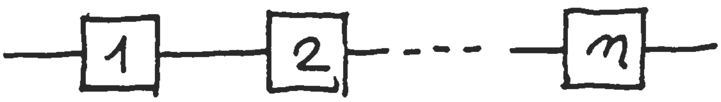
SISTEMI SERIE

$R_1(t)$ = aff. 1

$R_2(t)$ = aff 2

$$R_s(t) = R_1(t) \cdot R_2(t)$$



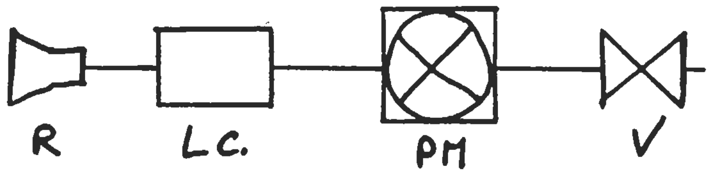
$$R_s(t) = \prod_{i=1}^{n} R_i(t)$$

Se: $R_i = e^{-\lambda_i t}$

$$R_s = e^{-\lambda_s t} \qquad \lambda_s = \sum_{i=1}^{n} \lambda_i$$

$$MTBF = \frac{1}{\lambda_s}$$

CALCOLO AFFIDABILITÀ SISTEMI SERIE
(ESEMPIO SISTEMA DI POMPAGGIO)



R = Rivelatore Sensore $\qquad \lambda_R = 2 \cdot 10^{-6}$ g/h

LC = Logica di Controllo $\qquad \lambda_{LC} = 5 \cdot 10^{-6}$ g/h

PM = Gruppo Motore Pompa $\qquad \lambda_{PM} = 2 \cdot 10^{-5}$ g/h

V = Valvola $\qquad \lambda_V = 1 \cdot 10^{-5}$ g/h

Calcolo affidabilità su base annua : $t = 8760$ h

$$R_R(t=1\text{anno}) = e^{-\lambda_R t} = 0.98$$

$$R_{LC}(t=1\text{anno}) = e^{-\lambda_{LC} t} = 0.96$$

$$R_{PM}(t=1\text{anno}) = e^{-\lambda_{PM} t} = 0.84$$

$$R_V(t=1\text{anno}) = e^{-\lambda_V t} = 0.92$$

$\geq 0{,}944$

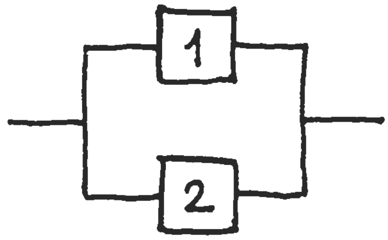
P : Q

$$R_{Sis}(t=1\text{anno}) = 0.98 \cdot 0.96 \cdot 0.84 \cdot 0.92 = 0.727$$

$$R'_{Sis}(t) = (0.98+0.02) \cdot 0.96 \cdot 0.84 \cdot 0.92 = 0.742$$

$$R^4_S(t) = 0.98 \cdot 0.96 \cdot (0.84+0.02) \cdot 0.92 = 0.744$$

SISTEMI PARALLELO



$$F_1(t) = 1 - R_1(t)$$
$$F_2(t) = 1 - R_2(t)$$

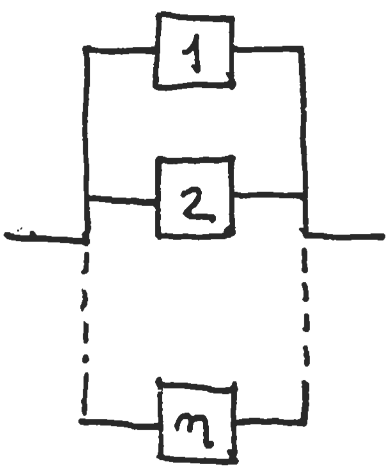
$$F_S(t) = F_1(t) \cdot F_2(t)$$

$$1 - R_S(t) = [1 - R_1(t)][1 - R_2(t)]$$

$$R_S(t) = R_1(t) + R_2(t) - R_1(t) R_2(t)$$

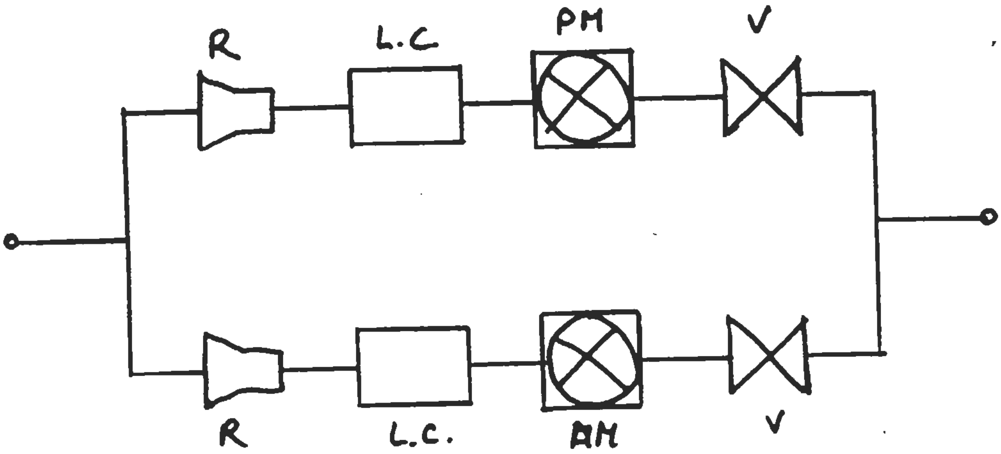
Se : $R_i = e^{-\lambda_i t}$

$$MTBF = \frac{1}{\lambda_1} + \frac{1}{\lambda_2} - \frac{1}{\lambda_1 + \lambda_2}$$



$$R_S(t) = 1 - \prod_{i=1}^{n} [1 - R_i(t)]$$

ESEMPIO SISTEMA PARALLELO

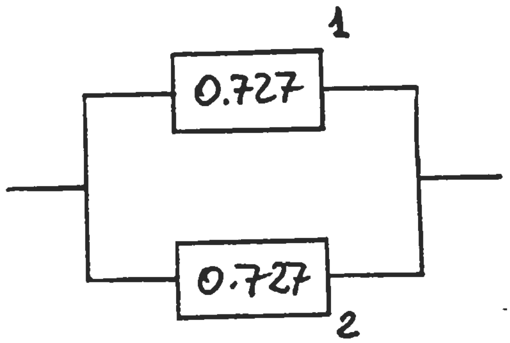


Per $t = 1$ anno

$R_R(t) = 0.98$; $R_{LC}(t) = 0.96$

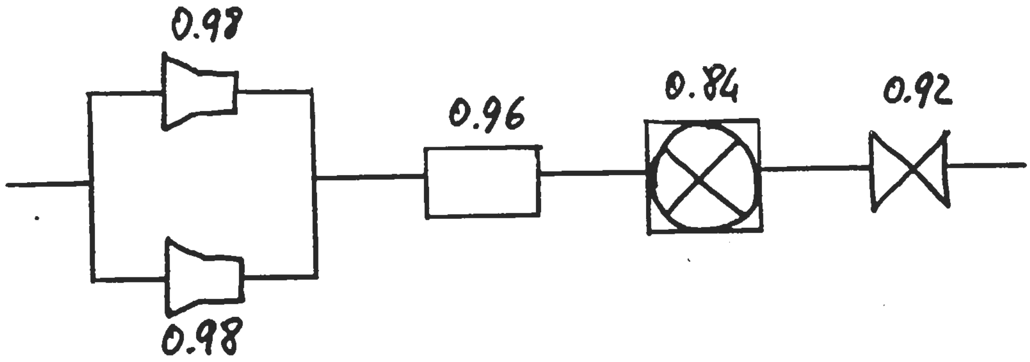
$R_{PM}(t) = 0.84$; $R_V(t) = 0.92$

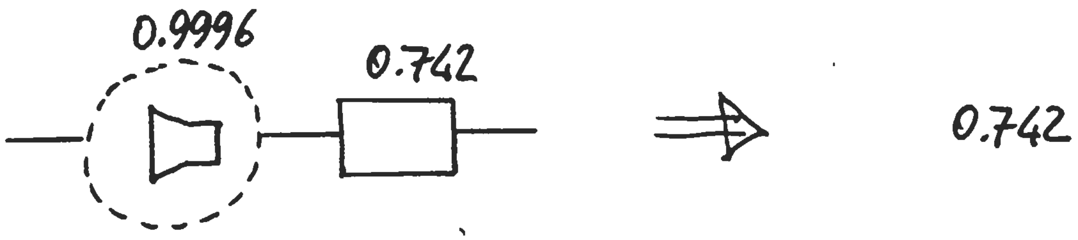
$R_{serie} = 0.98 \cdot 0.96 \cdot 0.84 \cdot 0.92 = 0.727$

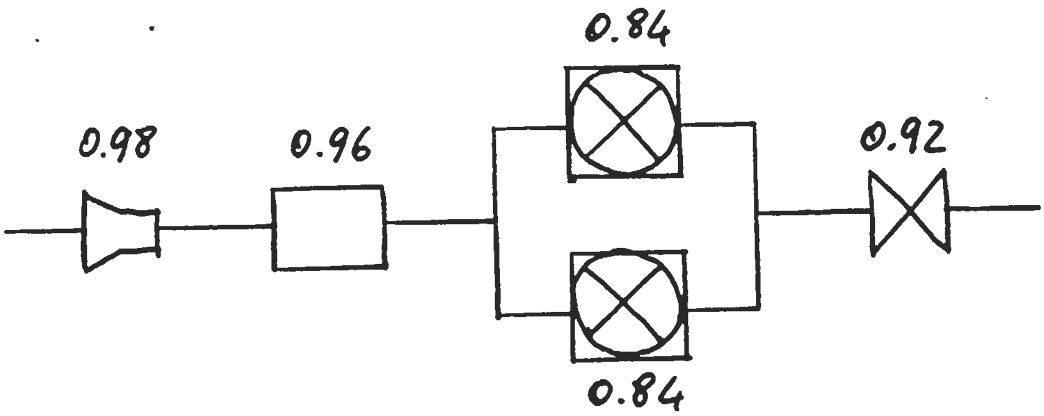


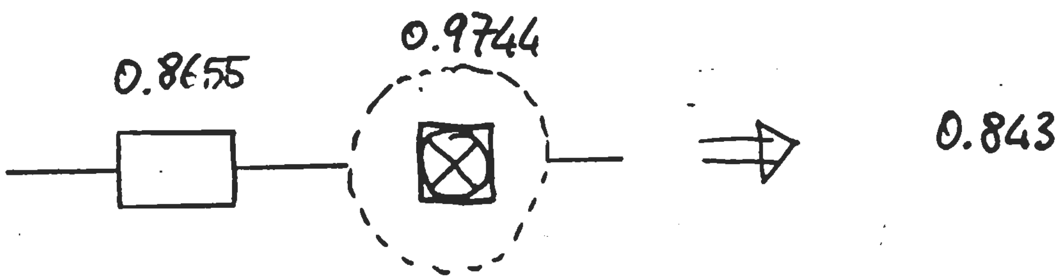
$R_{Sis} = R_1 + R_2 - R_1 R_2 = 2 * 0.727 - (0.727)^2 = 0.925$

ESEMPIO SISTEMA PARALLELO





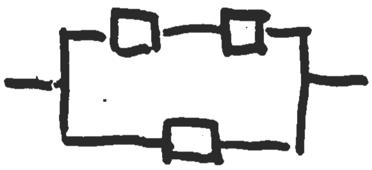




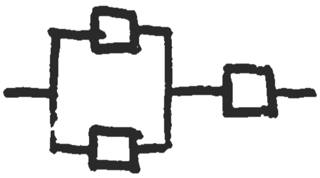
POSSIBILI CONFIGURAZIONI
SERIE - PARALLELO
DI TRE ELEMENTI

(elementi identici)

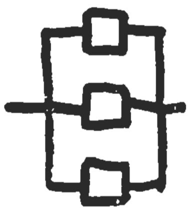
$R(t) = r^3$



$R(t) = r + r^2 - r^3$

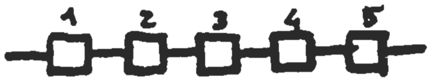


$R(t) = 2r^2 - r^3$

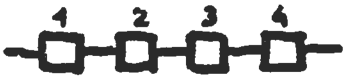


$R(t) = 3r - 3r^2 + r^3$

CONFRONTO CONFIGURAZIONI
(COMPONENTI IDENTICI)



$\tau_i = 0.97915$ $R_s = 0.9$

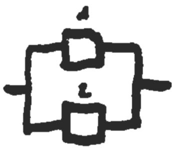


$\tau_i = 0{,}9740$ $R_s = 0.9$

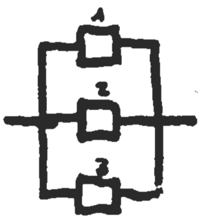
$\tau_i = 0{,}9650$ $R_s = 0.9$

$\tau_i = 0{,}94868$ $R_s = 0.9$

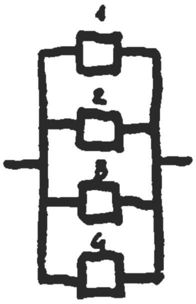
$\tau_i = 0.9$ $R_s = 0.9$



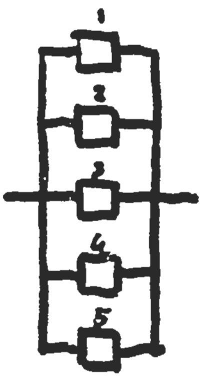
$\tau_i = 0{,}68377$ $R_s = 0.9$



$\tau_i = 0{,}5358$ $R_s = 0.9$



$\tau_i = 0{,}43766$ $R_s = 0.9$

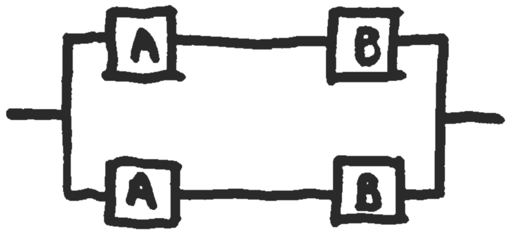


$\tau_i = 0.36904$ $R_s = 0.9$

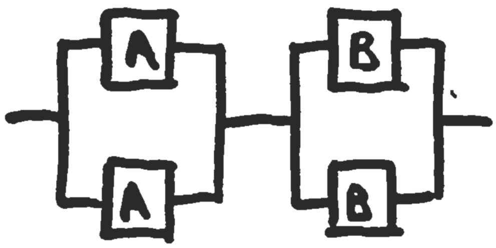
CONFRONTO RIDONDANZE

a) 

$$R_a = r_A \cdot r_B$$

b) 

$$R_b = 2r_A r_B - r_A^2 r_B^2$$
$$= r_A r_B (2 - r_A r_B)$$

c) 

$$R_c = r_A(2-r_A)\cdot r_B(2-r_B) =$$
$$= r_A r_B (4 - 2(r_A + r_B) + r_A r_B)$$

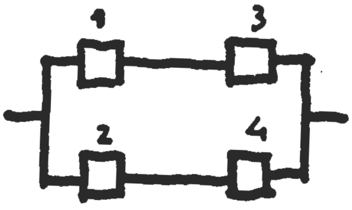
$R_b > R_a$; $R_c > R_a$

$$\frac{R_c}{R_B} = \frac{4 - 2(r_A + r_B) + r_A r_B}{2 - r_A r_B} = 1 + \frac{2(1-r_A)(1-r_B)}{2 - r_A r_B} > 1$$

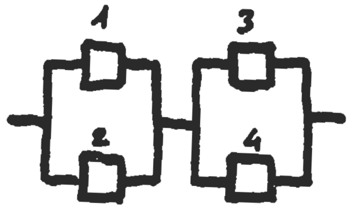
CONFRONTO RIDONDANZE
(COMPONENTI IDENTICI)

a) 

$R_a = r^2$

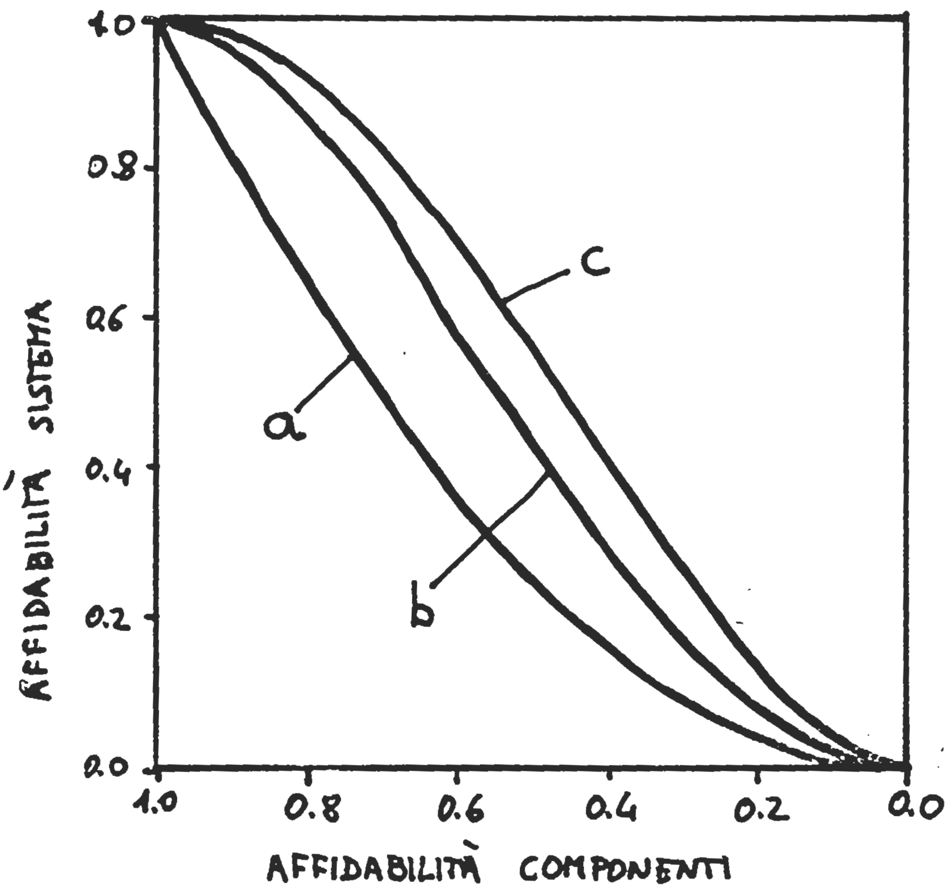
b) 

$R_b = r^2 (2 - r^2)$

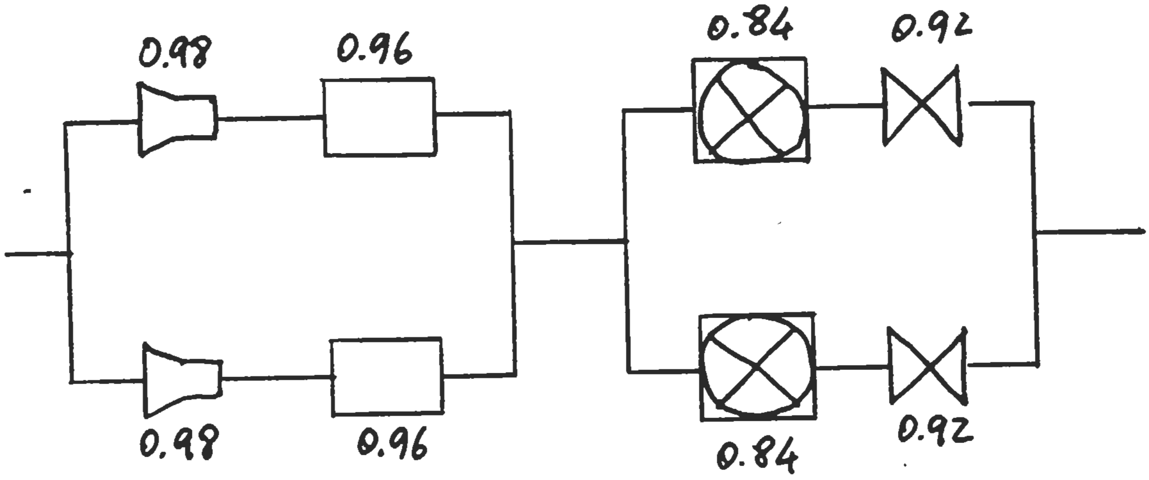
c) 

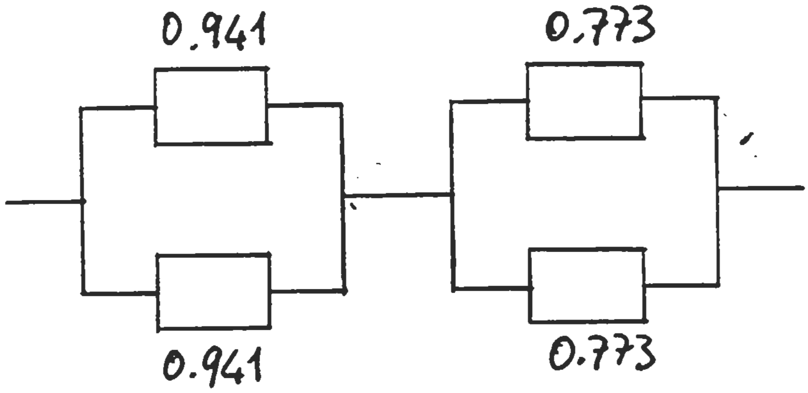
$R_c = r^2 (2 - r)^2$

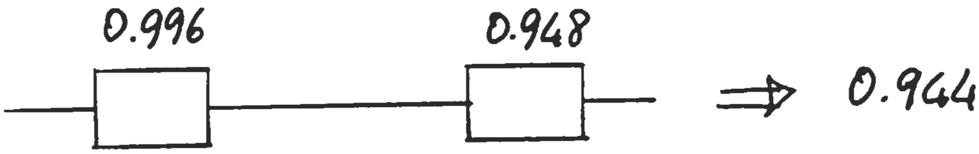
STATI	
0 0 0 0	
1 0 0 0	
0 1 0 0	
0 0 1 0	
0 0 0 1	
1 1 0 0	b, c
1 0 1 0	
1 0 0 1	b
0 1 1 0	b
0 1 0 1	
0 0 1 1	b, c
1 1 1 0	b, c
1 1 0 1	b, c
1 0 1 1	b, c
0 1 1 1	b, c
1 1 1 1	b, c



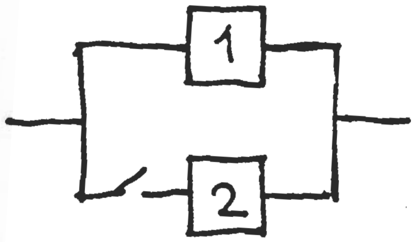
RIDONDANZA PER COMPONENTI







STAND BY (ATTESA)

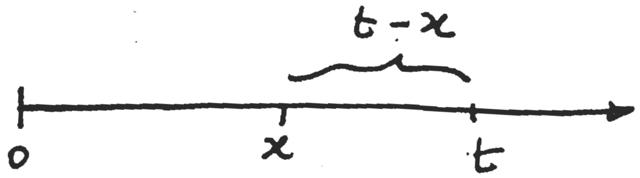


Il sistema funziona fra $0 \longmapsto t$ se:

a) (1) non si rompe fra $0-t$ $\qquad R_1(t)$

b) (1) si rompe $0 \leq x < t$ ma (2) lavora per $t-x$

$R_S =$ Prob{evento a} + Prob{evento b}



$$\text{Prob}\{b\} = \int_0^t R_2(t-x)\, f_1(x)\, dx$$

Se: $R_1(t) = R_2(t) = e^{-\lambda t}$

$$R_S(t) = e^{-\lambda t}(1-\lambda t) \qquad MTBF = \frac{2}{\lambda}$$

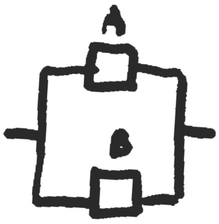
+ OK

a) 

$R_S = e^{-\lambda_A t}$ $\qquad$ $MTTF = \dfrac{1}{\lambda_A}$

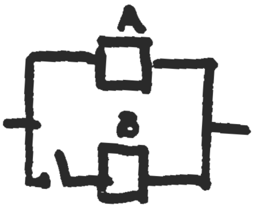
b) 

$R_S = e^{-(\lambda_A + \lambda_B)t}$ $\qquad$ $MTTF = \dfrac{1}{\lambda_A + \lambda_B}$

c) 

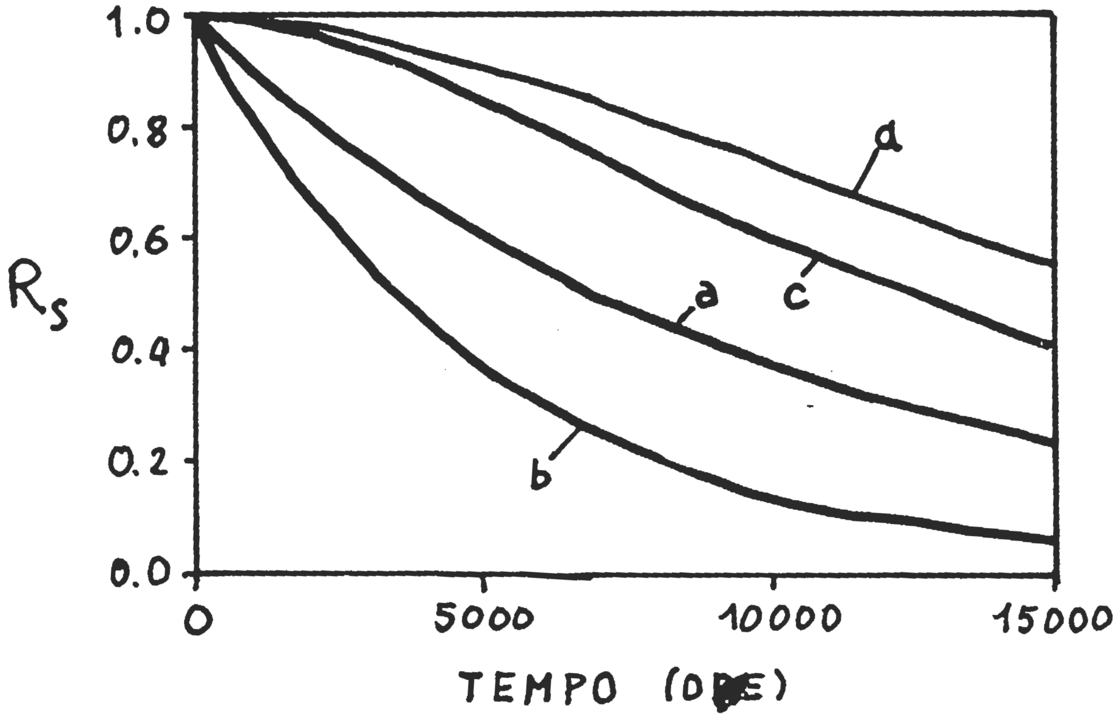
$R_S = e^{-\lambda_A t} + e^{-\lambda_B t} - e^{-(\lambda_A + \lambda_B)t}$

$MTTF = \dfrac{1}{\lambda_A} + \dfrac{1}{\lambda_B} - \dfrac{1}{\lambda_A + \lambda_B}$

d) 

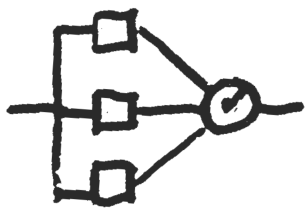
$(\lambda_A = \lambda_B = \lambda)$ $\quad R_S = e^{-\lambda t}(1 + \lambda t)$ $\qquad MTTF = \dfrac{2}{\lambda}$

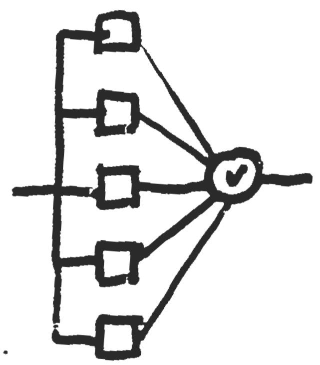
$\lambda_A = \lambda_B = 10^{-4}\,h^{-1}$ $\quad$ MTTF = a) 10'000 ; b) 5000 ; c) 15'000 ; d) 20'000

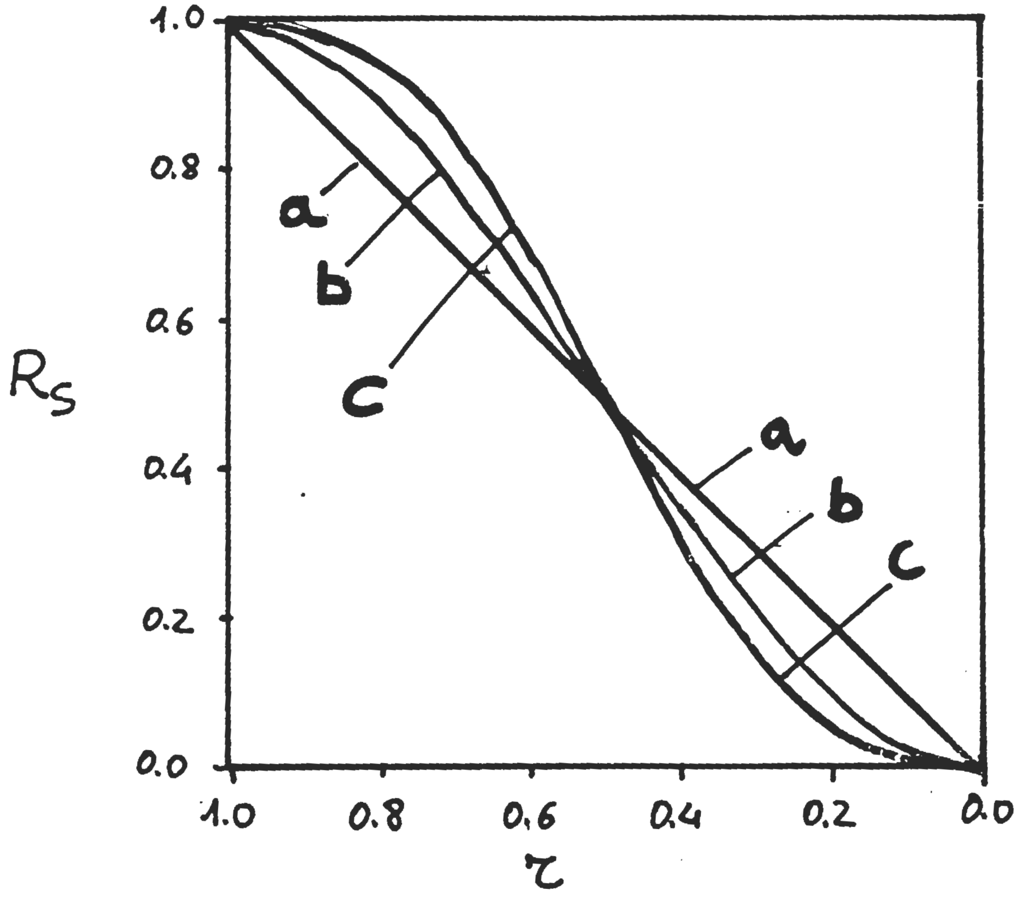


CONFRONTO RIDONDANZE A VOTO DI MAGGIORANZA

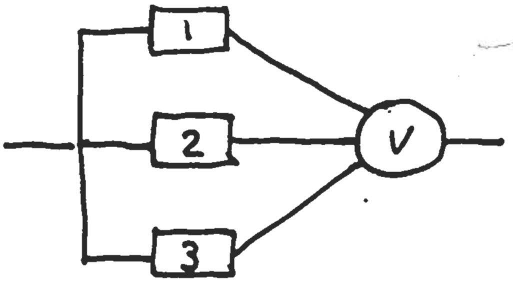
a)  sing. $R_S = \tau$

b)  2:3 $R_S = 3\tau^2 - 2\tau^3$

c)  3:5 $R_S = 6\tau^5 - 15\tau^4 + 10\tau^3$



RIDONDANZA K : n



0 guasti	000	r^3
1 guasto	100 010 001	$3r^2(1-r)$
2 guasti	110 101 011	$3r(1-r)^2$
3 guasti	111	$(1-r)^3$

$$R_S = r^3 + 3r^2(1-r) = 3r^2 - 2r^3$$

probabilità di 2 o 3 guasti

0 guasti o 1 guasto