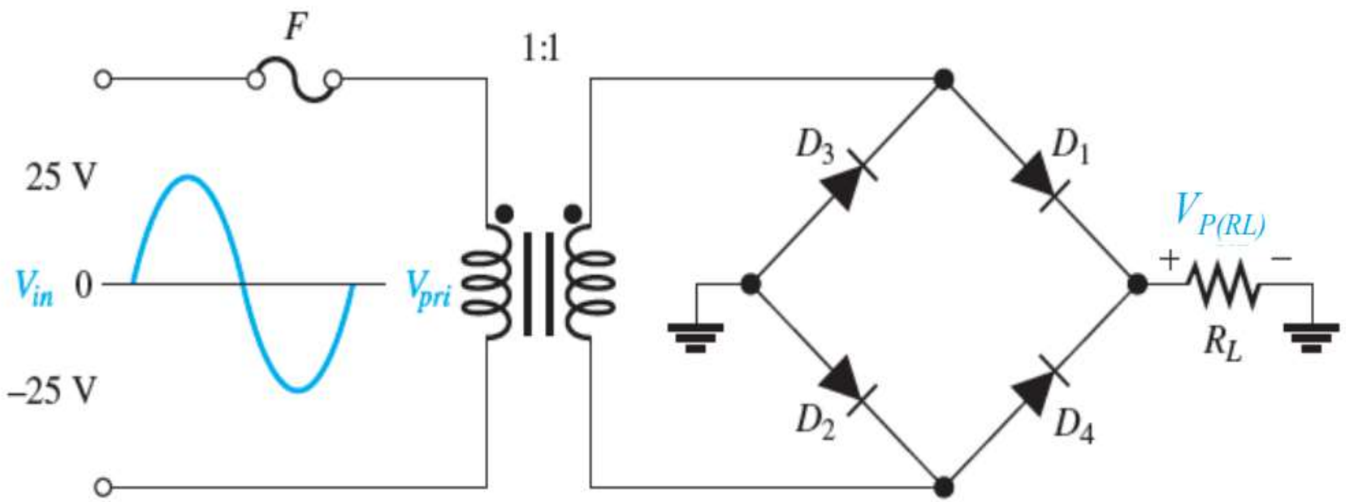


$$V_{AVG} = \frac{2V_{p(out)}}{\pi} = \frac{2*15}{3.14} = 9.55\ V$$

Example

a) Determine the peak output voltage $V_{p(out)}$, $V_p(RL)$ and V_{AVG} for the bridge rectifier in Figure below.

b) What is the minimum PIV rating required for the diodes?



Solution

Sol:

a) $V_{p(out)} = V_{p(sec)} = nV_{p(in)} = (1)25\ V = 25\ V$

$V_{p(RL)} = V_{p(out)} - 2\ (V_B) = 23.6\ V$

$$V_{AVG} = \frac{2V_{p(RL)}}{\pi} = \frac{47.2}{3.14} = 15\ V$$

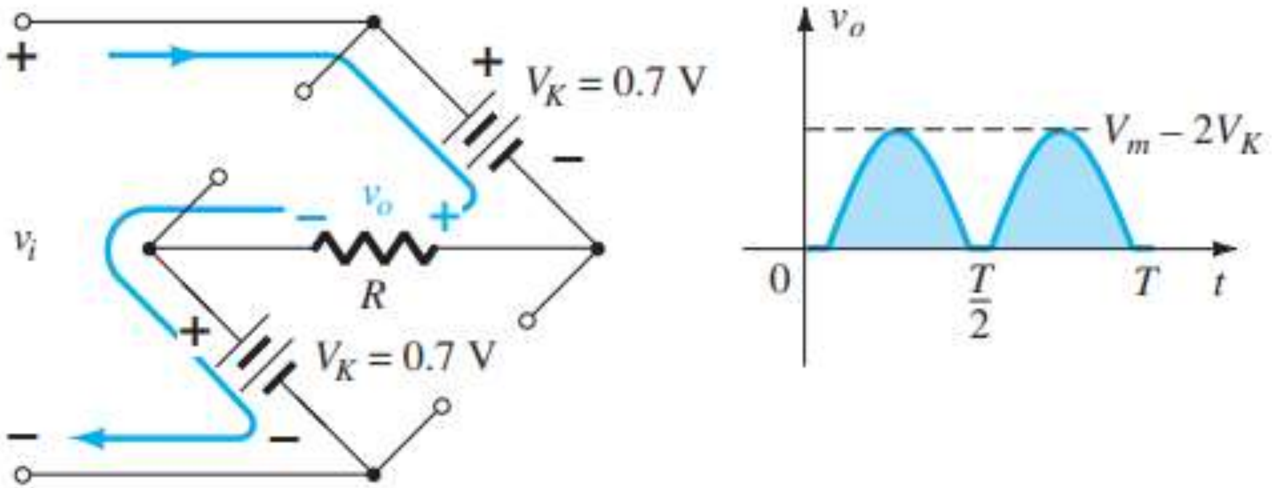
b) $\text{PIV} = \text{V}_{p(sec)} = \text{V}_{p(out)} = 25\ V$

Full-Wave Bridge Rectifier

If silicon rather than ideal diodes are employed as shown in Figure below, the application of Kirchhoff’s voltage law around the conduction path results in

$$v_i - V_K - v_o - V_K = 0$$

$$v_o = v_i - 2V_K$$



Full-Wave Bridge Rectifier

$V_{dc} = 2(0.318Vm),$ $\boxed{V_{dc} = 0.636\, V_m}$ full-wave

The peak value of the output voltage Vo is therefore

$$V_{o_{max}} = V_m - 2V_K$$

For situations where $V_m >> 2V_K$, the following equation can be applied for the average value with a relatively high level of accuracy:

$$\boxed{V_{dc} \cong 0.636(V_m - 2V_K)}$$

Equations

Approximate:

Silicon: $V_K = 0.7\text{ V}$; I_D is determined by network.

Germanium: $V_K = 0.3\text{ V}$; I_D is determined by network.

Gallium arsenide: $V_K = 1.2\text{ V}$; I_D is determined by network.

Ideal:

$V_K = 0\text{ V}$; I_D is determined by network.

For conduction:

$$V_D \geq V_K$$

Half-wave rectifier:

$$V_{dc} = 0.318V_m$$

Full-wave rectifier:

$$V_{dc} = 0.636V_m$$