Universidade Federal de Santa Catarina
Campus Joinville
Centro Tecnológico de Joinville - CTJ
Departamento de Engenharias da Mobilidade

EMB5116 – ELETRÔNICA ANALÓGICA

CIRCUITOS COM DIODOS

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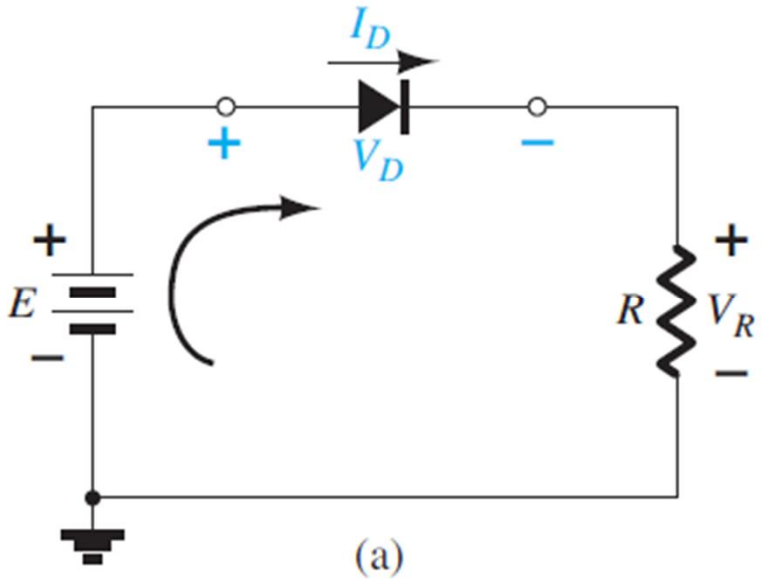
Joinville, 2025

SUMÁRIO

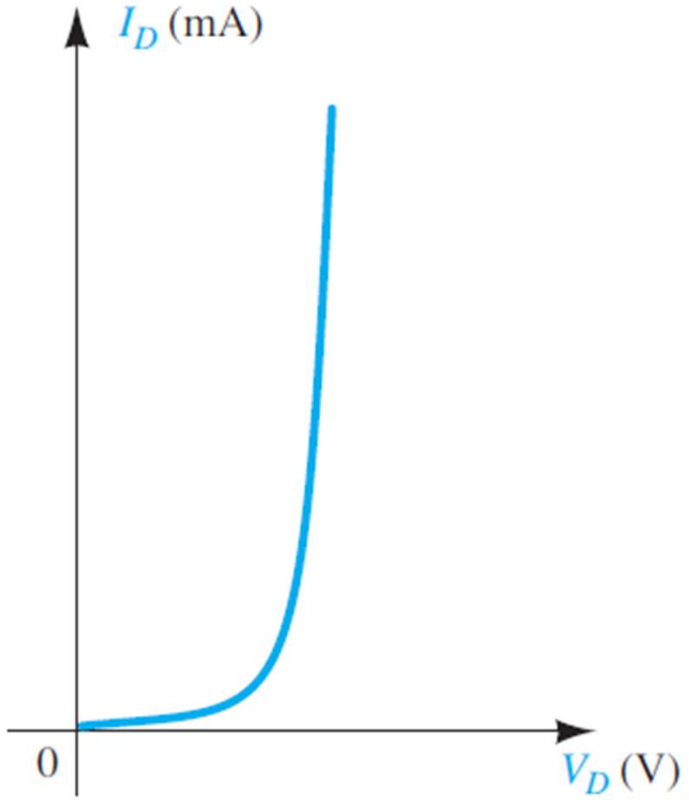
- Análise por reta de carga
- Circuitos com diodos:
  - Retificadores;
  - Ceifadores;
  - Grampeadores.

ANÁLISE POR RETA DE CARGA

- Resolver o circuito significa determinar os valores de corrente e tensão que vão satisfazer ao mesmo tempo as características do diodo quanto os parâmetros do circuito escolhido.



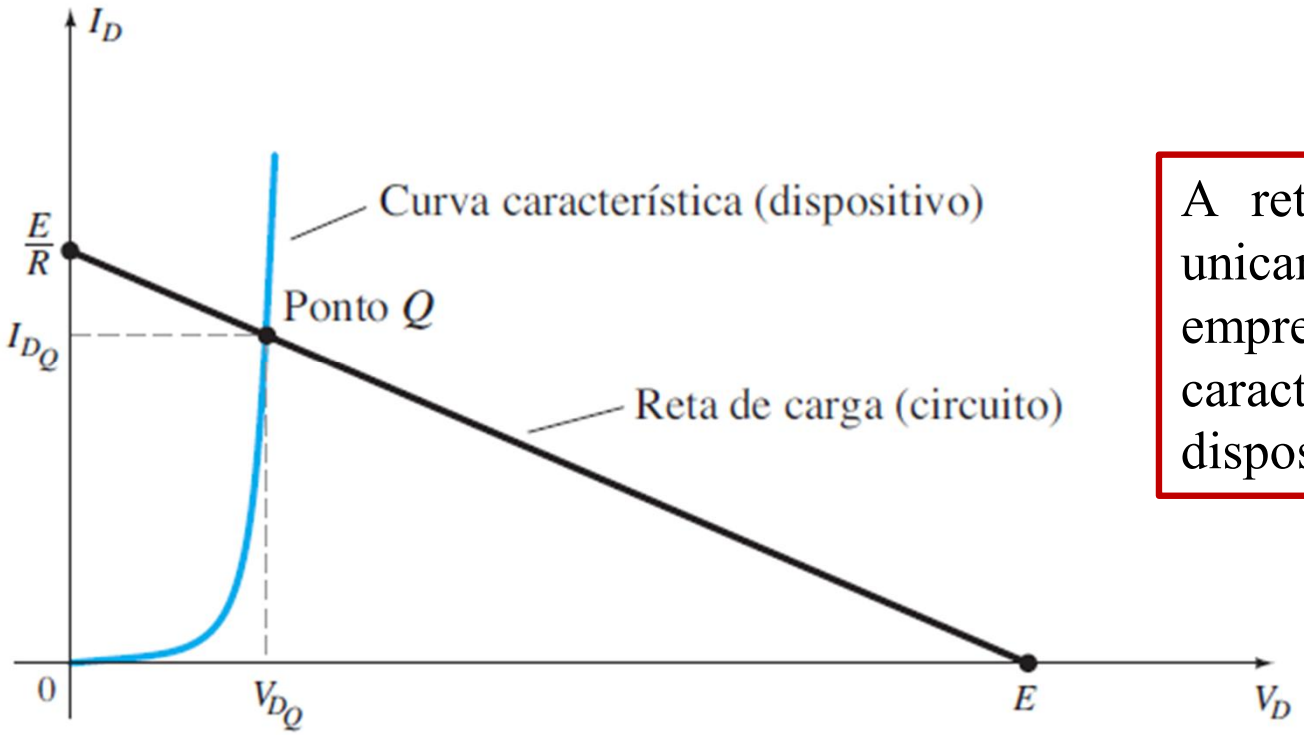
(a)



(b)

ANÁLISE POR RETA DE CARGA

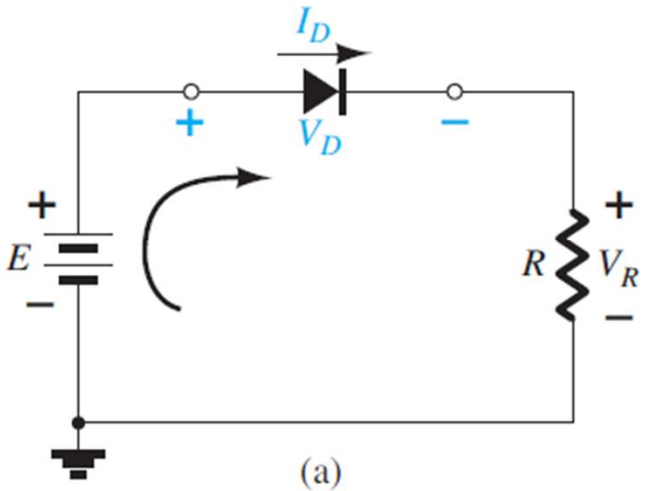
- A linha reta é denominada reta de carga, porque a interseção no eixo vertical é definida pela carga aplicada R.
- A interseção das duas curvas vai definir a solução para o circuito.

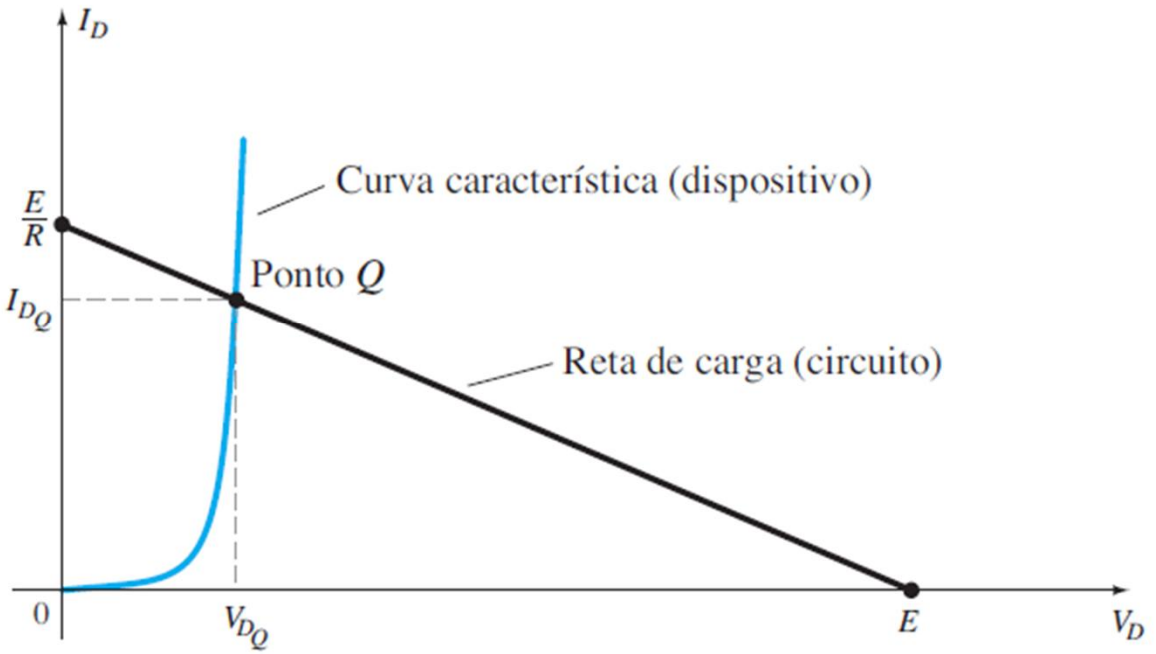


A reta de carga é determinada unicamente pelo circuito empregado, enquanto a curva característica é definida pelo dispositivo escolhido.

ANÁLISE POR RETA DE CARGA

- A interseção pode ser determinada aplicando a Lei das Tensões de Kirchhoff:



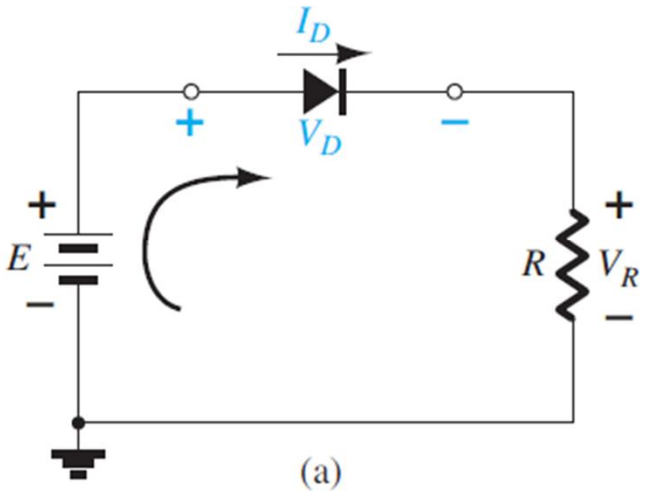


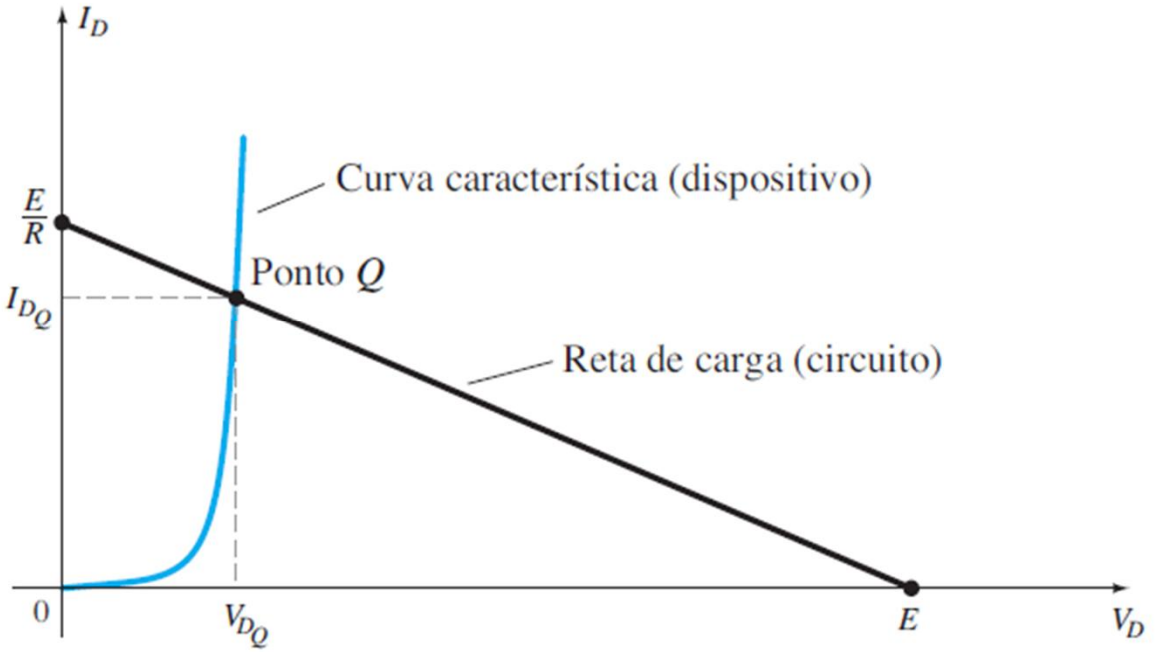
ANÁLISE POR RETA DE CARGA

- A interseção pode ser determinada aplicando a Lei das Tensões de Kirchhoff:

$$E = V_D + I_D R$$

$$I_D = \frac{E}{R}\Big|_{V_D=0} \qquad V_D = E\Big|_{I_D=0}$$





ANÁLISE POR RETA DE CARGA

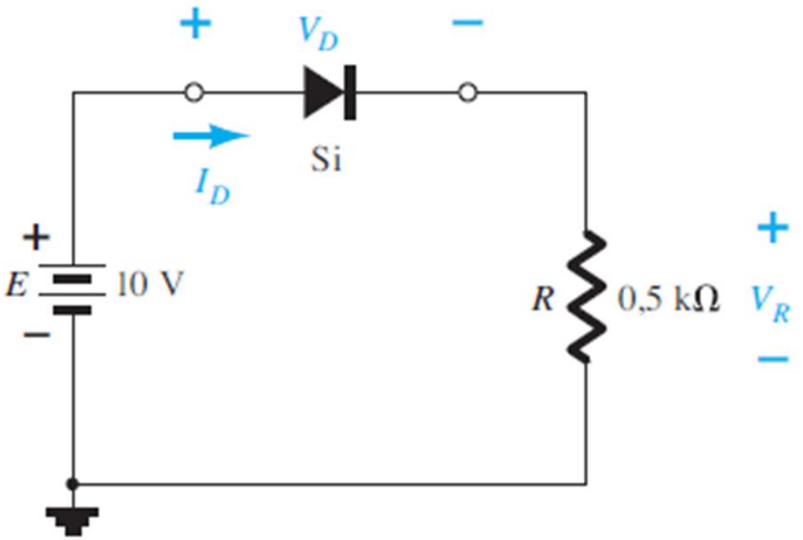
- Exemplo numérico:

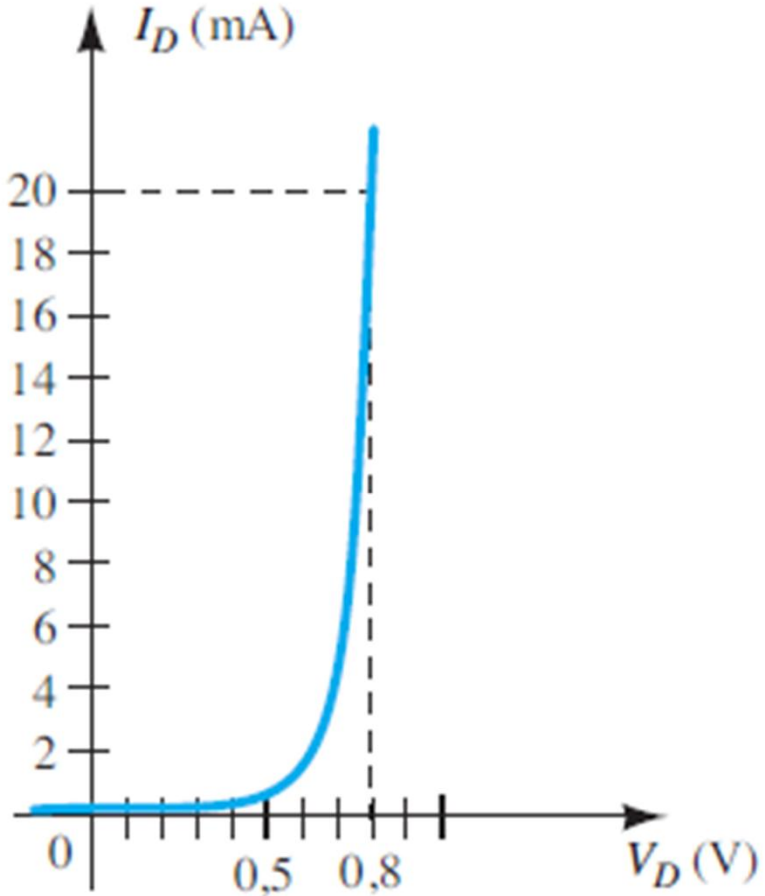
  Determine:

  a) V_{DQ} e I_{DQ}.

  b) V_R

  c) Resistência cc do diodo





ANÁLISE POR RETA DE CARGA

- Exemplo numérico:

a) V_{DQ} e I_{DQ}

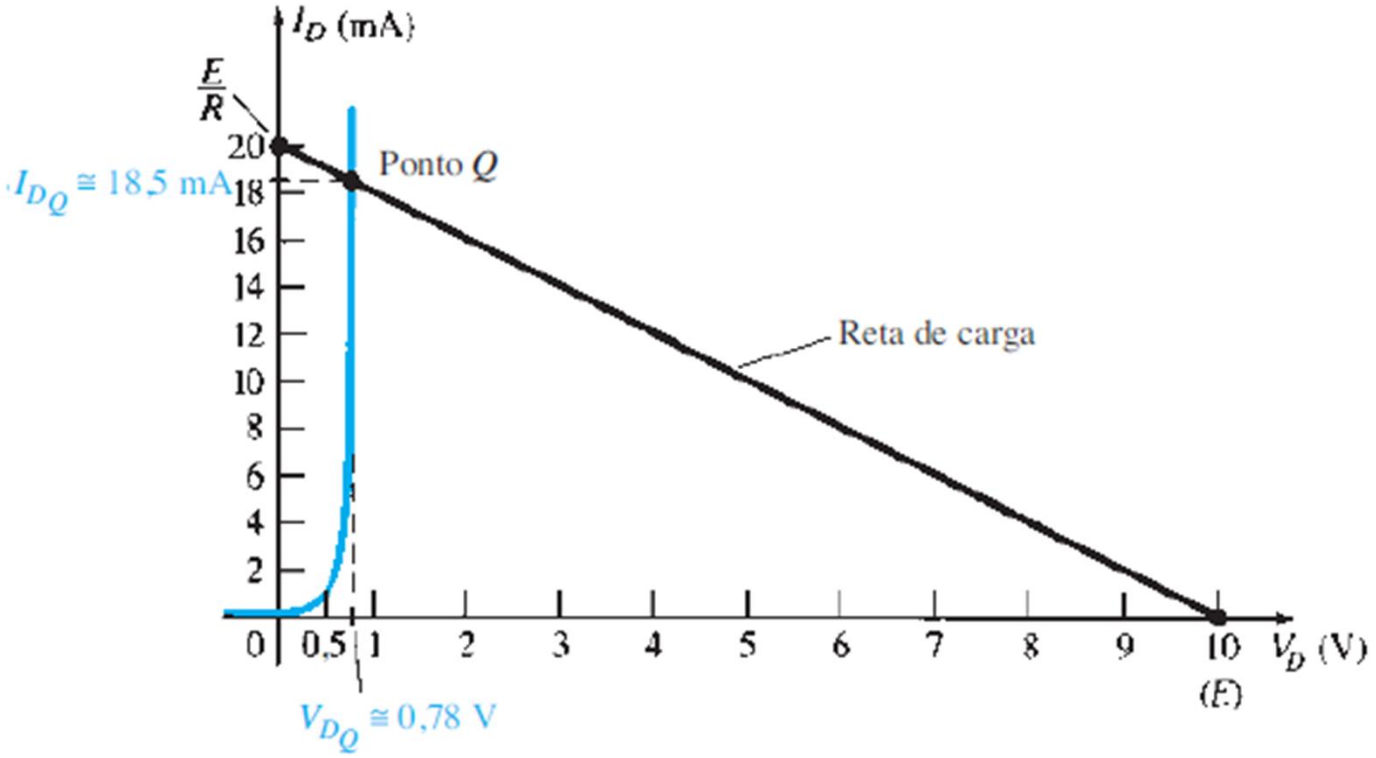
$V_{D_Q} \cong \mathbf{0{,}78\ V}$

$I_{D_Q} \cong \mathbf{18{,}5\ mA}$

Pontos da reta:

$$I_D = \left.\frac{E}{R}\right|_{V_D = 0\ \text{V}} = \frac{10\ \text{V}}{0{,}5\ \text{k}\Omega} = 20\ \text{mA}$$

$$V_D = E|_{I_D = 0\ \text{A}} = 10\ \text{V}$$



ANÁLISE POR RETA DE CARGA

- Exemplo numérico:

b) V_R

$$V_R = E - V_D = 10\ \text{V} - 0{,}78\ \text{V} = \mathbf{9{,}22\ V}$$

c) Resistência cc do diodo

$$R_D = \frac{V_{D_Q}}{I_{D_Q}} = \frac{0{,}78\ \text{V}}{18{,}5\ \text{mA}} = 42{,}16\ \Omega$$

CIRCUITOS RETIFICADORES

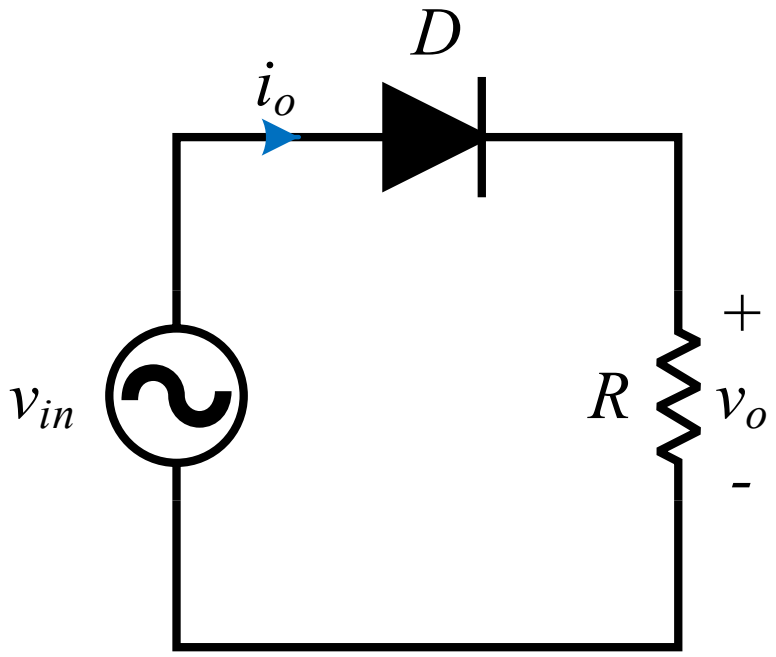
CIRCUITOS RETIFICADORES

- Os retificadores possuem entrada CA (alternada) e saída CC (contínua).

  - **Monofásicos: meia onda e onda-completa;**

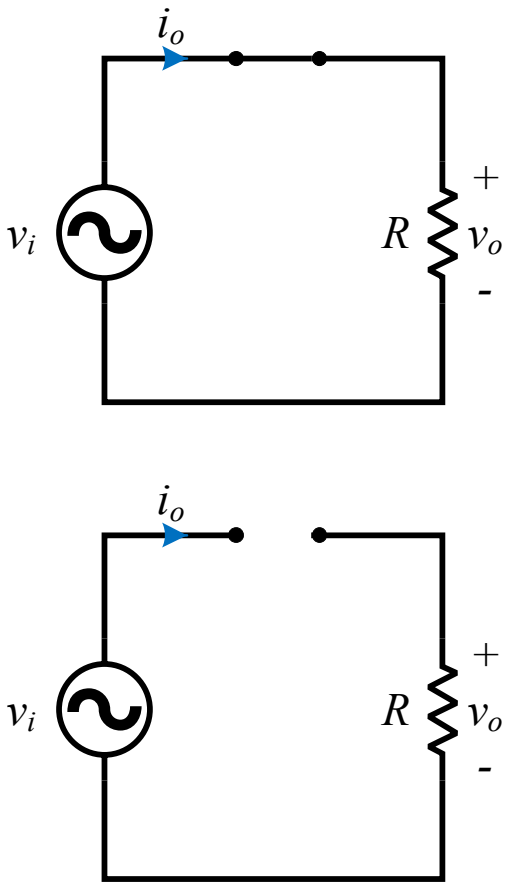
CIRCUITOS RETIFICADORES

- **RETIFICAÇÃO DE MEIA-ONDA:**



CIRCUITOS RETIFICADORES

- **RETIFICAÇÃO DE MEIA-ONDA:**



- Possui duas etapas de operação:

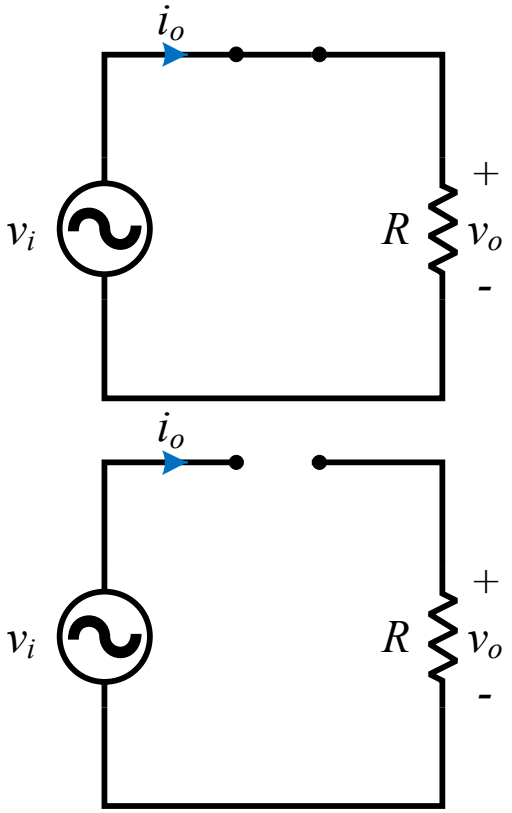
❑ **1ª etapa:** Semiciclo positivo da tensão de entrada, $v_{in}>0$, o diodo é polarizado diretamente e entra em condução. A tensão de entrada é aplicada na carga R.

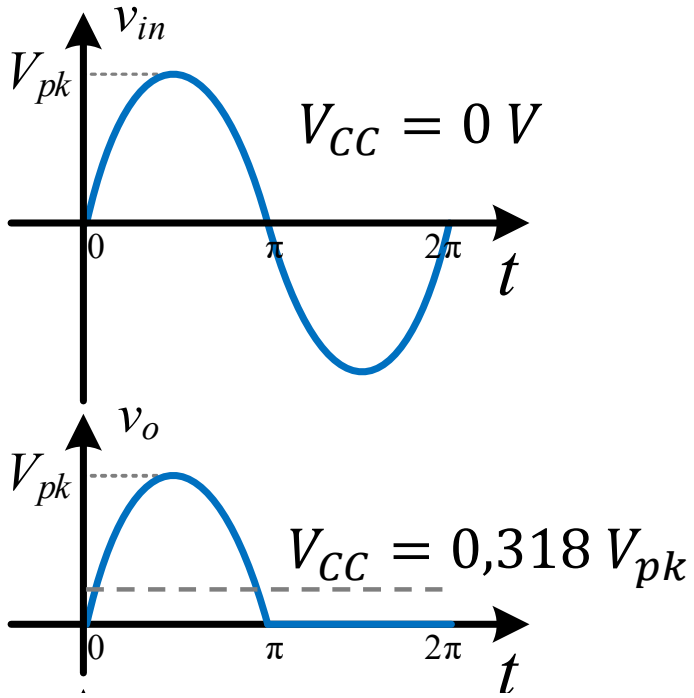
❑ **2ª etapa:** Semiciclo negativo da tensão de entrada, $v_{in}<0$, o diodo está bloqueado e a tensão na carga é zero.

CIRCUITOS RETIFICADORES

- **RETIFICAÇÃO DE MEIA-ONDA:**

$$v_{i(\omega t)} = V_{pk} sen(\omega t)$$

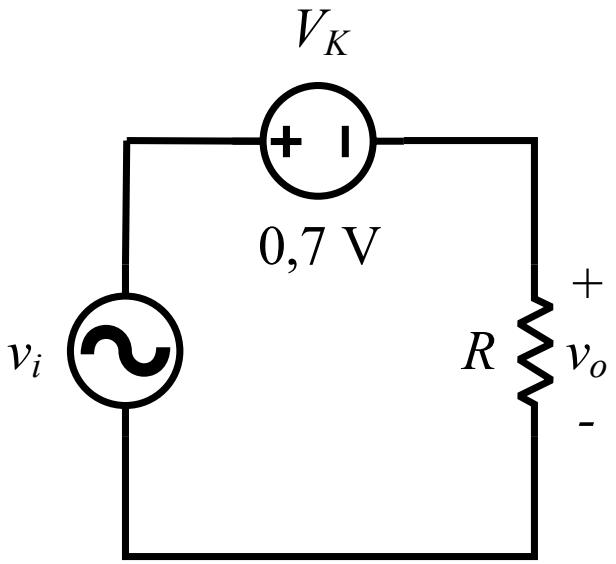


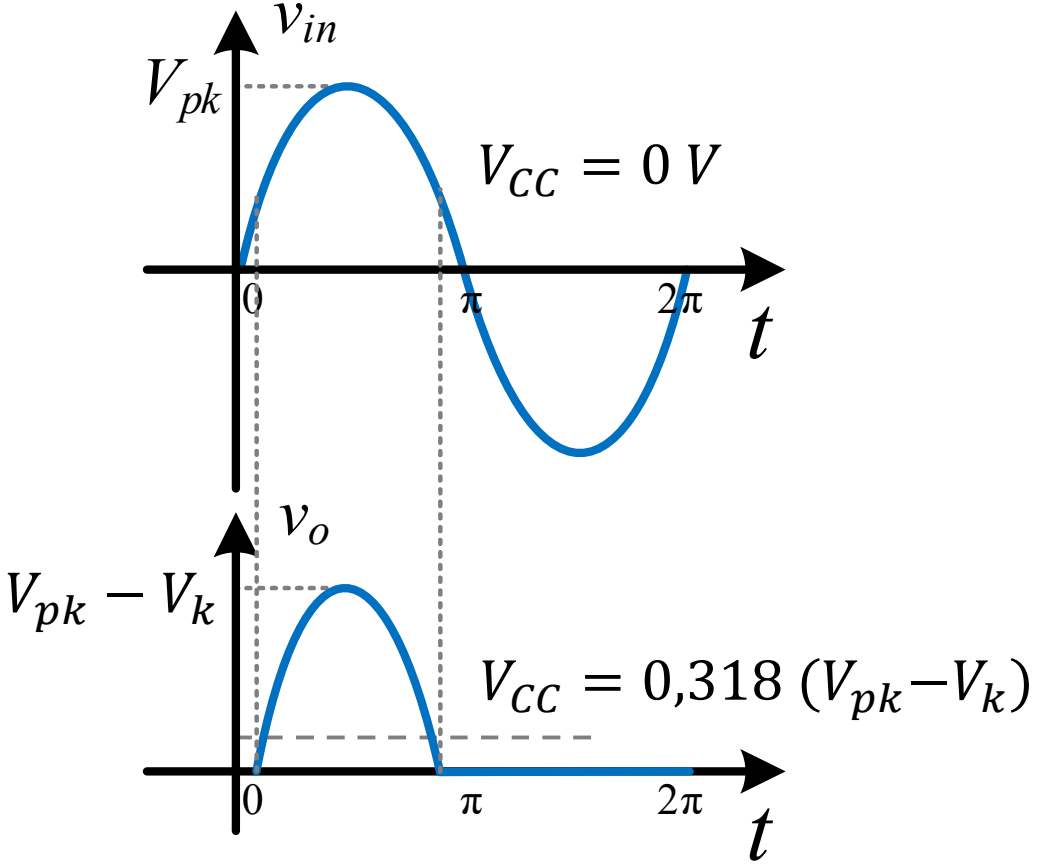


CIRCUITOS RETIFICADORES

- **RETIFICAÇÃO DE MEIA-ONDA (diodo real):**

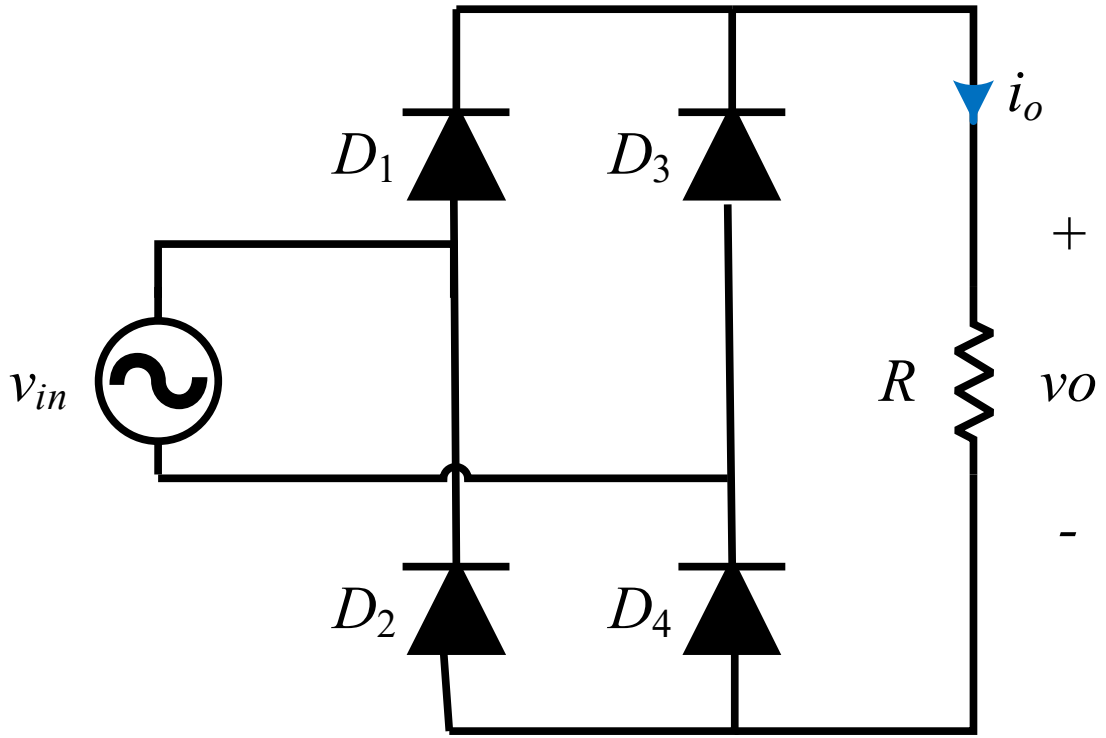
$$v_{i(\omega t)} = V_{pk} sen(\omega t)$$





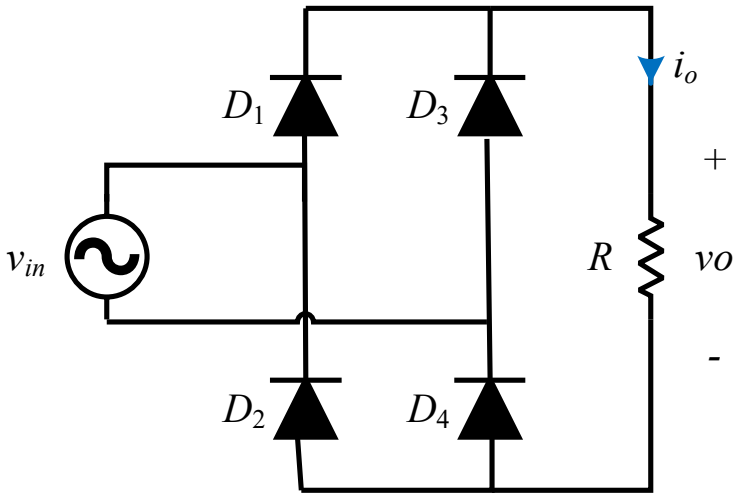
CIRCUITOS RETIFICADORES

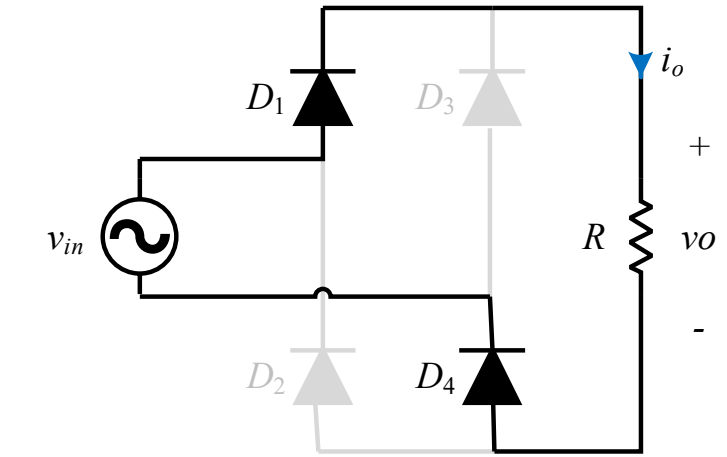
- **RETIFICAÇÃO DE ONDA COMPLETA:**

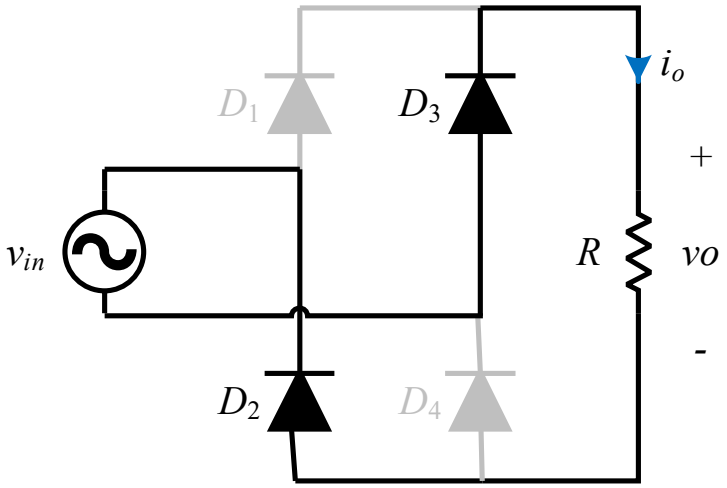


CIRCUITOS RETIFICADORES

- **RETIFICAÇÃO DE ONDA COMPLETA:**

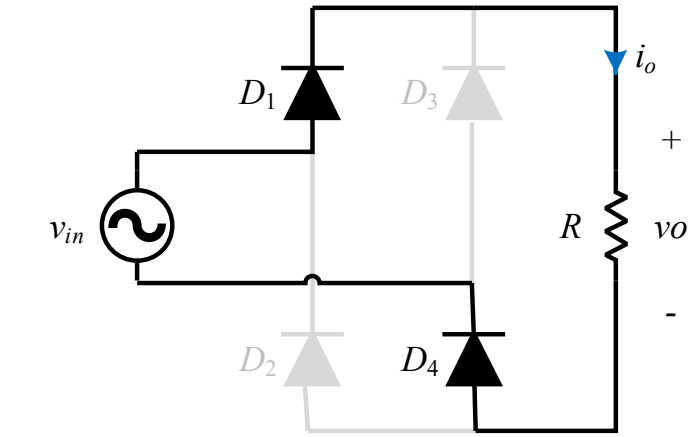


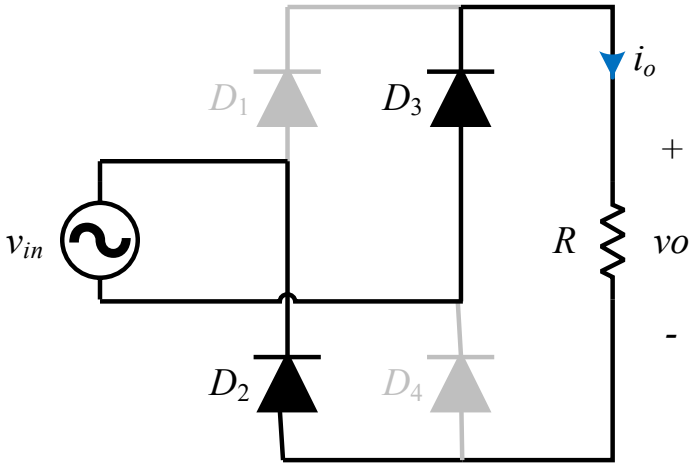




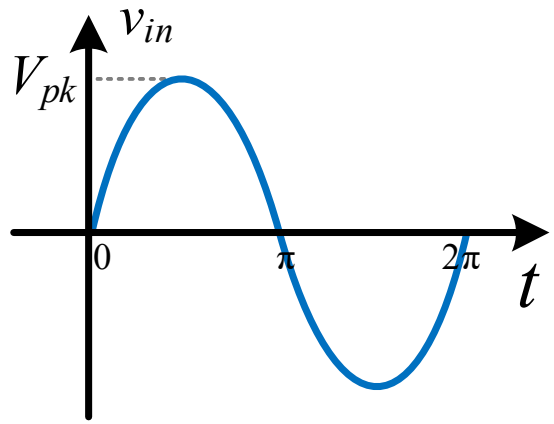
CIRCUITOS RETIFICADORES

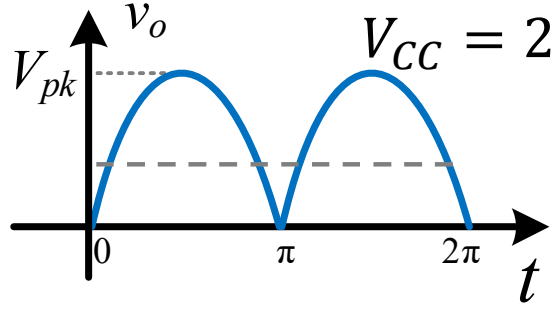
- **RETIFICAÇÃO DE ONDA COMPLETA:**





$$v_{in(\omega t)} = V_{pk} sen(\omega t)$$

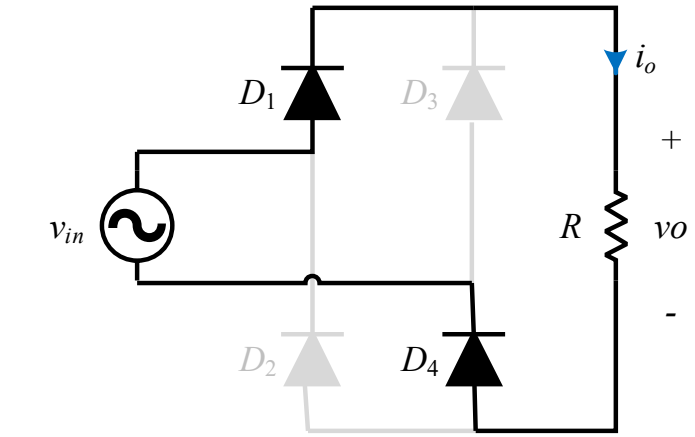


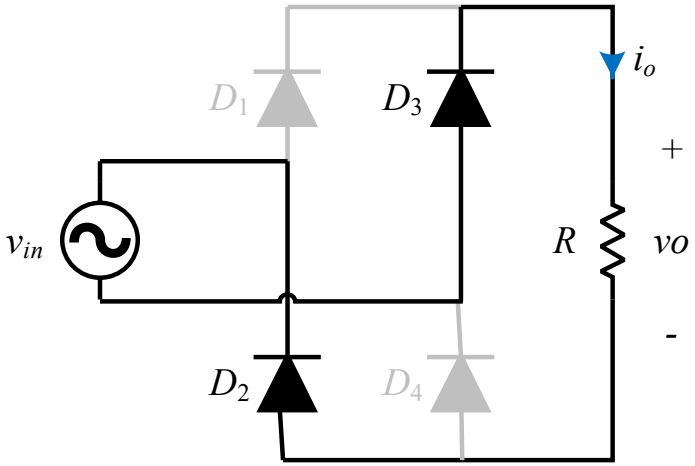


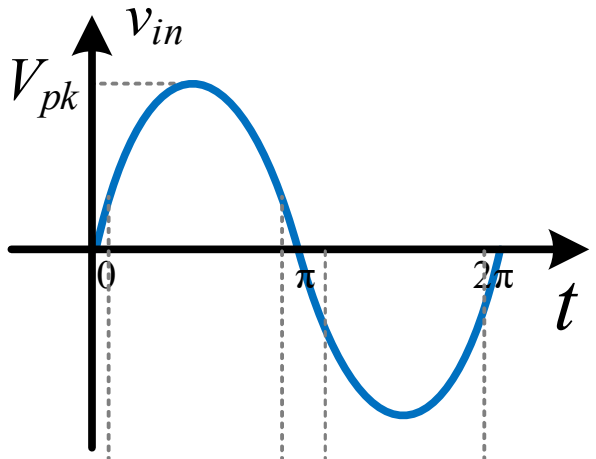
$$V_{CC} = 2 * 0{,}318\ (V_{pk})$$

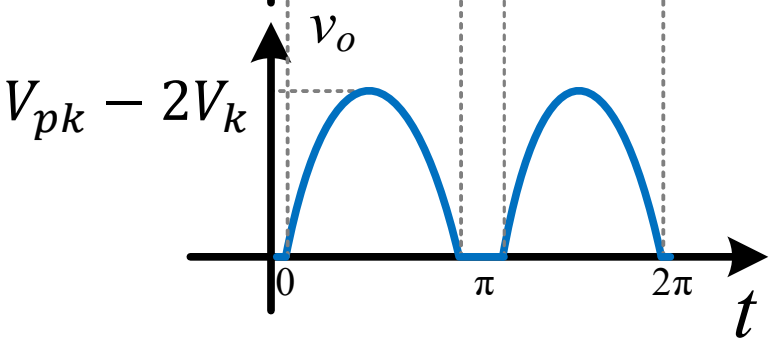
CIRCUITOS RETIFICADORES

- **RETIFICAÇÃO DE ONDA COMPLETA (diodo real):**









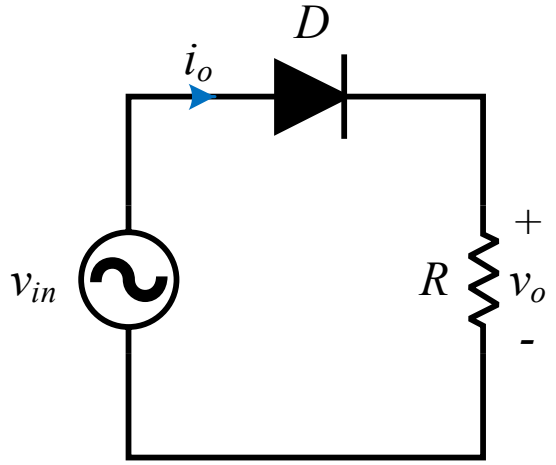
$$V_{CC} = 2 * 0{,}318\ (V_{pk} - 2V_k)$$

CIRCUITOS CEIFADORES

CIRCUITOS CEIFADORES

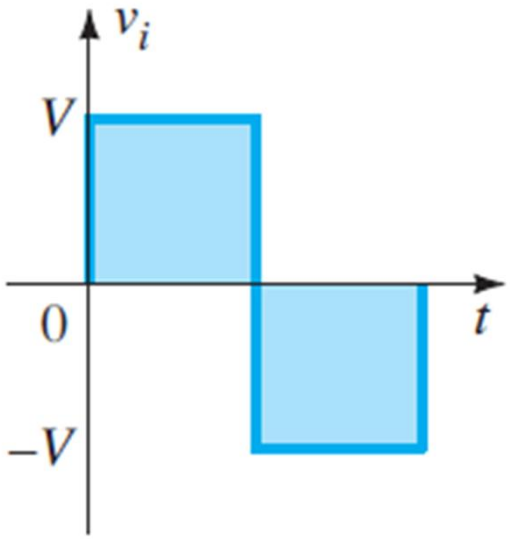
- **Ceifadores** são circuitos que utilizam diodos para "ceifar" uma porção de um sinal de entrada sem distorcer o restante da forma de onda aplicada.

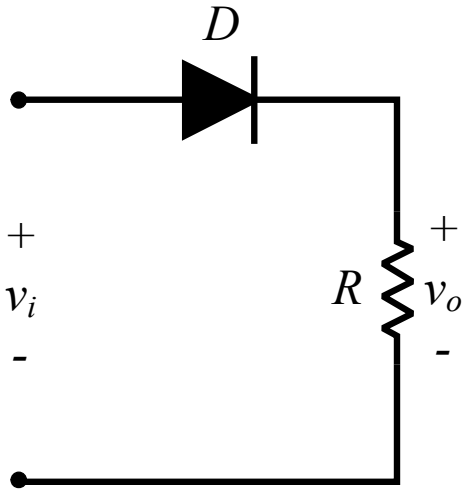
- Retificador de meia onda é o exemplo da forma mais simples de um ceifador.



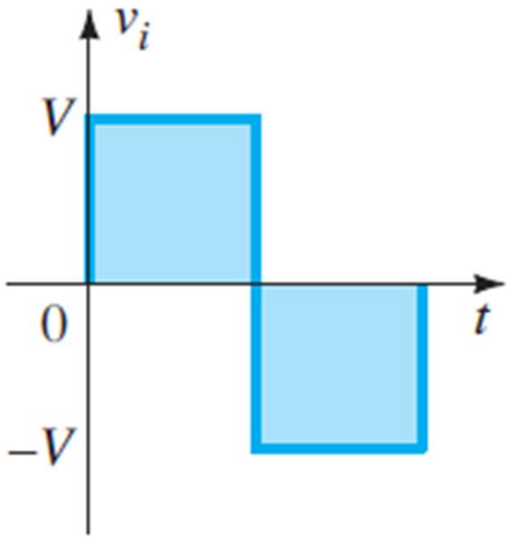
- Há duas categorias gerais de ceifadores: em série e em paralelo.

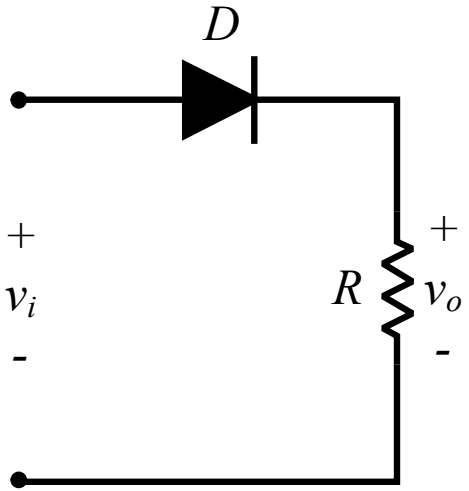
CEIFADORES EM SÉRIE

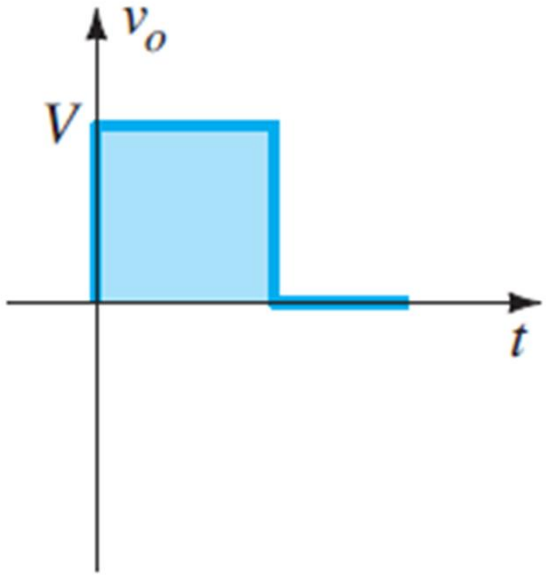




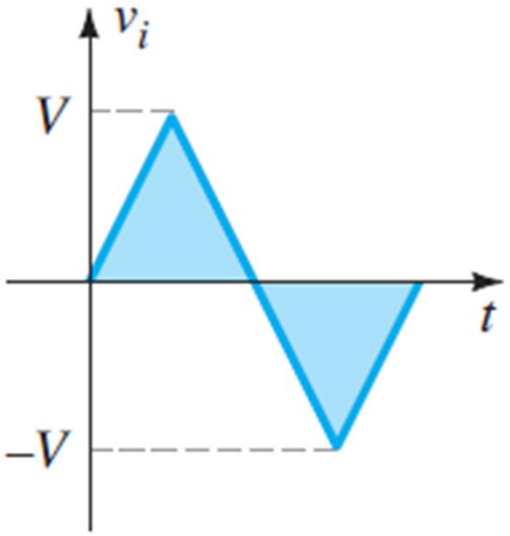
CEIFADORES EM SÉRIE

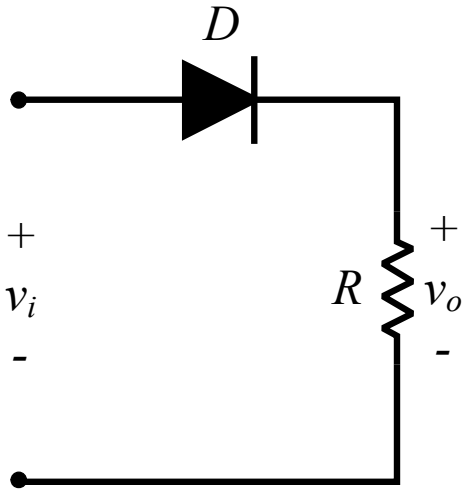






CEIFADORES EM SÉRIE





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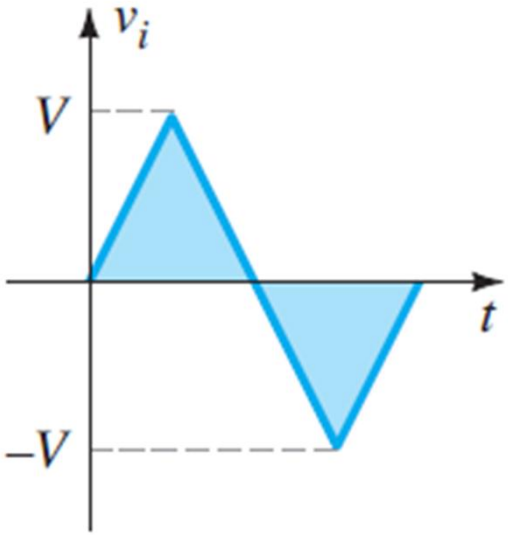

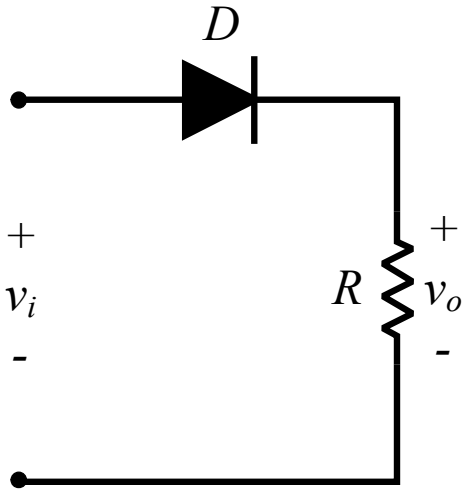

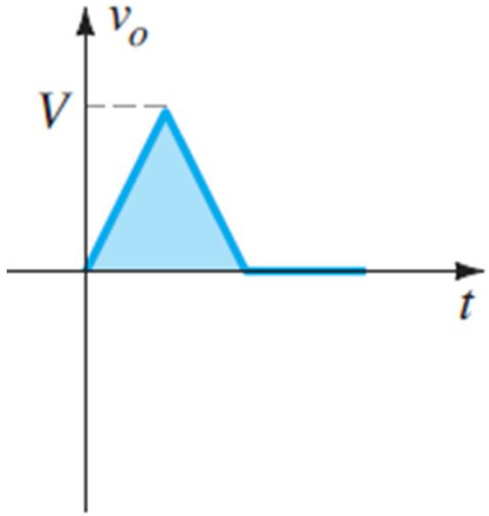

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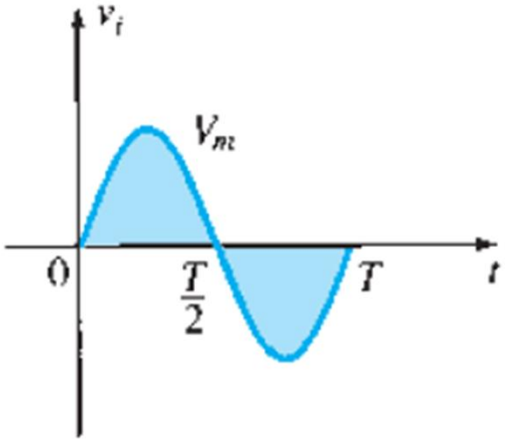

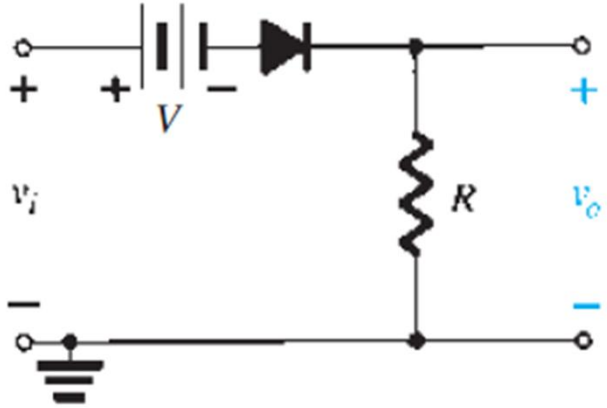

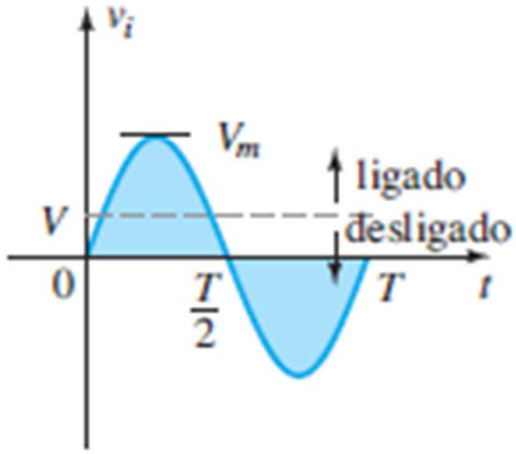

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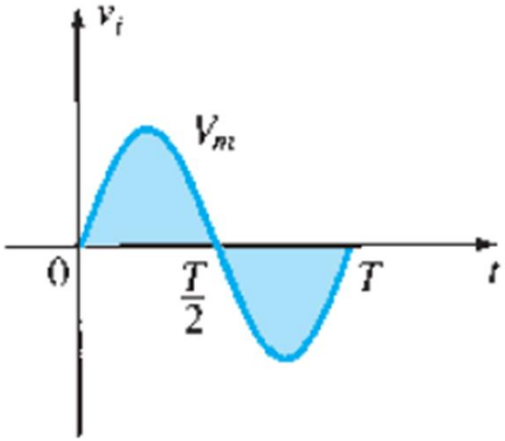
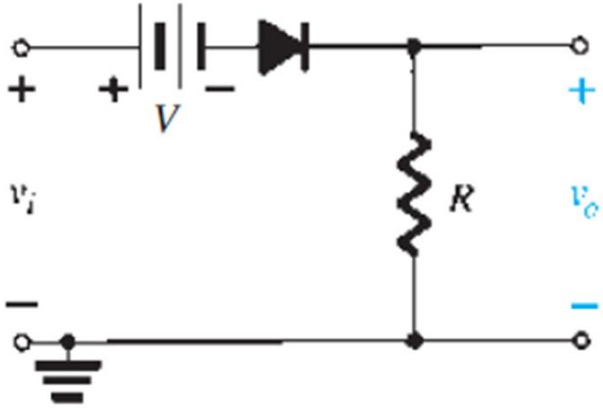
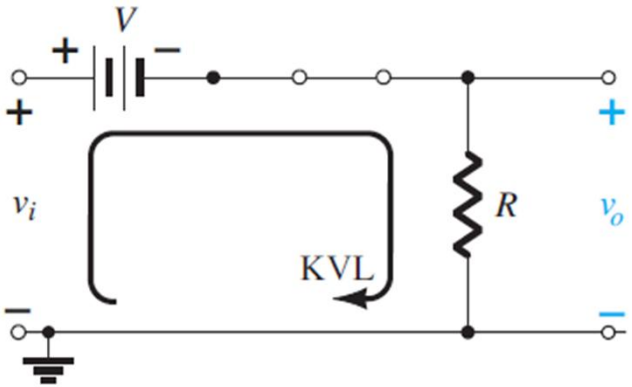


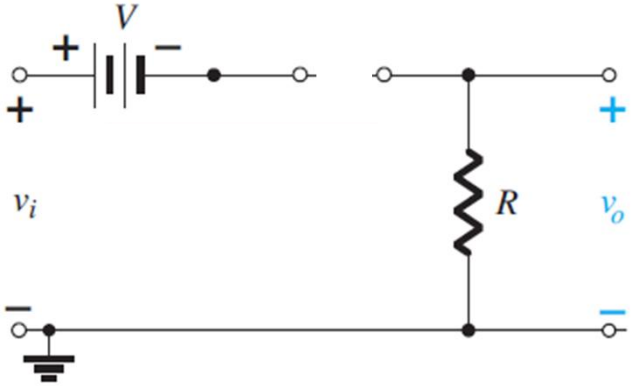


Diodo on



$v_o = v_i - V$

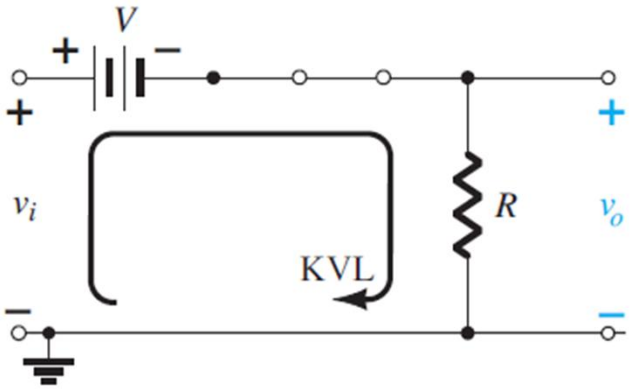
Diodo off



$v_o = 0\ V$

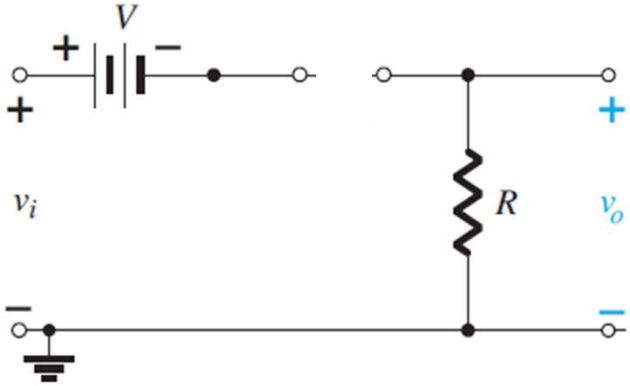
CEIFADORES EM SÉRIE

Diodo on

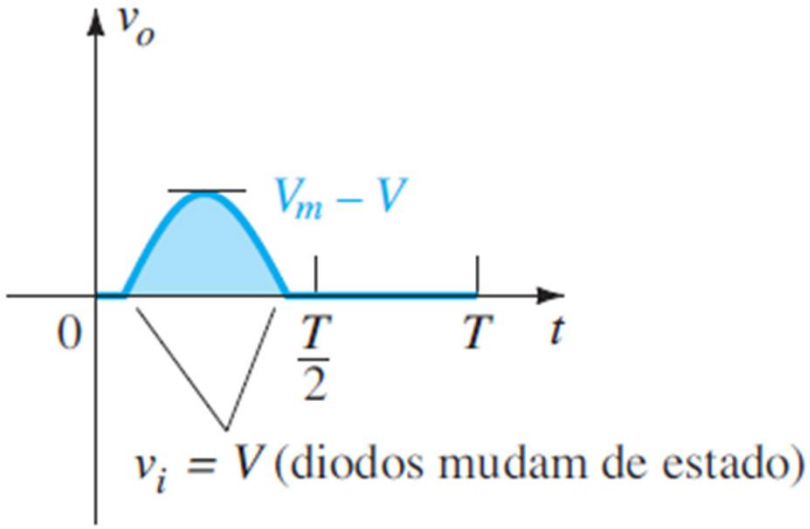


$$v_o = v_i - V$$

Diodo off

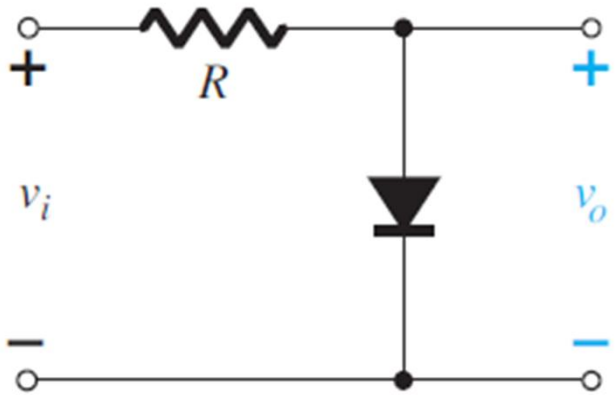


$$v_o = 0\ V$$

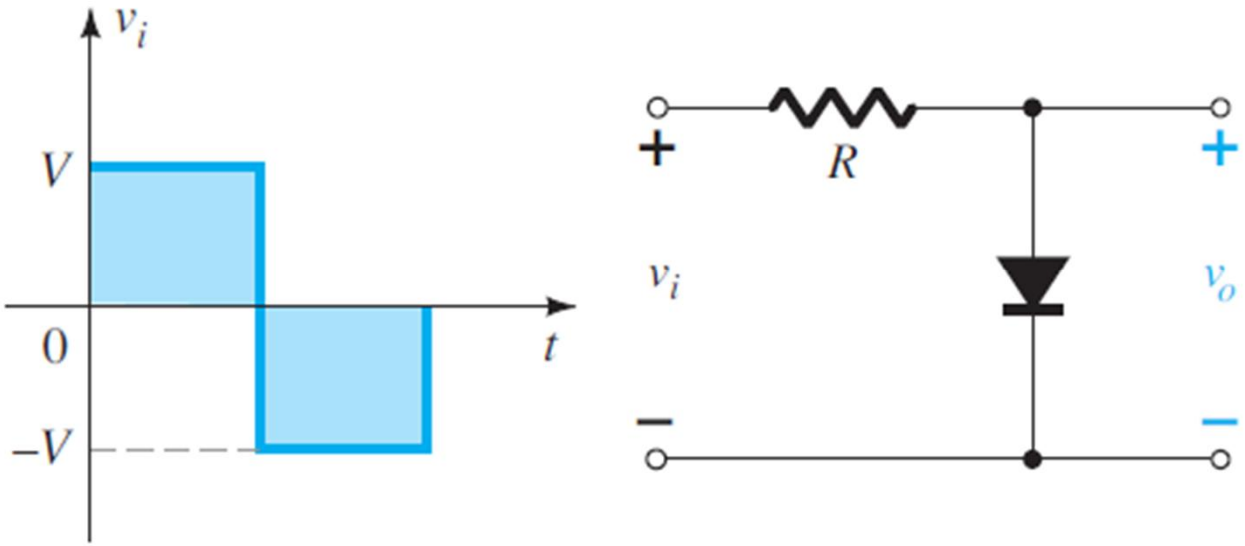


$v_i = V$ (diodos mudam de estado)

CEIFADORES EM PARALELO



CEIFADORES EM PARALELO



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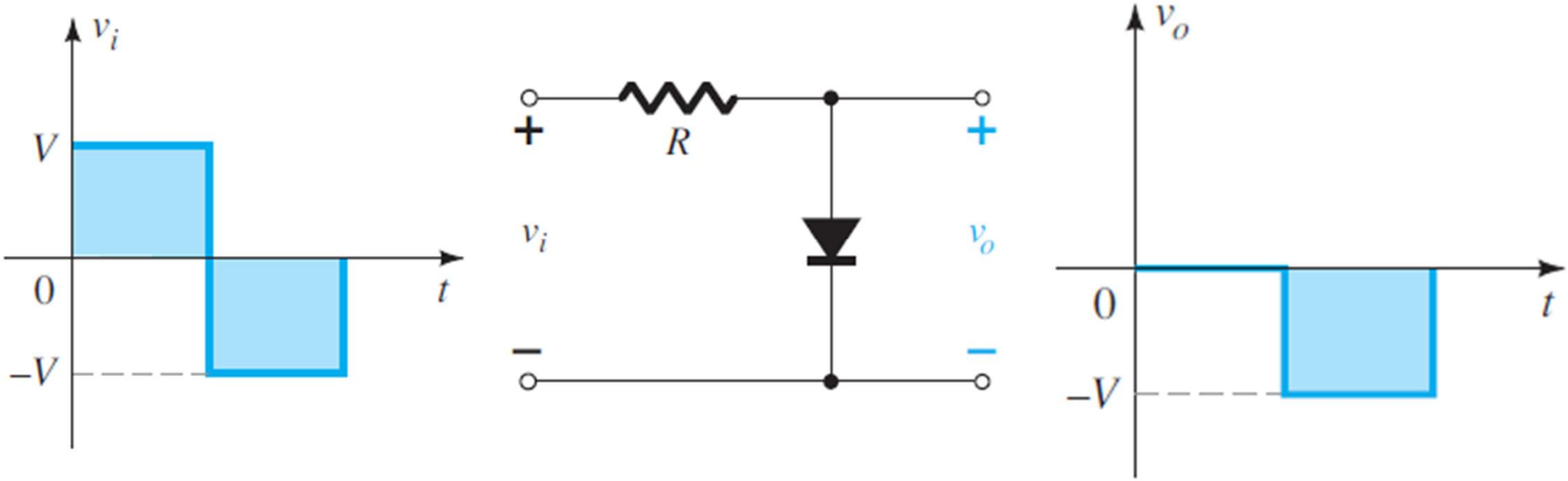

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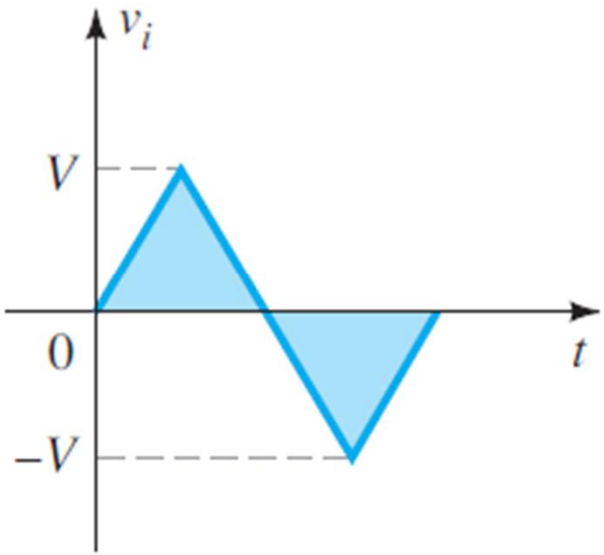

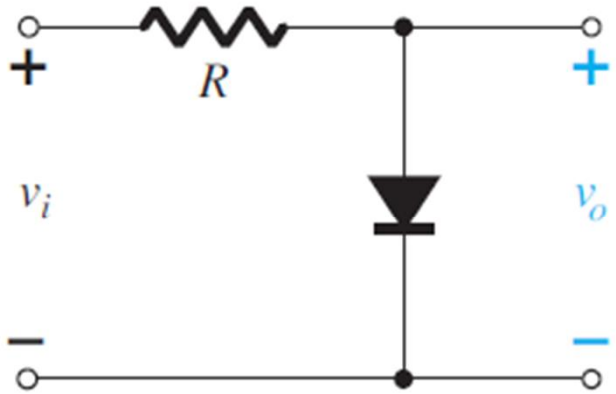

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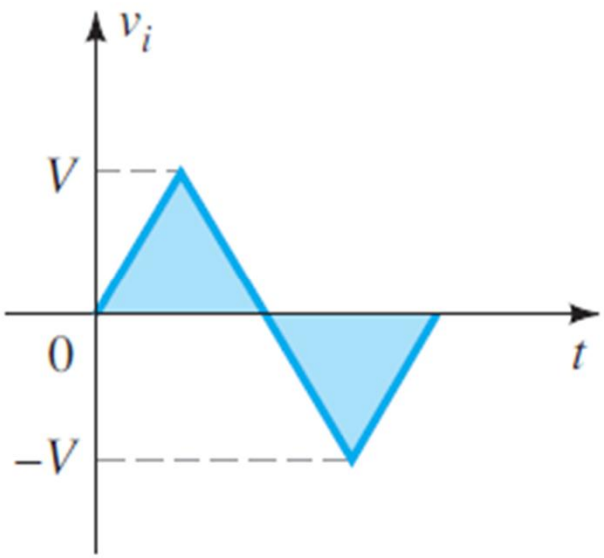
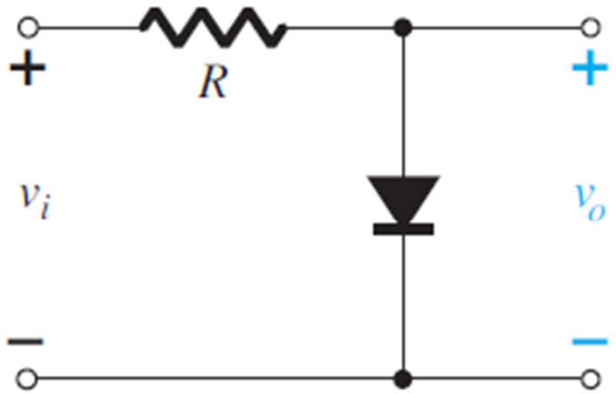
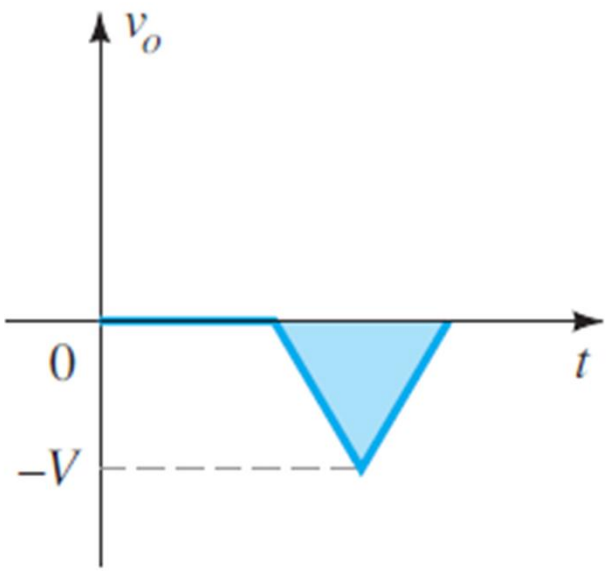


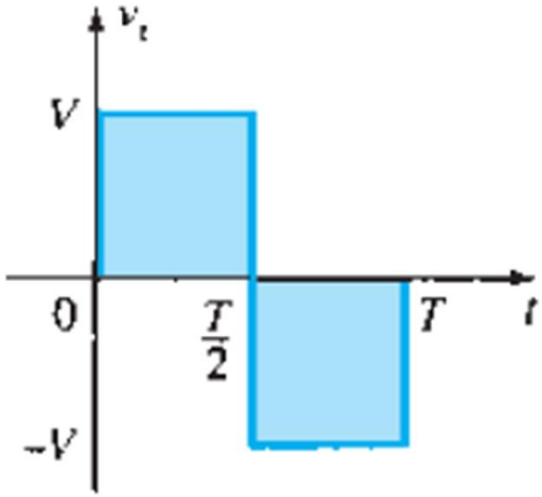


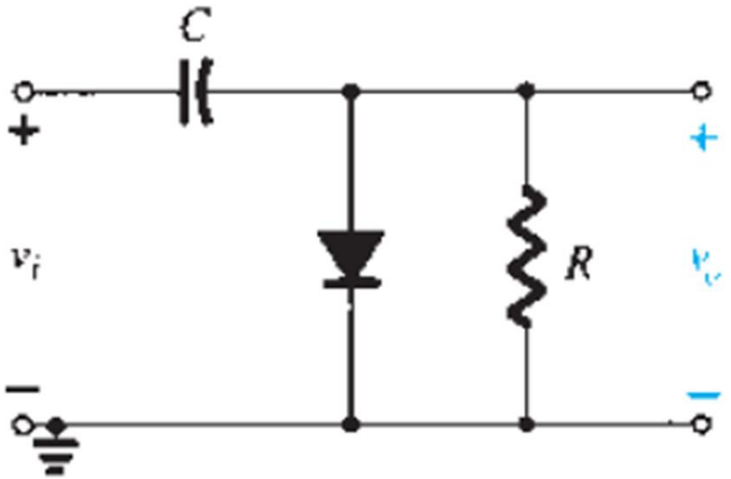


CIRCUITOS GRAMPEADORES

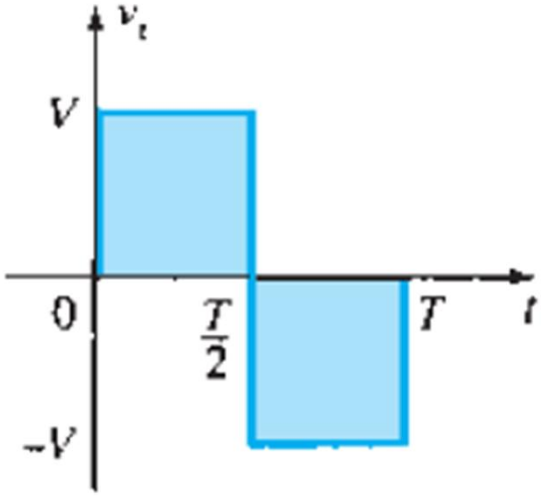
CIRCUITOS GRAMPEADORES

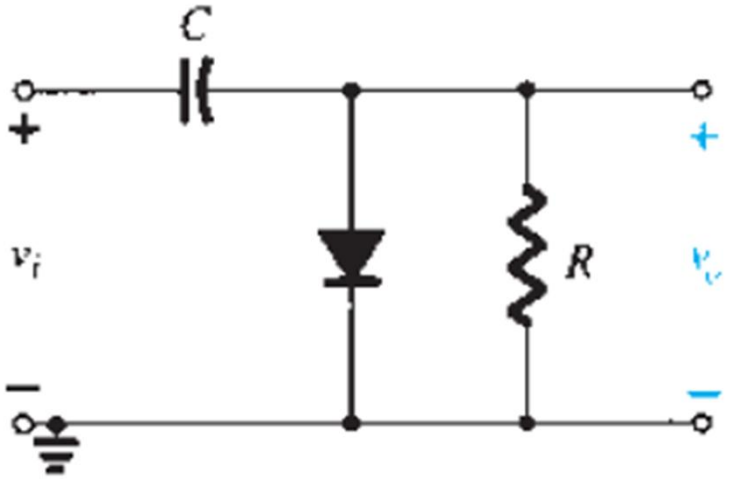
- **Grampeadores** são circuitos constituídos de um diodo, um resistor e um capacitor que desloca uma forma de onda para um nível CC diferente, sem alterar a aparência do sinal aplicado.



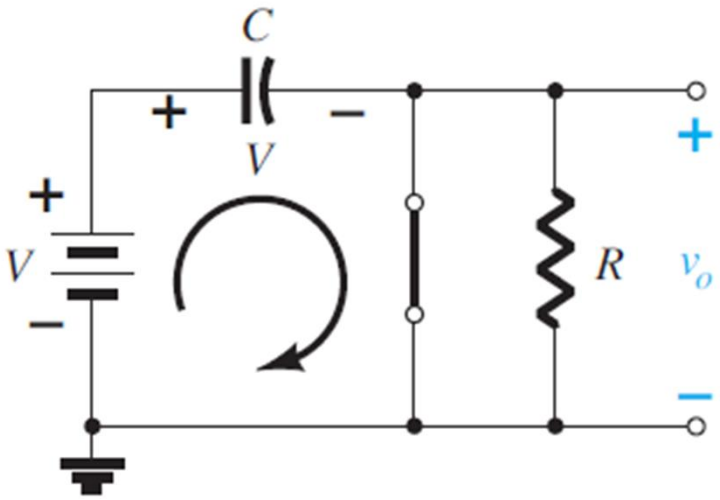


CIRCUITOS GRAMPEADORES



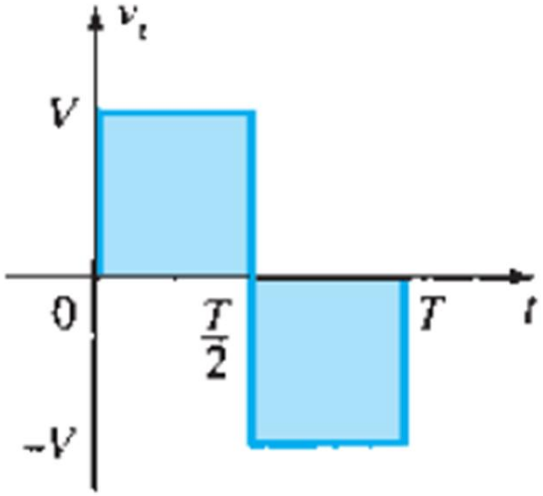


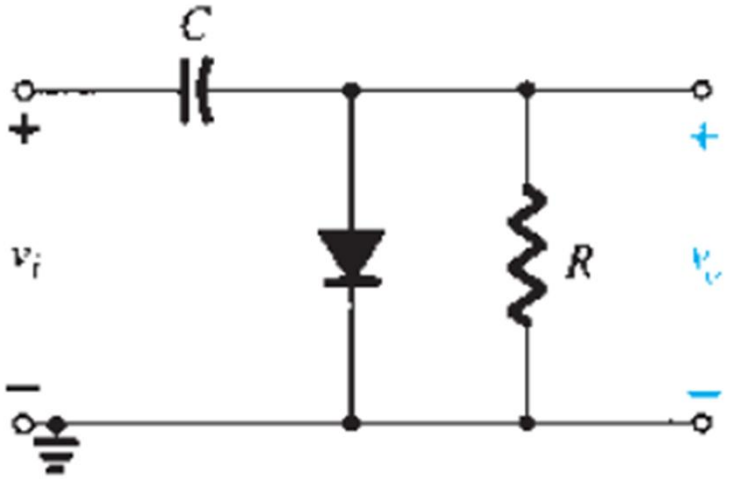
Diodo on



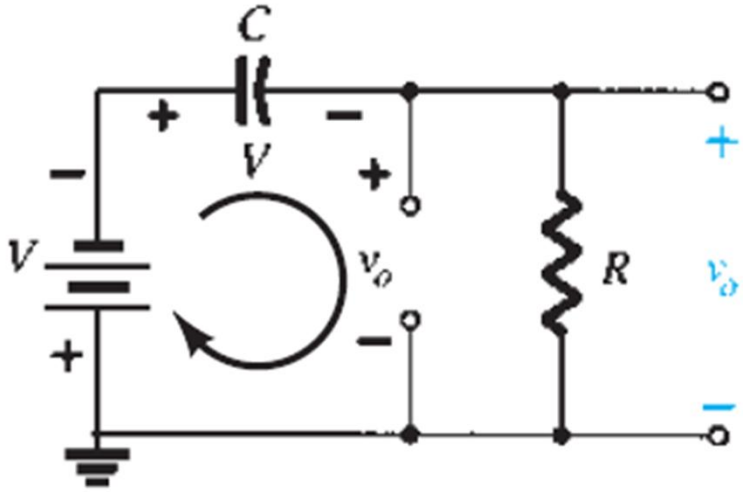
$V_o = 0V$

CIRCUITOS GRAMPEADORES





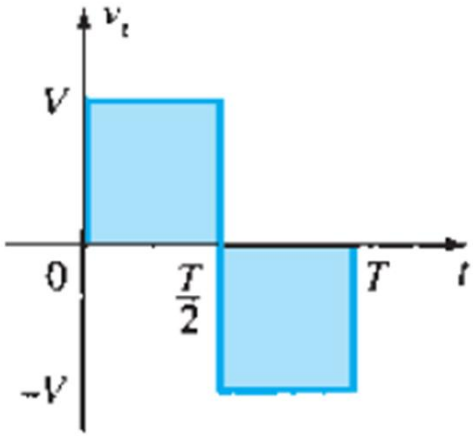
Diodo off

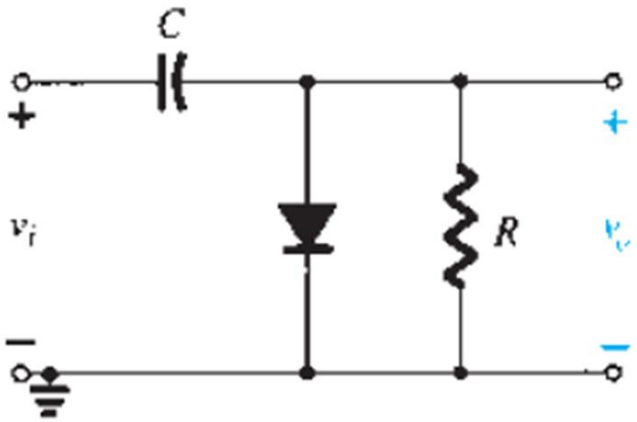


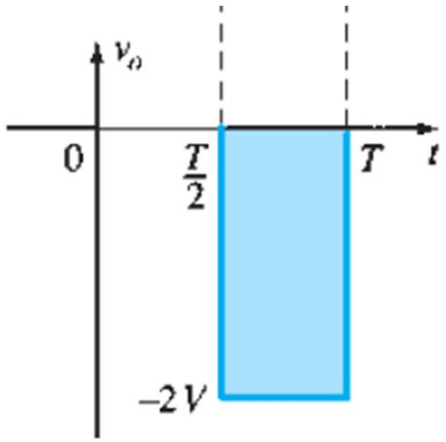
$$+V + V + V_o = 0$$

$$V_o = -2V$$

CIRCUITOS GRAMPEADORES







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Até a próxima aula!

Joinville, 2025