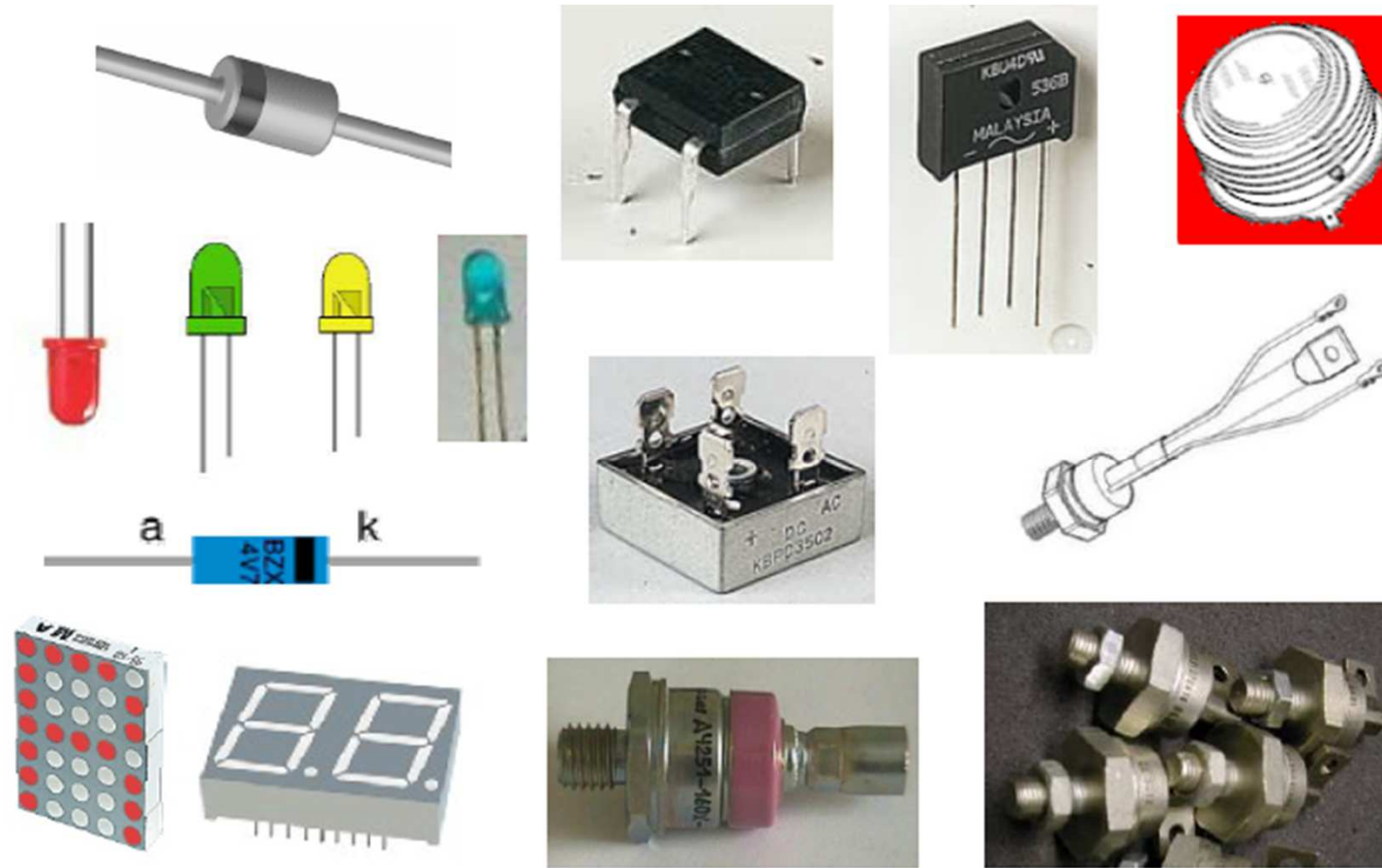


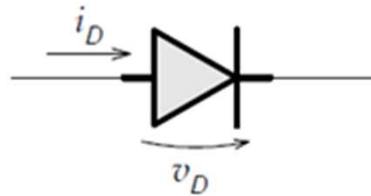
# 1- Diodos



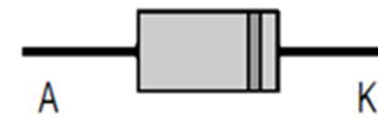
- Componente de dois terminais;
- Aplicações: conversor de tensão CA/CC, circuitos digitais, equipamentos de telecomunicações, circuitos de controle etc.



Junção PN



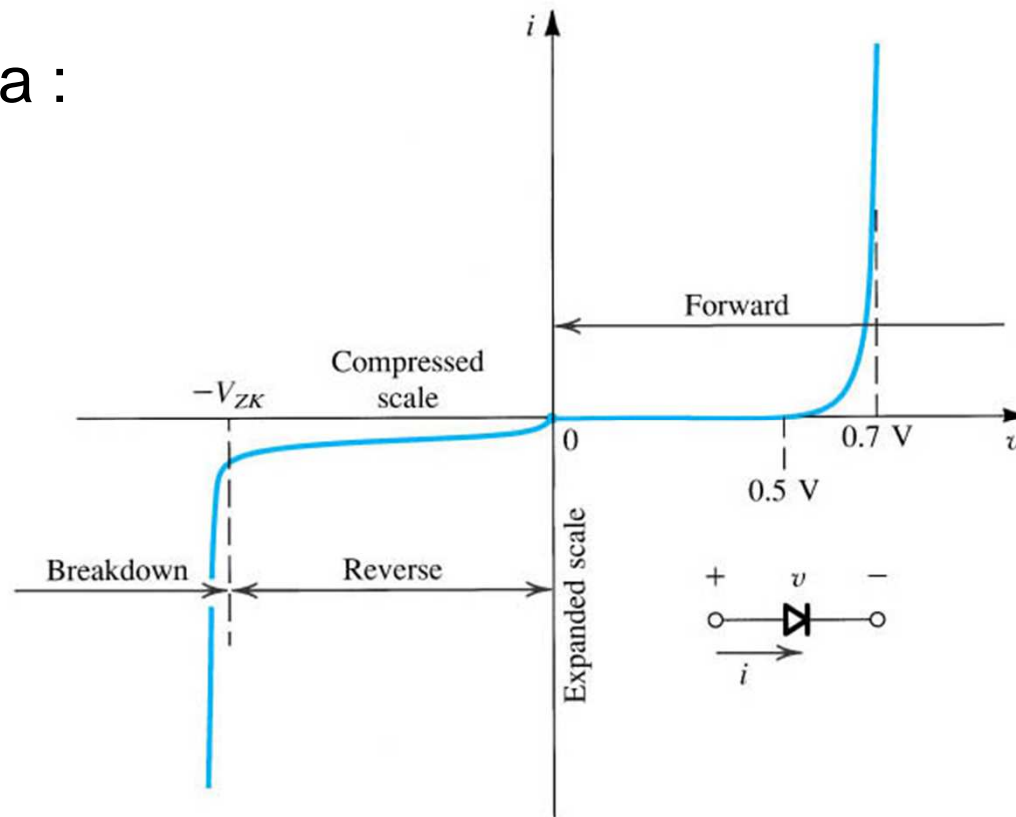
Símbolo



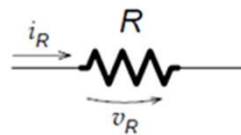
Forma comercial  
mais usual

O material mais utilizado na fabricação de diodos é o silício (Si), no qual é acrescentada pequenas quantidades de “impurezas” para produzir as junções do tipo P e N.

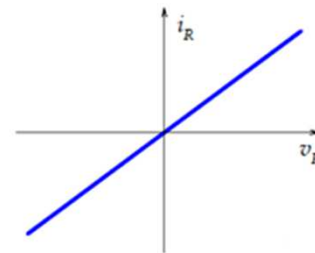
# Curva característica :



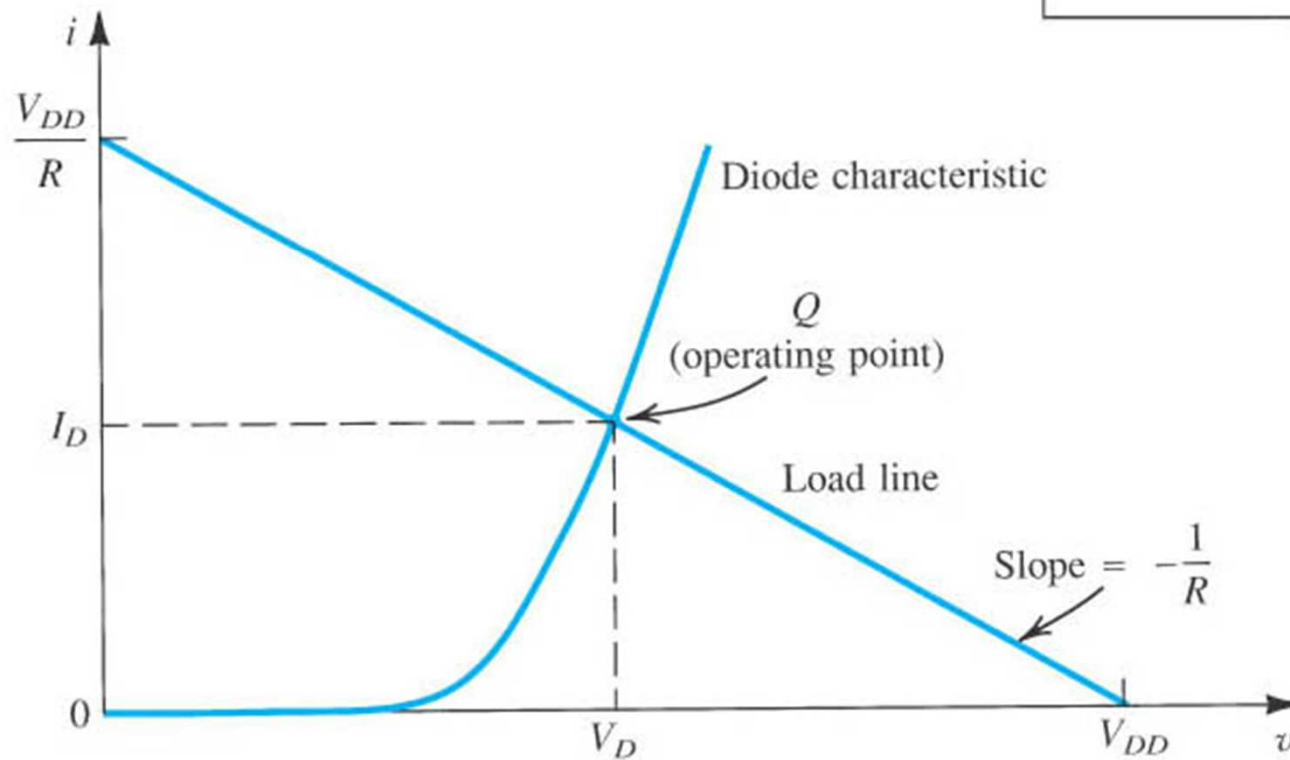
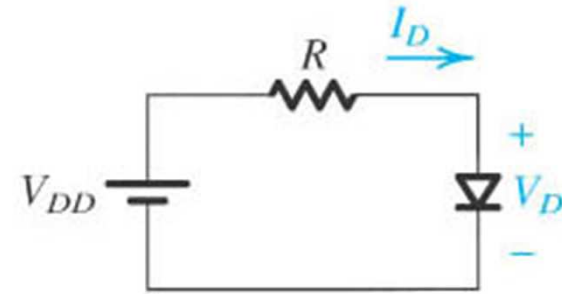
**Resistência**  
- dispositivo linear



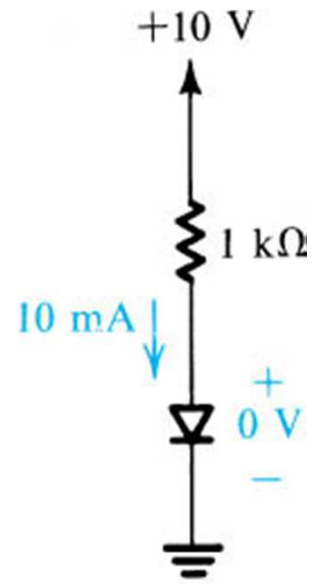
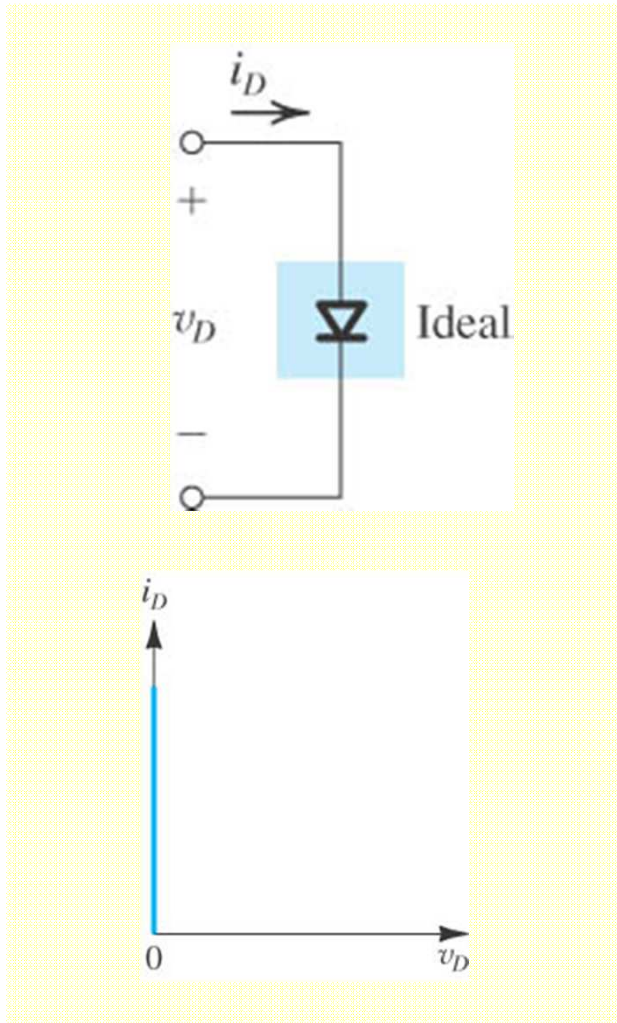
$$i_R = \frac{v_R}{R}$$



Ponto de operação:

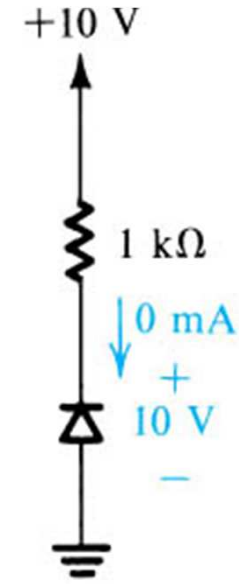


# Diodo ideal funcionando como chave:



(a)

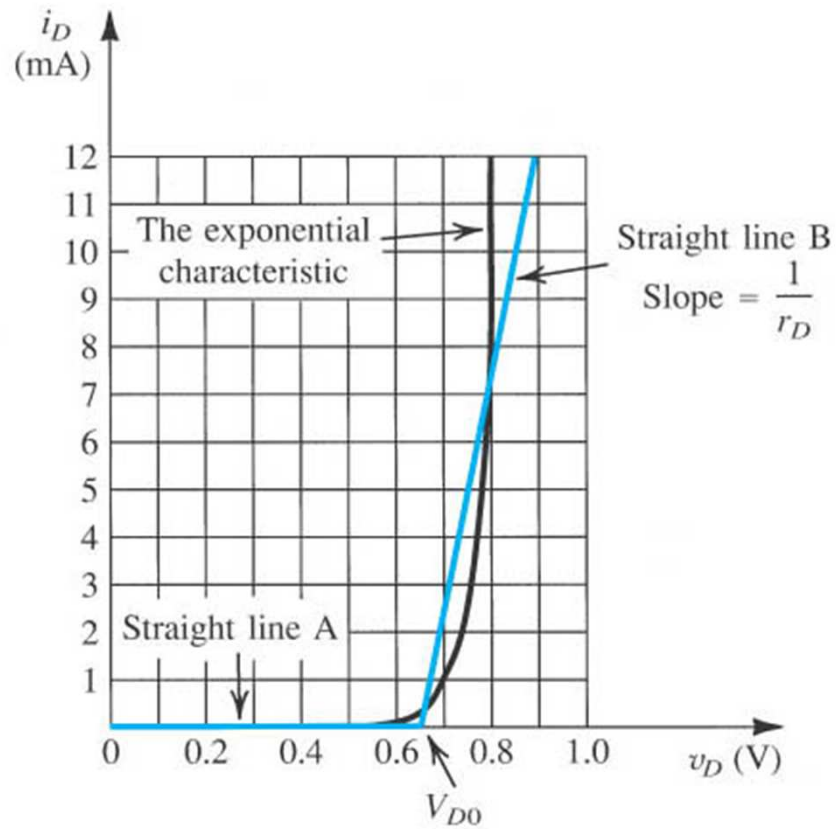
Chave fechada  
(condução)



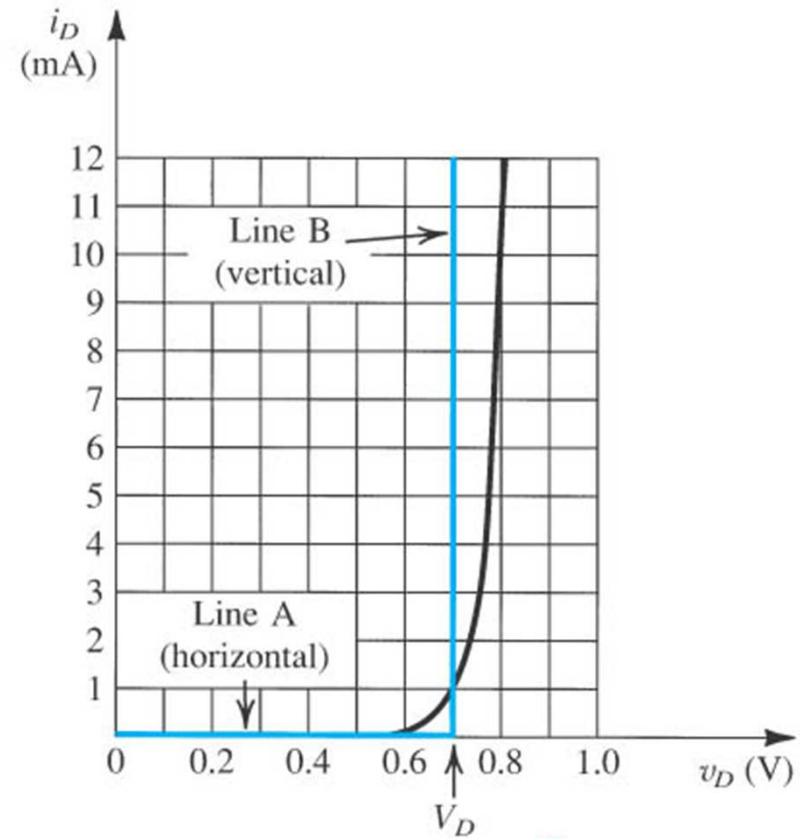
(b)

Chave aberta  
(bloqueio)

## Modelos de aproximação:

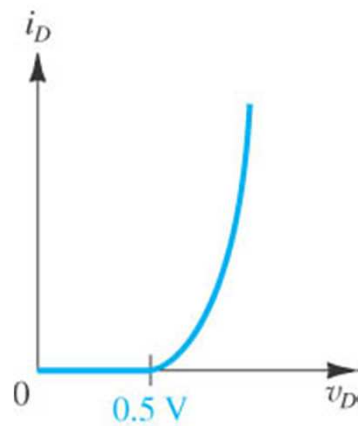
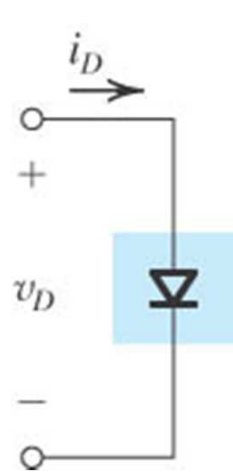


Modelo linear por partes

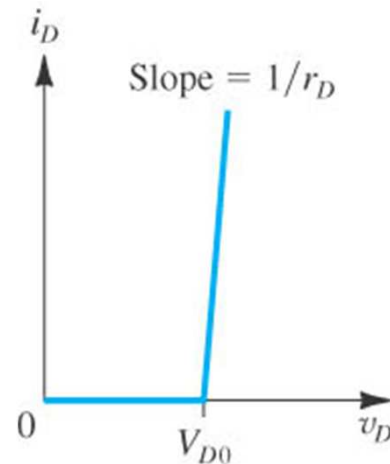
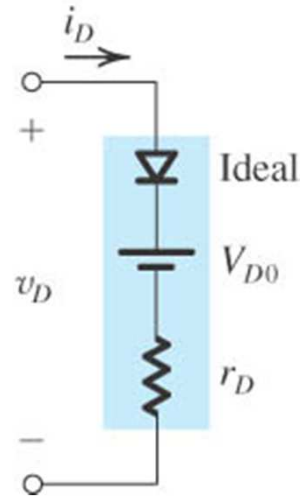


Modelo com queda de tensão constante

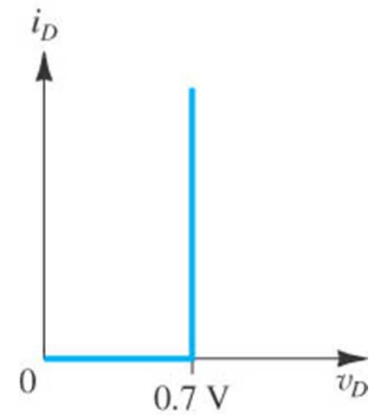
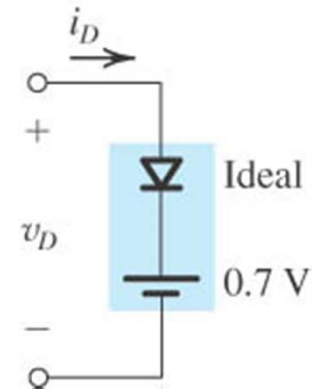
## Modelos de aproximação:



Real



Linear por partes



Queda de tensão constante

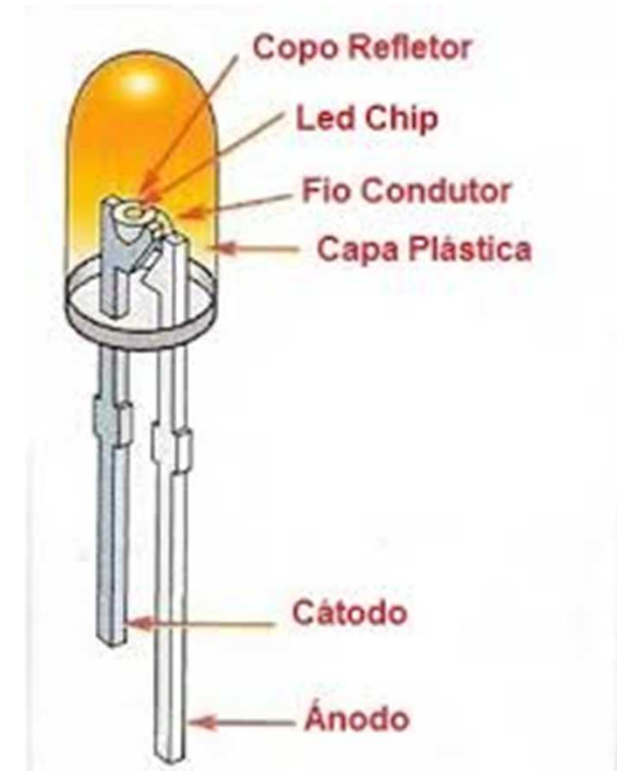
# LED – Diodo Emissor de Luz

## Aplicações:

- Sinalização, display, comando e controle.

## Características:

- Material: - Arsenieto de gálio (GaAs)  
- Fosfeto de gálio (GaP)
- Vida útil: > 40.000 h
- Acionamento instantâneo
- Baixa tensão de operação
- Robusto
- Não suportam tensão reversa de valor significativo (5 V)
- Correntes típicas de 10 a 50 mA
- Tensões típicas de 1,8 a 3 V

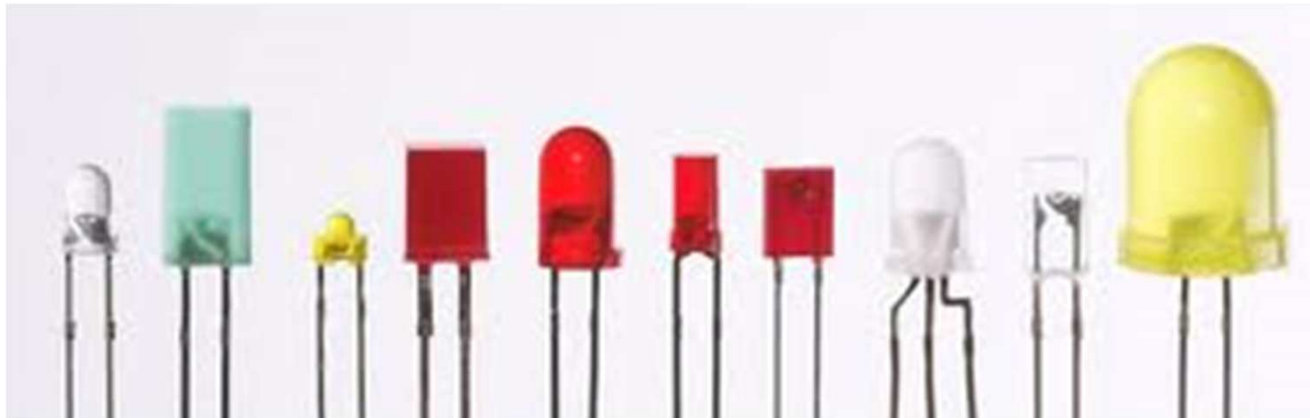
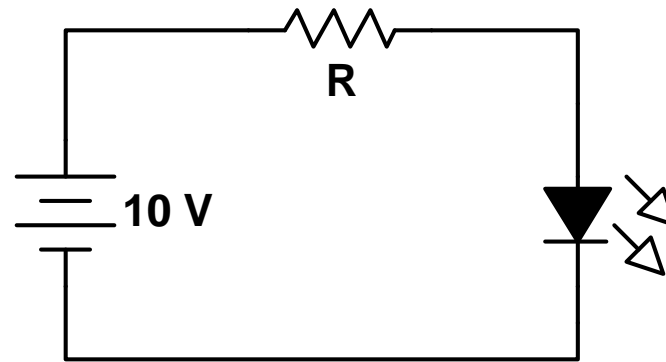




# LED – Diodo Emissor de Luz

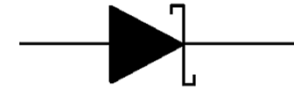
## Exemplo:

Calcule o valor do resistor abaixo para o funcionamento correto do LED.  
Considere  $V_L=2V$  e  $I_L=15mA$ .

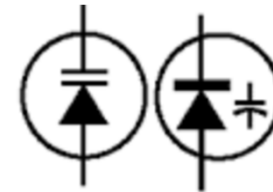


# Diodos especiais

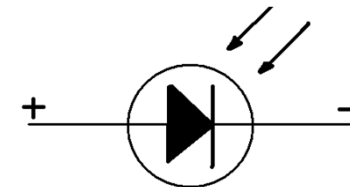
**Schottky:** Menor tempo de entrada em condução/bloqueio.  
Menor tensão de condução (entre 0,3 e 0,5V).



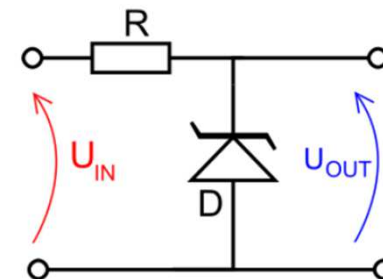
**Varactor ou varicap:** Diodo que possui uma capacitância variável que é função da tensão à qual ele é submetido.



**Fotodiodo:** Produz corrente elétrica na incidência de luz.



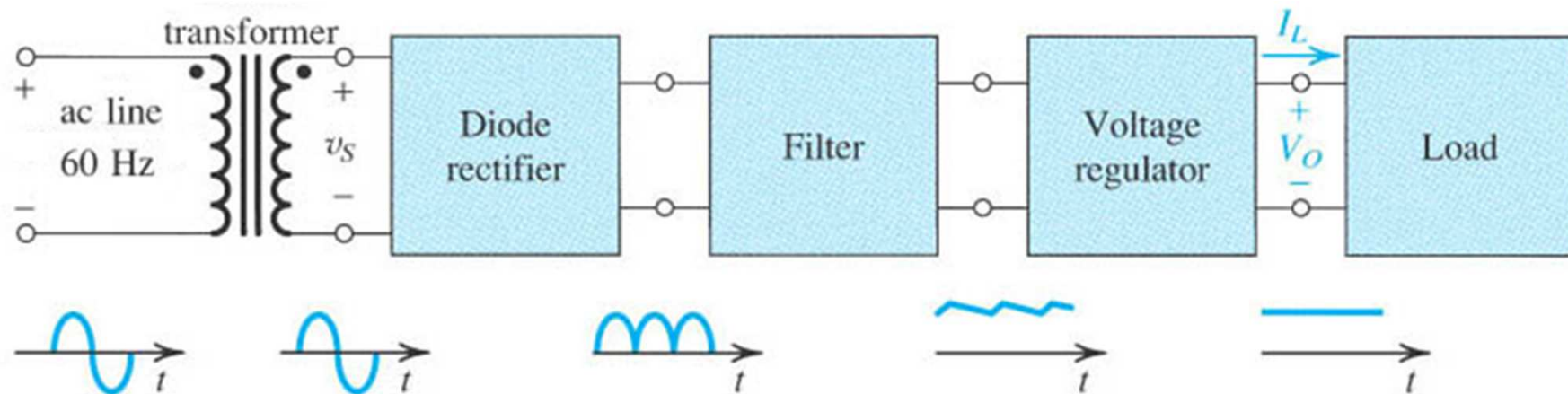
**Zener:** Opera com tensão reversa. Utilizado principalmente em fontes de tensão regulada.



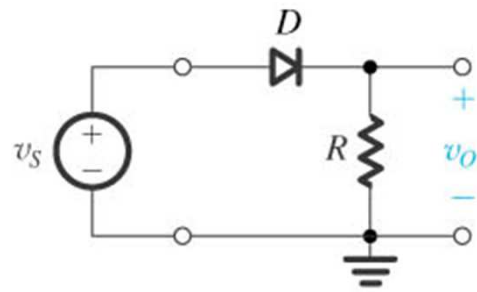
# 2- Circuitos Retificadores

11

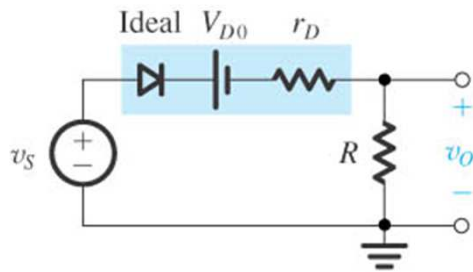
Função: Converter uma forma de onda alternada em contínua



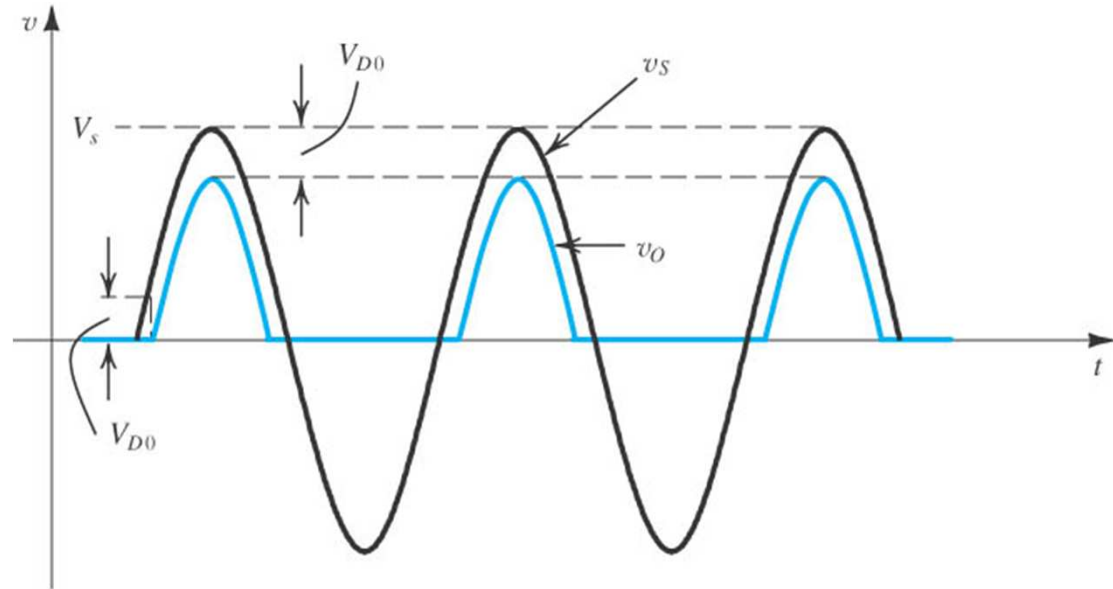
## 2.1 – Retificador de meia onda



(a)

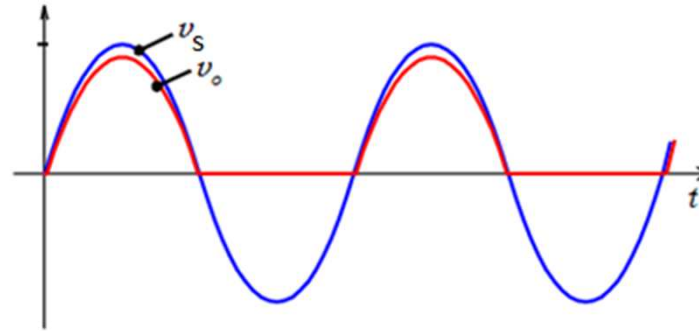
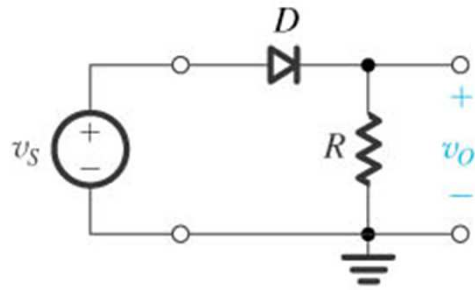


(b)



(d)

## 2.1 – Retificador de meia onda



$$V_{op} = V_{sp} - V_D$$

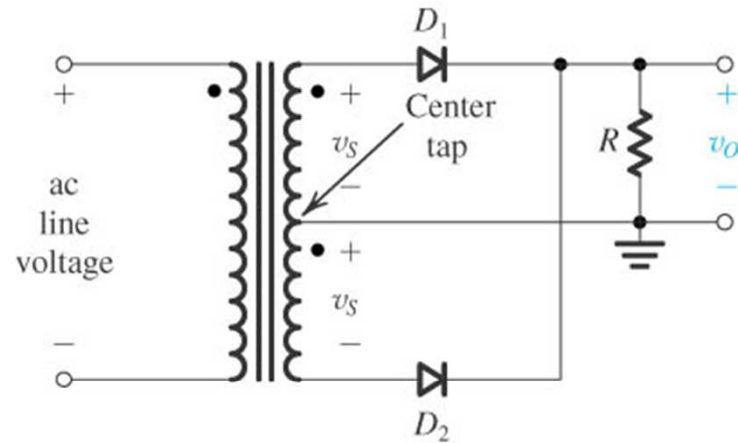
Valor médio:  $V_{md} = \frac{1}{T} \int_0^T f(\omega t) d\omega t$

$$V_{md} = \frac{1}{2\pi} \int_0^{\pi} V_{op} \cdot \text{sen}\omega t d\omega t \approx \frac{V_{op}}{\pi} \quad [\text{V}]$$

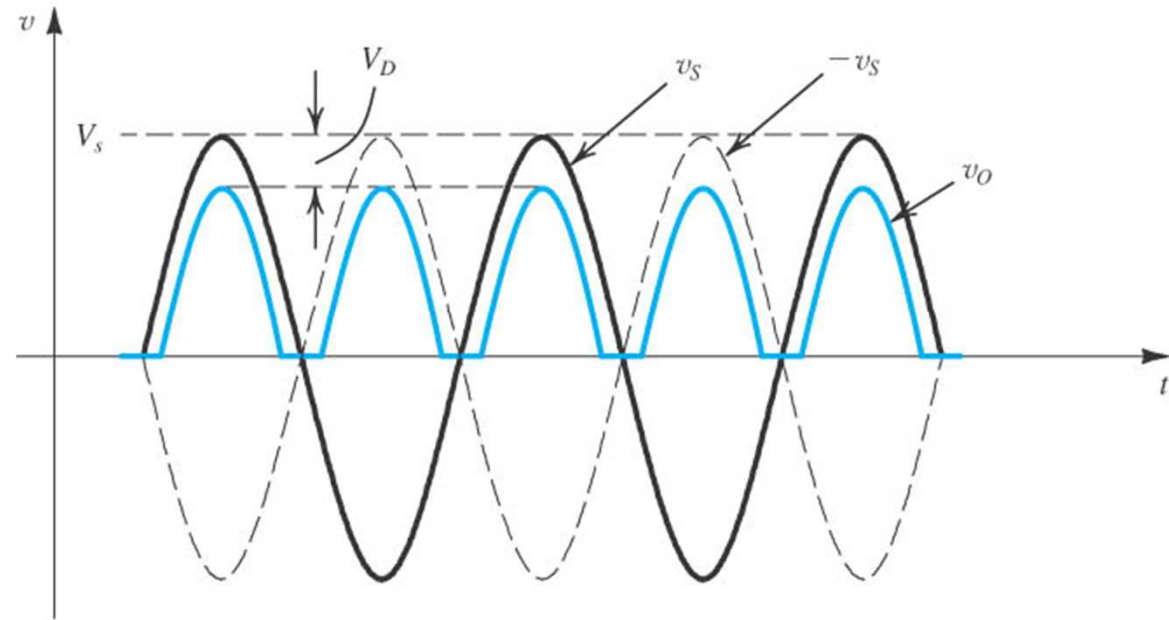
$$PIV = -V_{sp} \quad [\text{V}]$$

$$I_{Dmd} = I_{Omd} \quad [\text{A}]$$

## 2.2 – Retificador de onda completa com ponto médio

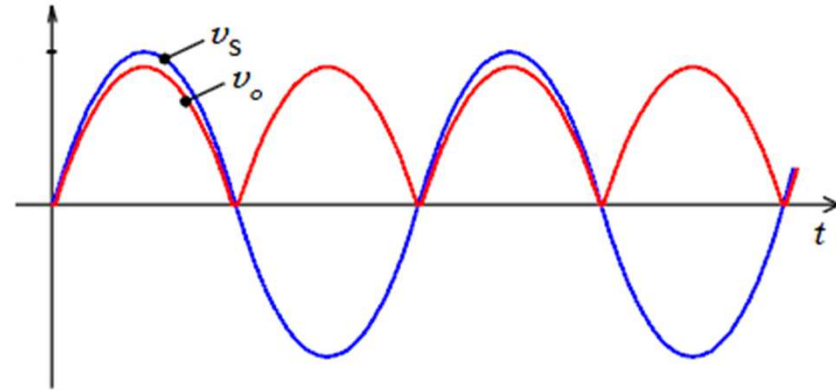
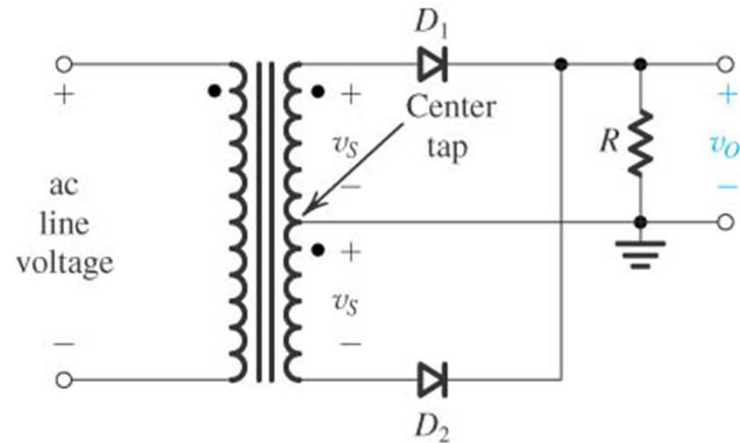


(a)



(c)

## 2.2 – Retificador de onda completa com ponto médio



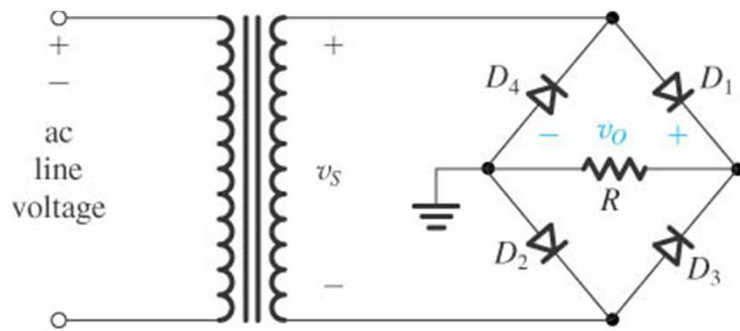
$$V_{op} = V_{sp} - V_D$$

$$V_{md} = \frac{1}{\pi} \int_0^{\pi} V_{op} \cdot \text{sen}wt \, dwt = \frac{2 \cdot V_{op}}{\pi} \quad [\text{V}]$$

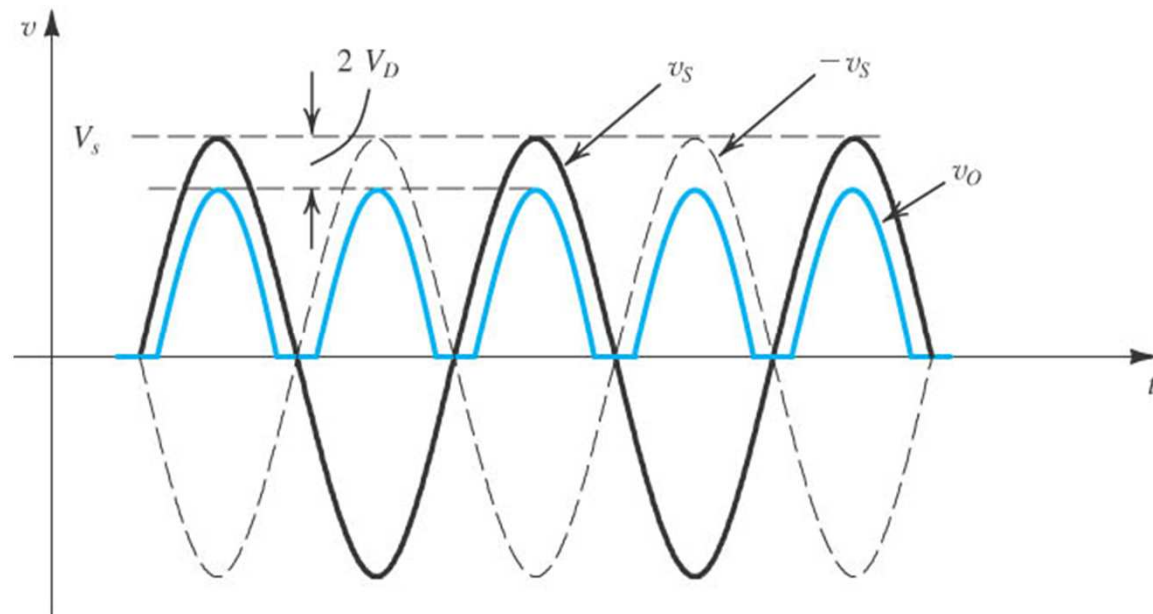
$$PIV = -2 \cdot V_{sp} + V_D$$

$$I_{Dmd} = \frac{I_{Omd}}{2} \quad [\text{A}]$$

## 2.3 – Retificador de onda completa em ponte



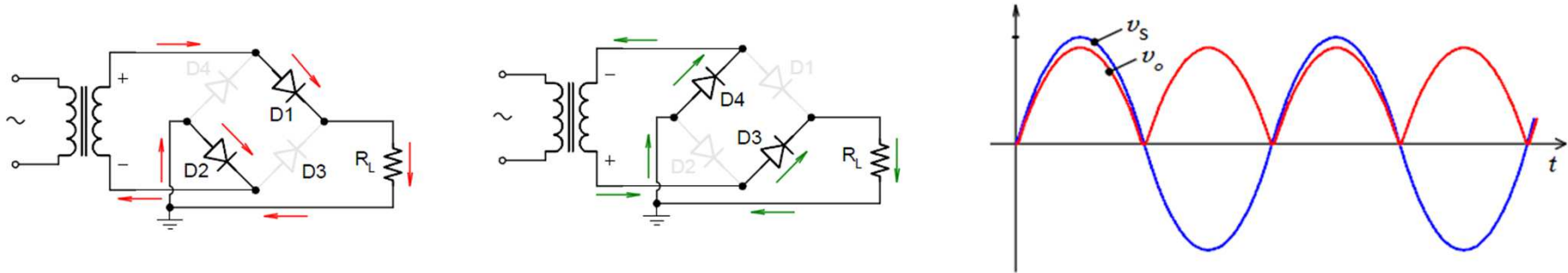
(a)



(b)



## 2.3 – Retificador de onda completa em ponte



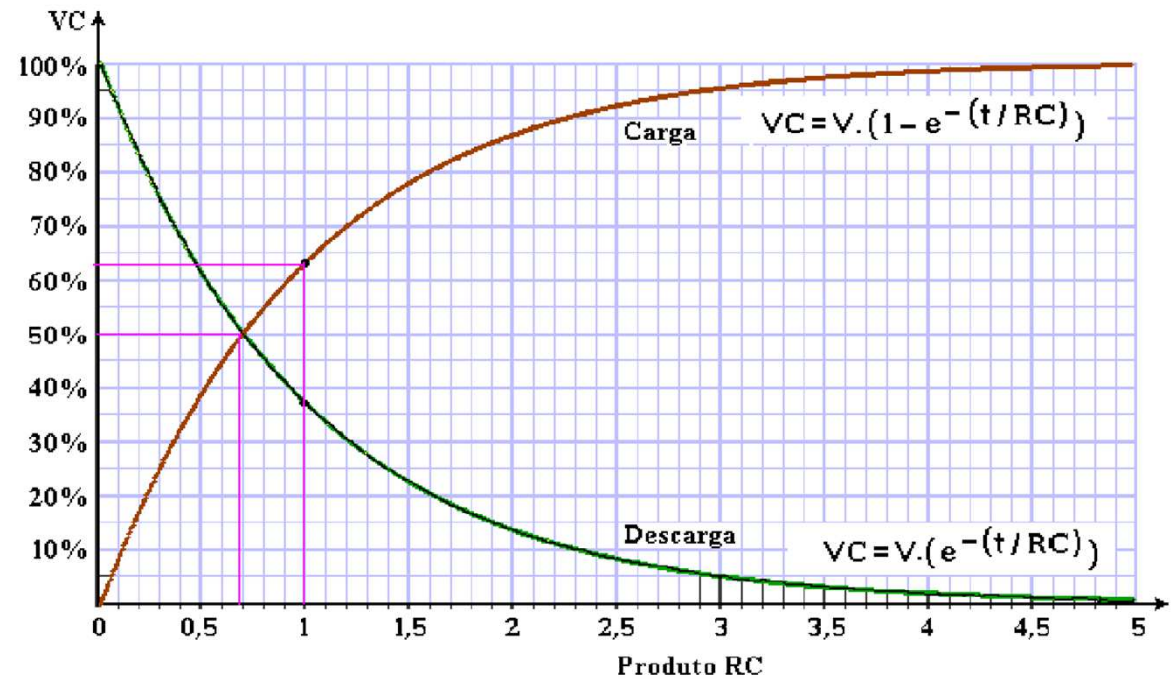
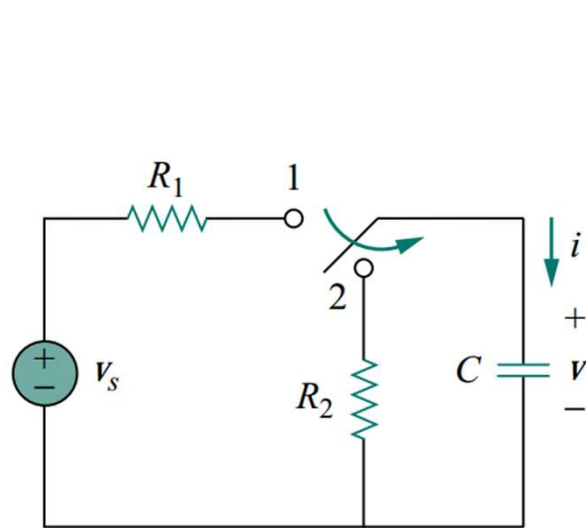
$$V_{op} = V_{sp} - 2 \cdot V_D$$

$$V_{md} = \frac{1}{\pi} \int_0^{\pi} V_{op} \cdot \text{sen} \omega t d\omega t = \frac{2 \cdot V_{op}}{\pi} \quad [\text{V}]$$

$$PIV = -V_{sp} + V_D \quad [\text{V}]$$

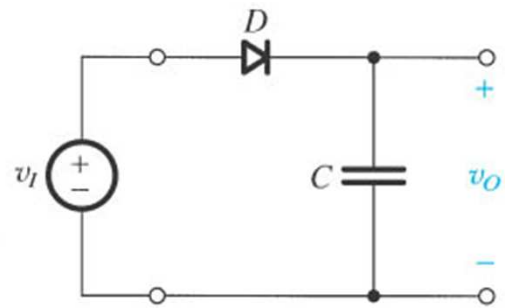
$$I_{Dmd} = \frac{I_{Omd}}{2} \quad [\text{A}]$$

## 2.4 – Retificador com filtro capacitivo

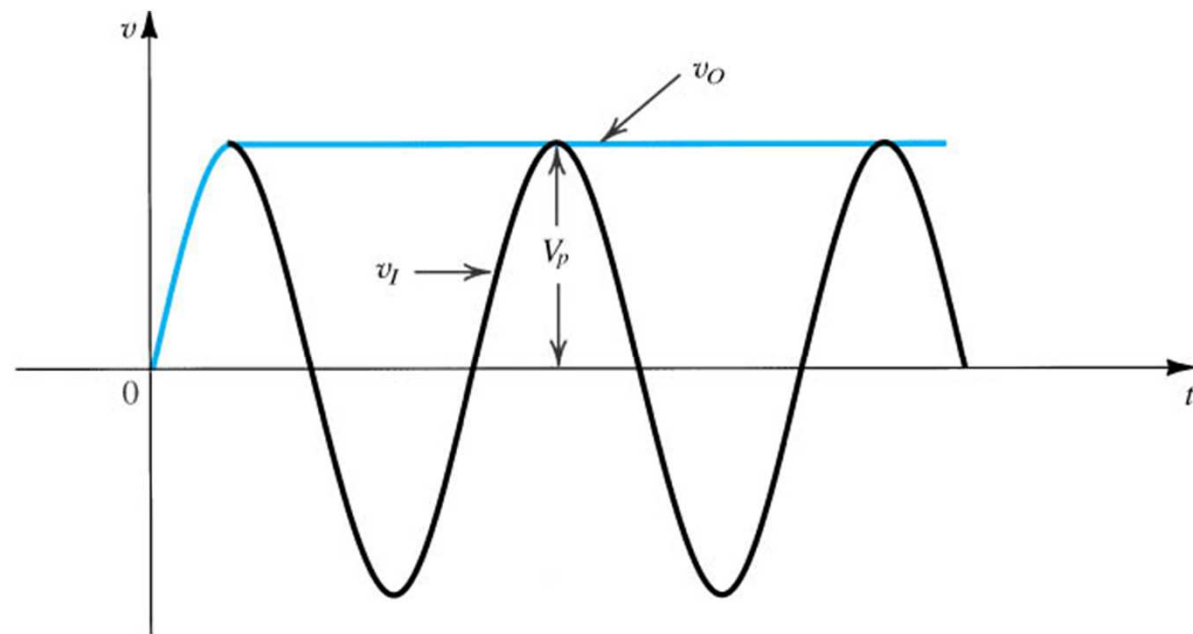


**Curva de carga e descarga do capacitor**

## 2.4 – Retificador com filtro capacitivo

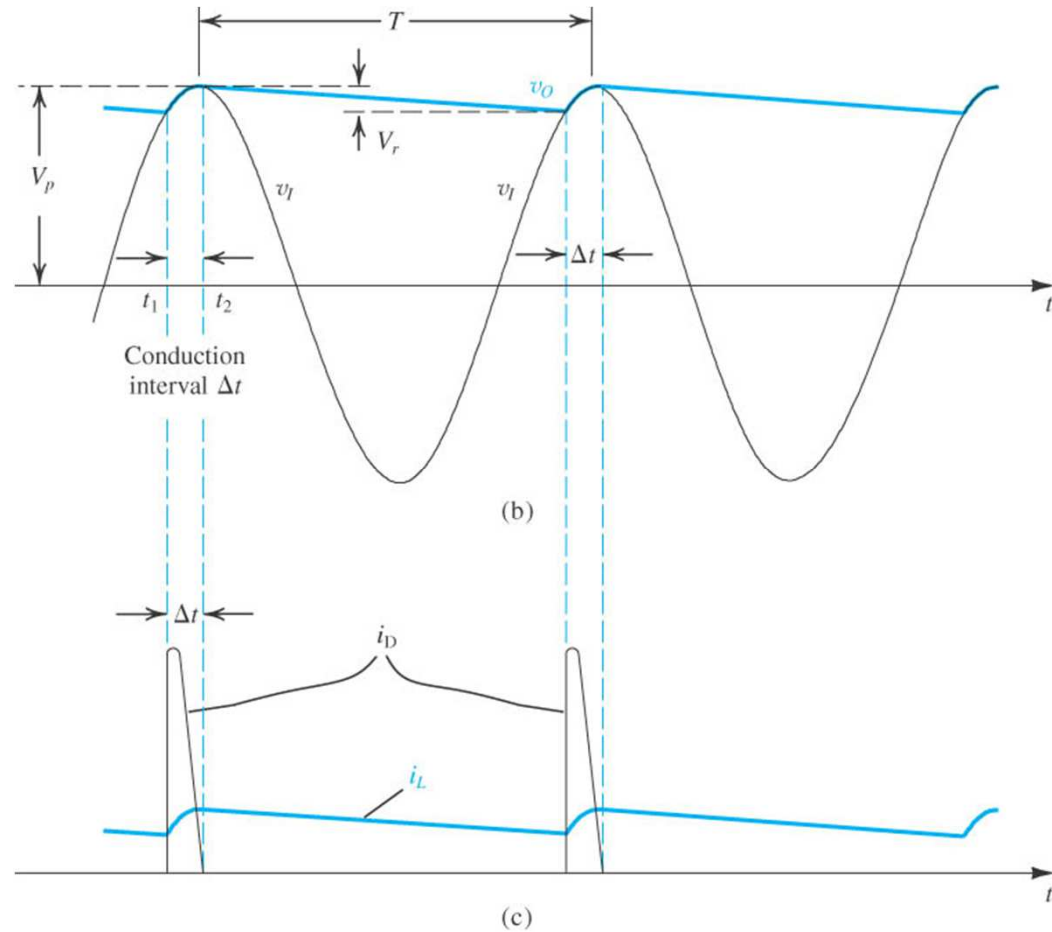
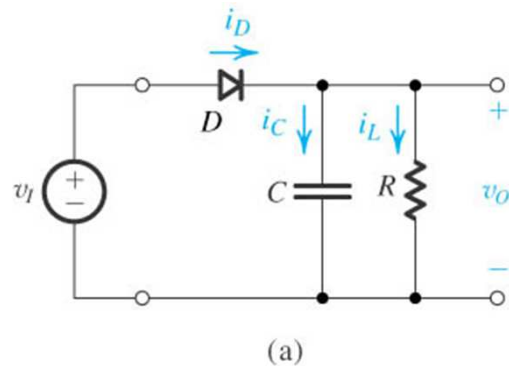


(a)



(b)

## 2.4.1 – Retificador de meia onda com filtro capacitivo



Para  $CR \gg T$ :

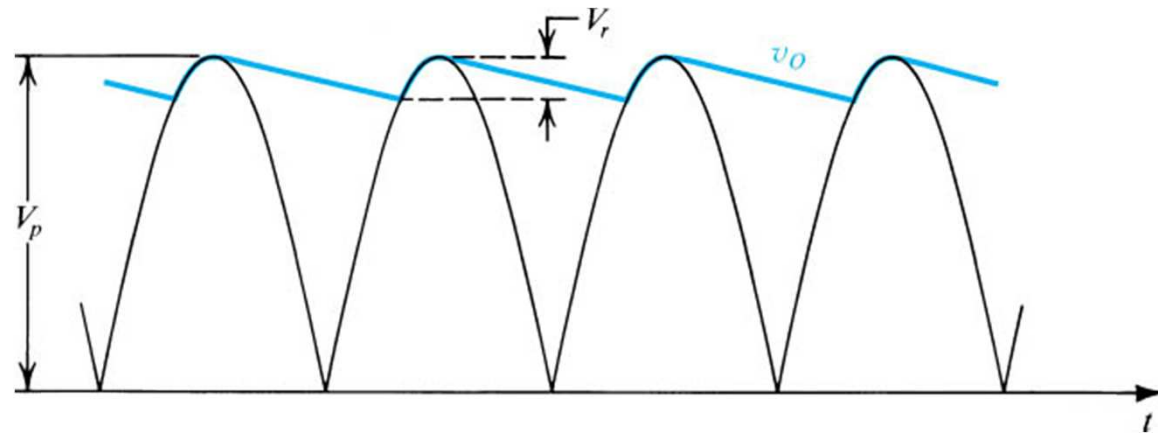
$$V_r \approx \frac{V_{Omd}}{f \cdot C \cdot R} = \frac{I_{Omd}}{f \cdot C}$$

$$V_{Omd} \approx V_{Op} - \frac{V_r}{2}$$

$$I_{Dp} = I_O \left( 1 + 2\pi \sqrt{\frac{2 \cdot V_{Op}}{V_r}} \right)$$

$$I_{Def} = I_O \left( 1 + \pi \sqrt{\frac{2 \cdot V_{Op}}{V_r}} \right)$$

## 2.4.2 – Retificador de onda completa com filtro capacitivo



Para  $CR \gg T$ :

$$V_r \approx \frac{V_{Omd}}{2 \cdot f \cdot C \cdot R} = \frac{I_{Omd}}{2 \cdot f \cdot C}$$

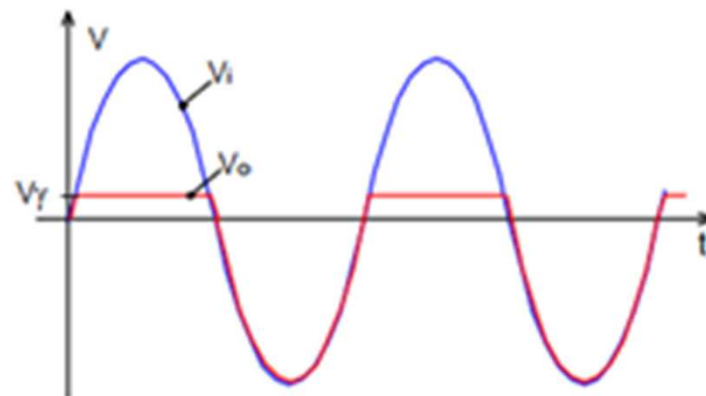
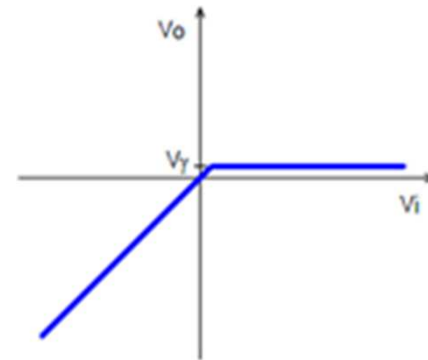
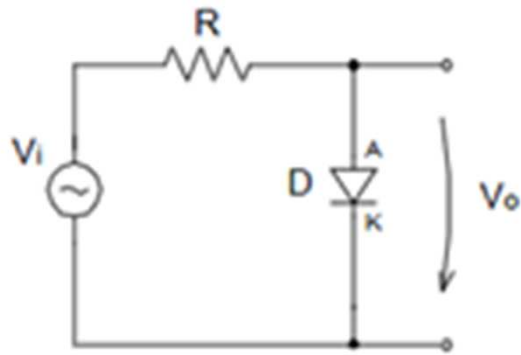
$$V_{Omd} \approx V_{Op} - \frac{V_r}{2}$$

$$I_{Def} = I_O \left( 1 + \pi \sqrt{\frac{V_{Op}}{2 \cdot V_r}} \right)$$

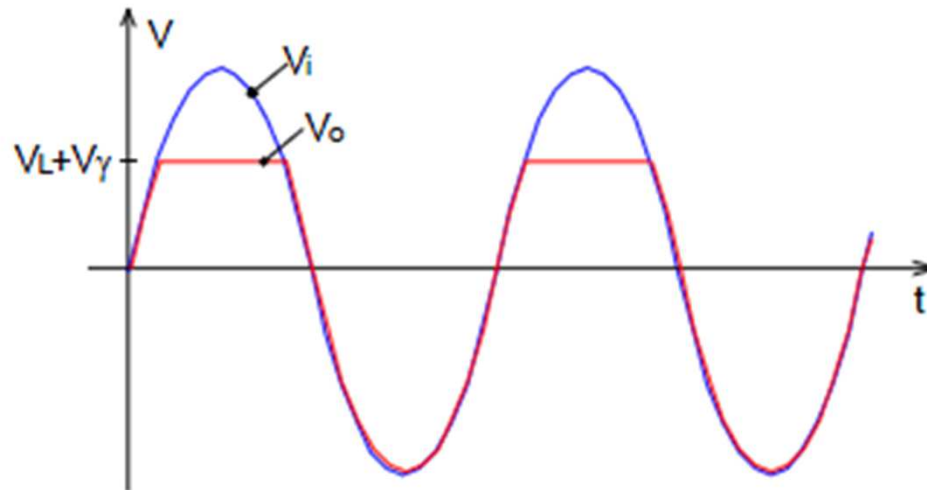
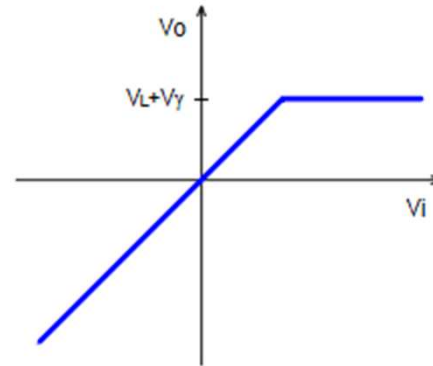
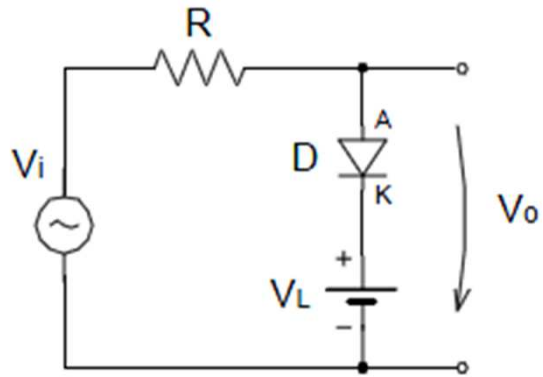
$$I_{Dp} = I_O \left( 1 + 2\pi \sqrt{\frac{V_{Op}}{2 \cdot V_r}} \right)$$

# 3- Circuitos Limitadores

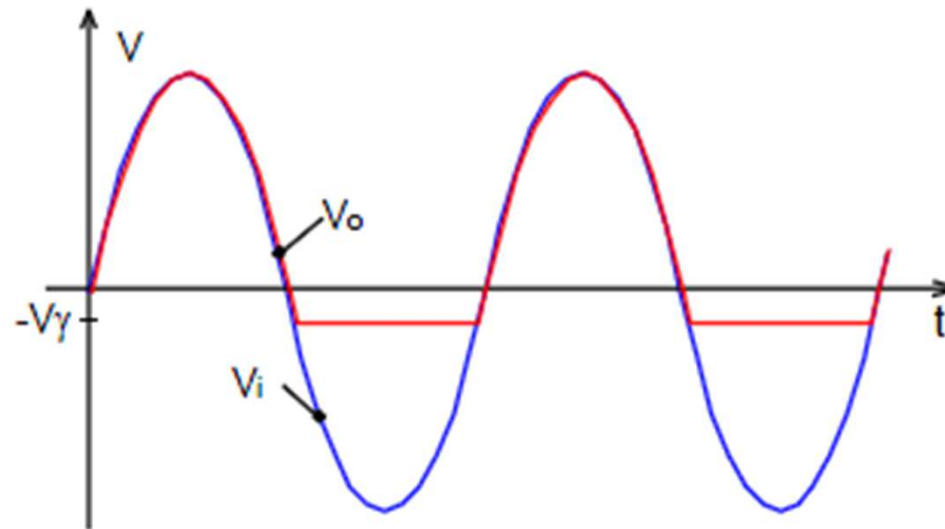
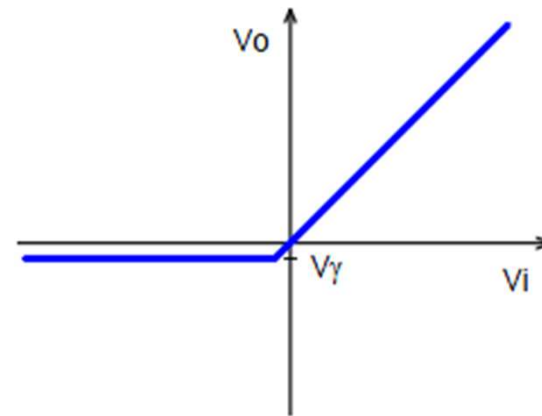
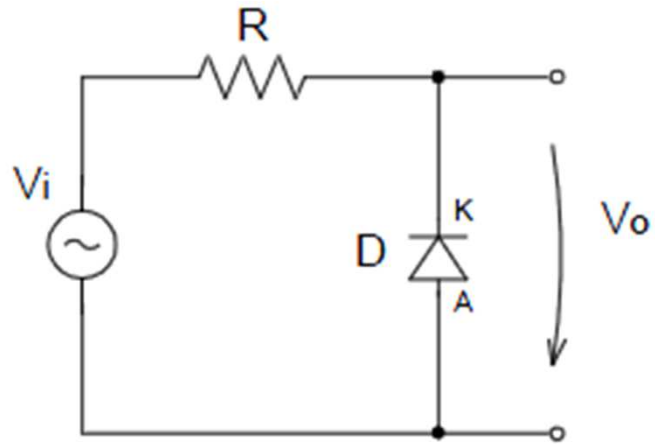
22



# Circuitos Limitadores

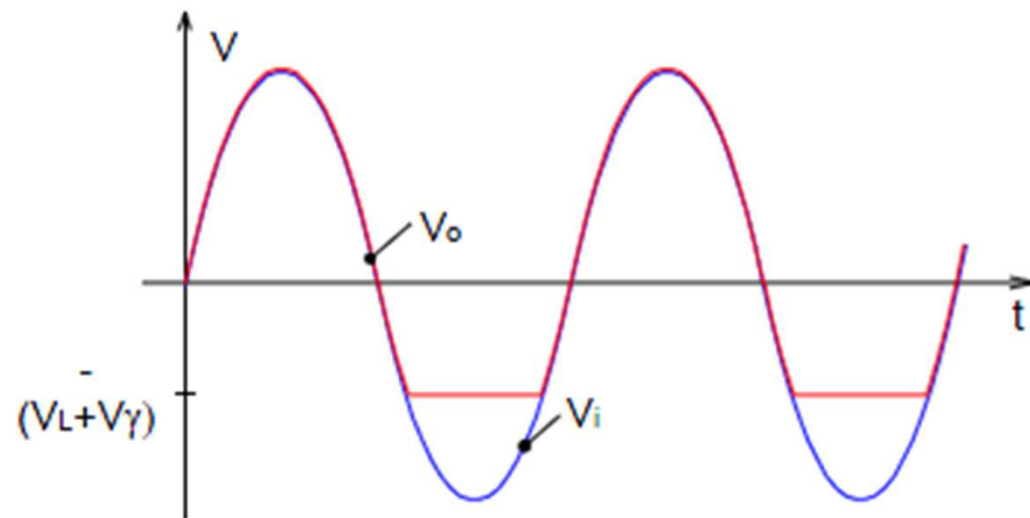
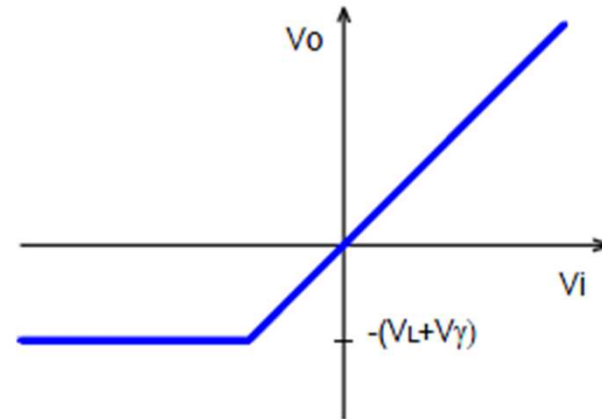
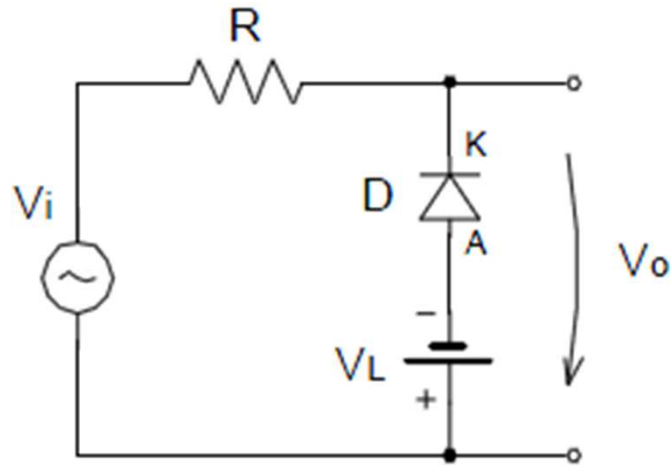


# Circuitos Limitadores

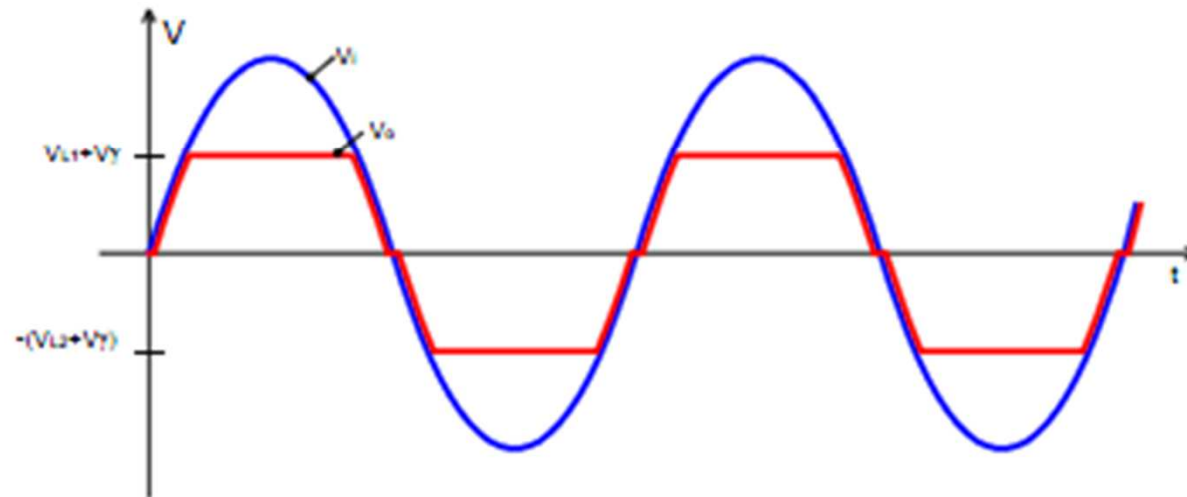
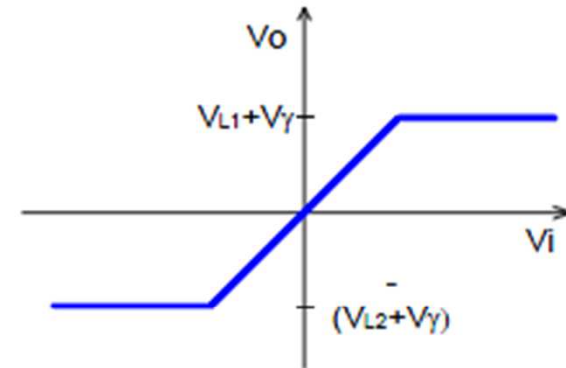
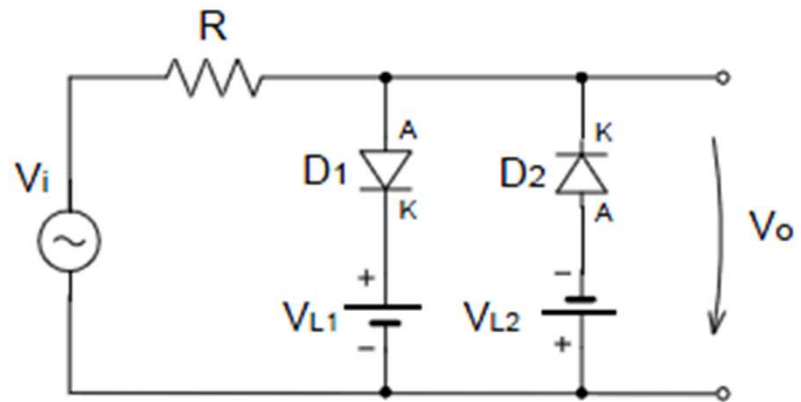




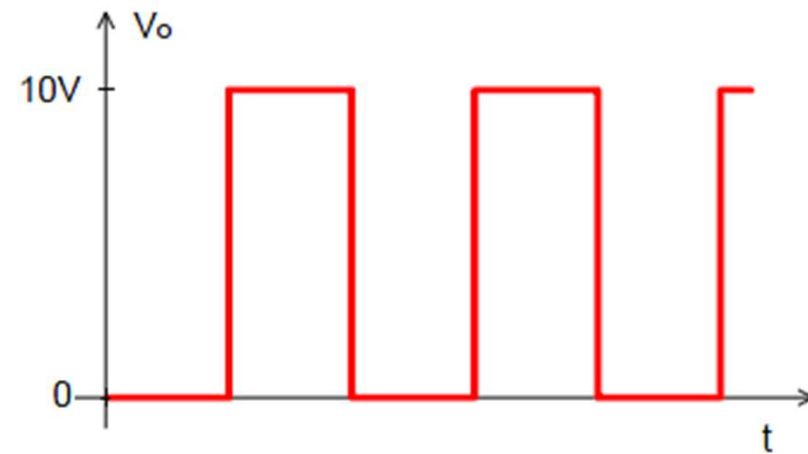
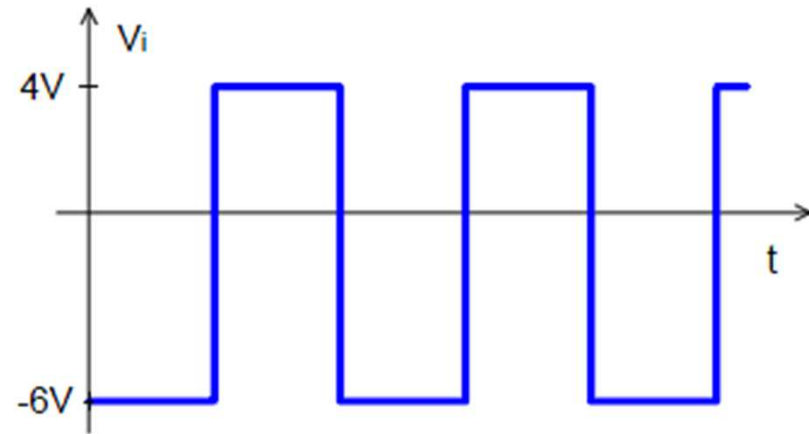
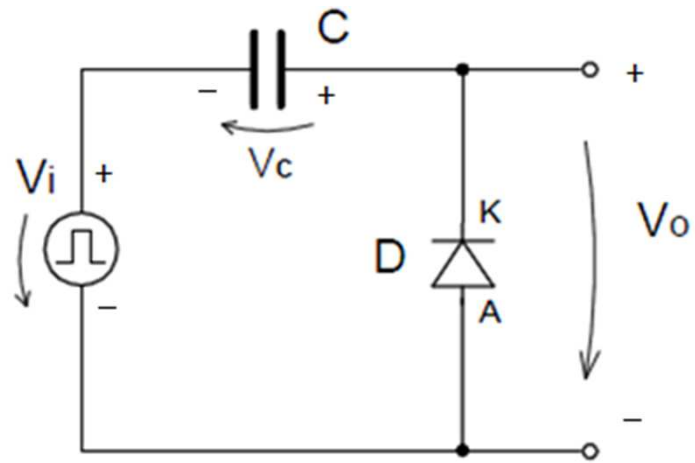
# Circuitos Limitadores



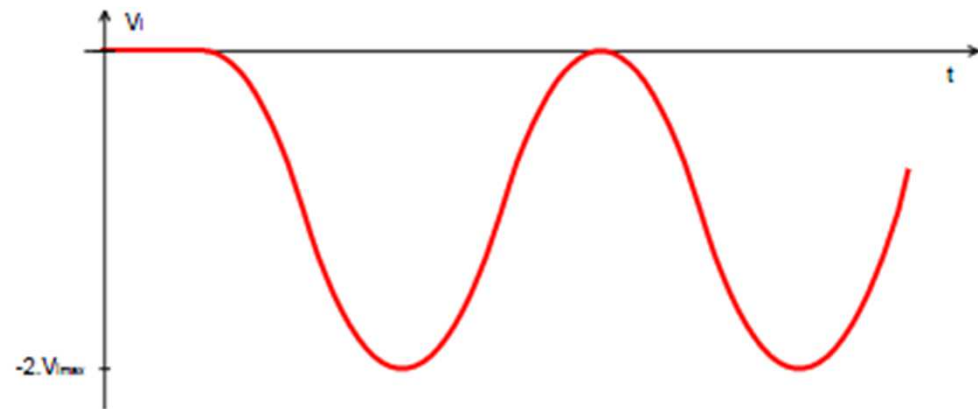
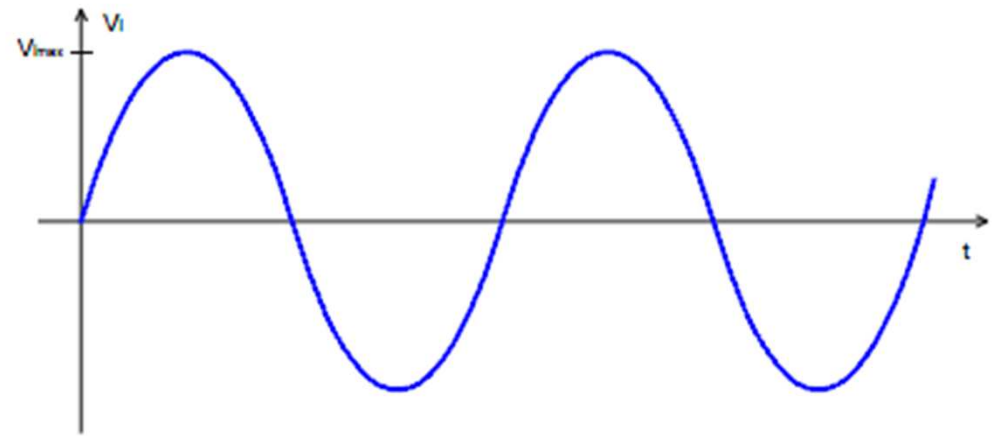
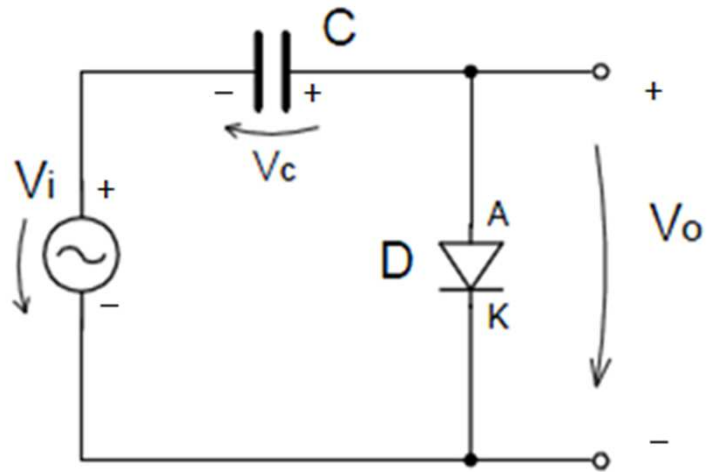
# Circuitos Limitadores



# Circuito Fixador



# Circuito Fixador



# Circuito Fixador

