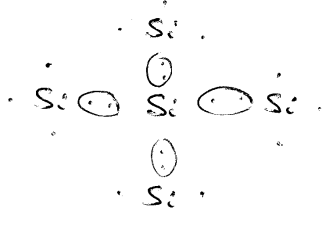


AVLA 4 - DIODOS

Princípio de funcionamento

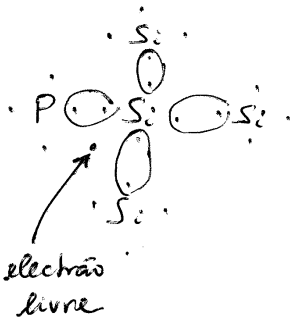


ligação covalente - 8 electrões de valência são partilhados por 4 átomos de silício adjacentes

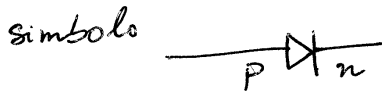
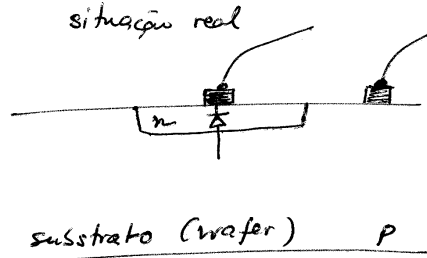
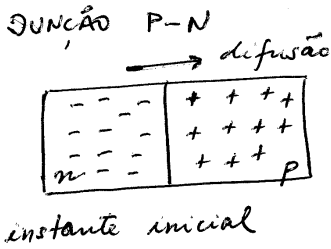
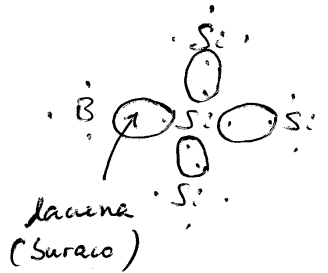
silício intrínseco — $n_i = p_i$ concentrações de electrões livres = concentração de buracos (lacunas)

silício dopado

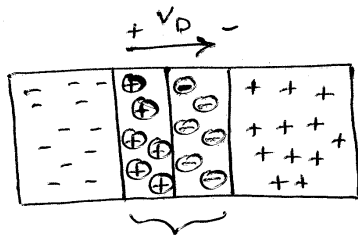
fósforo P



boro B



em equilíbrio

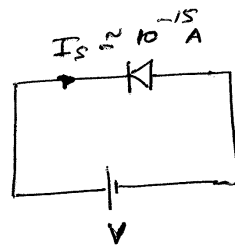
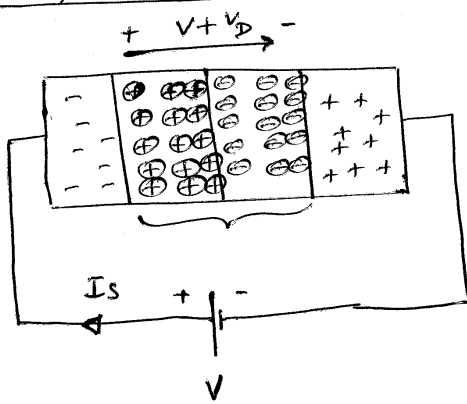


Zona de depleção = zona depleta (sem) cargas

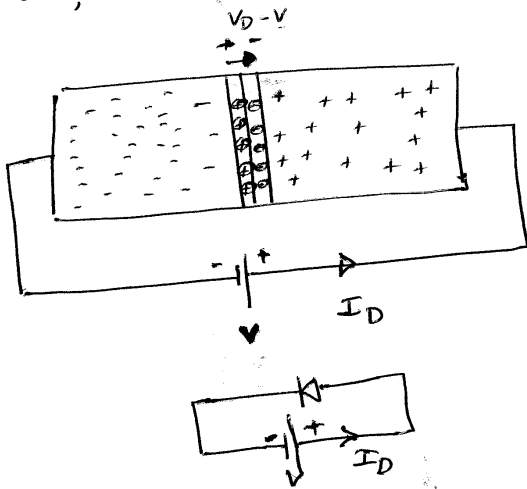
livres

V_D = potencial intrínseco de junção

JUNÇÃO INVERSAMENTE POLARIZADA



JUNÇÃO DIRECTAMENTE POLARIZADA

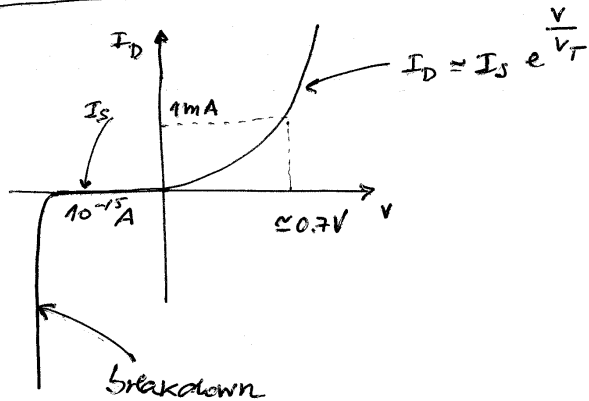


$$I_D = I_S \left(e^{\frac{V}{V_T}} - 1 \right)$$

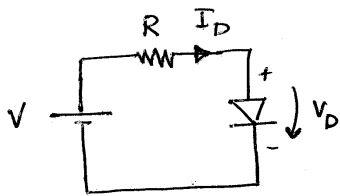
com $V_T = \frac{k_B T}{q} \approx 25 \text{ mV}$

com $T = 300 \text{ K}$
(temperatura ambiente)

Curva característica do diodo



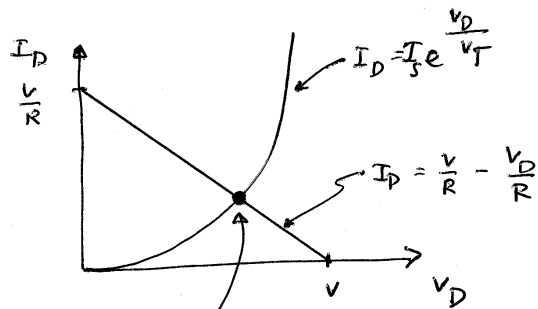
PONTO DE POLARIZAÇÃO (PONTO DE FUNCIONAMENTO)



$I_D = 0 \rightarrow V_D = V$
 $V_D = 0 \rightarrow I_D = \frac{V}{R}$

$I_D, V_D = ?$

$V = R I_D + V_D \Leftrightarrow I_D = \frac{V}{R} - \frac{V_D}{R}$



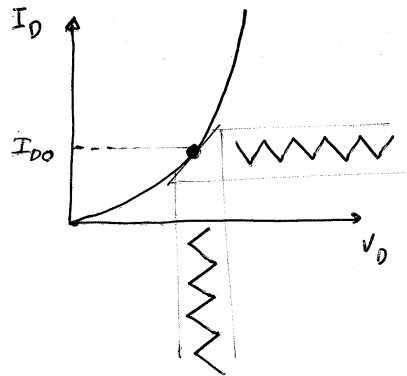
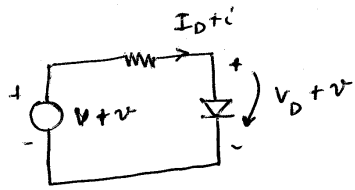
ponto de funcionamento é a interseção das duas equações

ponto de funcionamento aproximado

$V_D \approx 0.7$, logo

$I_D \approx \frac{V - V_D}{R} = \frac{V - 0.7V}{R}$

modelo de pequeno sinal



$$I_D = I_S e^{\frac{V_D}{V_T}}$$

$$\left. \frac{\partial I_D}{\partial V_D} \right|_{I_D = I_{D0}} = \frac{1}{V_T} \underbrace{I_S e^{\frac{V_D}{V_T}}}_{I_D} \Big|_{I_D = I_{D0}} = \frac{I_{D0}}{V_T}$$

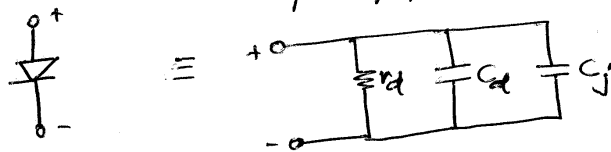
definindo

$$\frac{1}{r_d} = \left. \frac{\partial I_D}{\partial V_D} \right|_{I_D = I_{D0}} = \frac{I_{D0}}{V_T}$$

logo $r_d = \frac{V_T}{I_{D0}}$

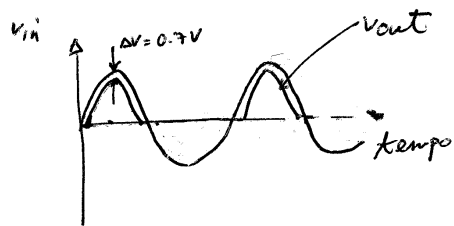
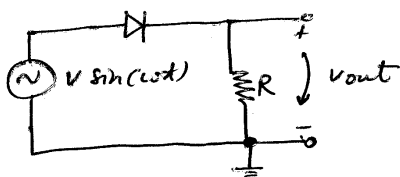
r_d = resistência dinâmica do diodo

para pequenos sinais

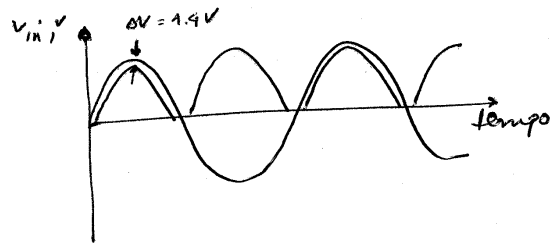
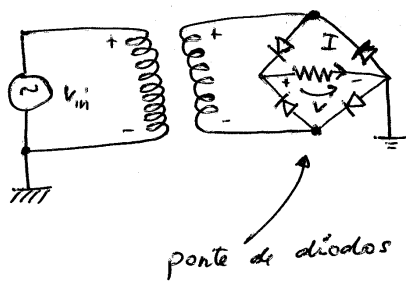


APLICAÇÕES DE DIODOS

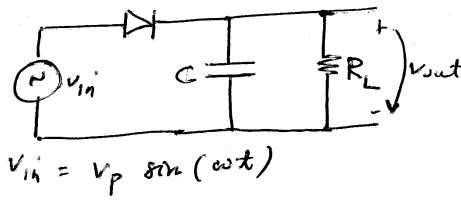
retificação de meia-onda



rectificação de onda completa



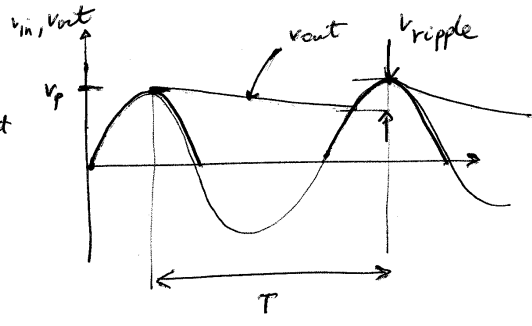
rectificação e filtragem (conversão de tensão AC em tensão DC)



$$V_{in} = V_p \sin(\omega t)$$

$$v_{out} = V_p e^{-\frac{t}{R_L C}}$$

$$V_p - V_{ripple} = V_p e^{-\frac{T}{R_L C}}$$



assumindo que $T \gg R_L C$ tem-se

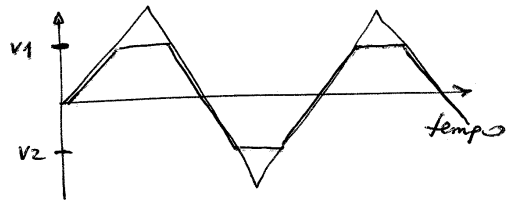
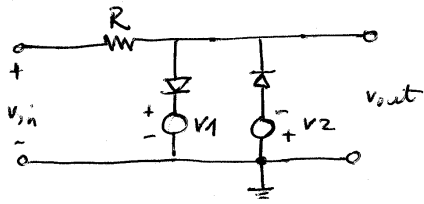
$$\left[\begin{aligned} f(x) = e^{-x} &= \sum_{n=0}^{\infty} \frac{d^n f(x)}{n! dx^n} f(0) \\ f'(x) &= -f(x) \\ f''(x) &= f(x) \end{aligned} \right]$$

$$V_p - V_{ripple} \approx V_p \left(1 - \frac{T}{R_L C} \right)$$

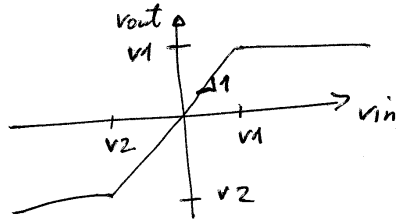
logo $V_{ripple} \approx V_p \frac{T}{R_L C}$

logo R_L e C devem ser o maior possíveis

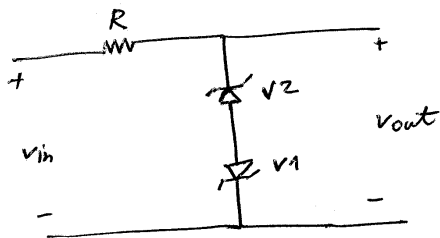
circuito limitadores (clipping)



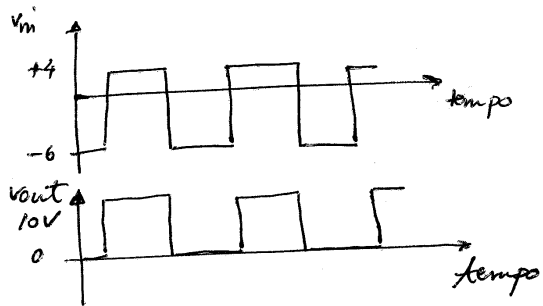
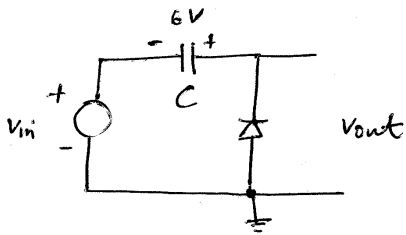
curva característica



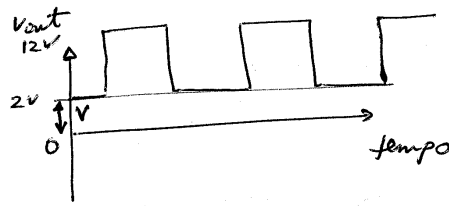
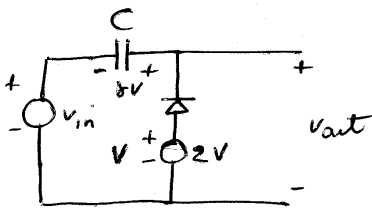
com diodos Zener



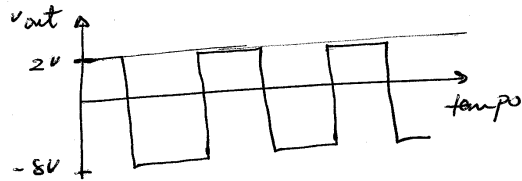
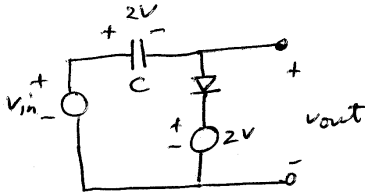
circuito fixadores (Clam ping)



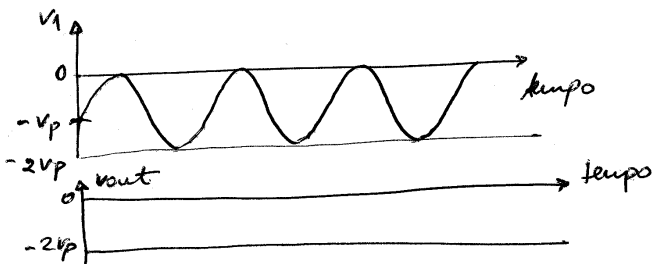
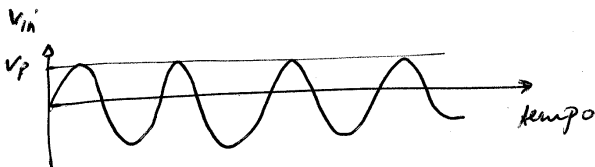
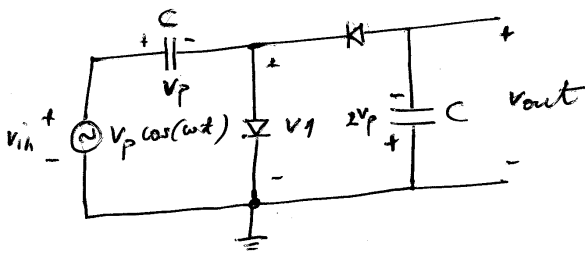
circuito fixadores (cont)



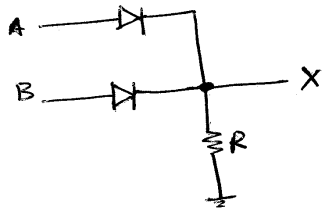
por simetria ...



Multiplicador (x2) de tensão

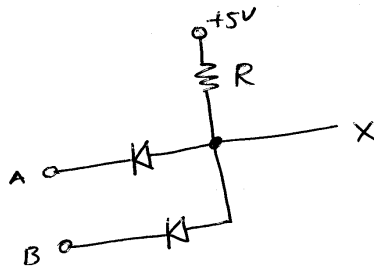


Lógica com diodos



A	B	X = A + B
0	0	0
0	5	5
5	0	5
5	5	5

OR



A	B	X = A · B
0	0	0
0	5	0
5	0	0
5	5	5

AND