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$$R_s(t) = \prod_{i=1}^{n} \exp\left(-\left(\frac{t}{\theta_i}\right)^{\beta_i}\right)$$

$$= \exp\left(-\sum_{i=1}^{n} \left(\frac{t}{\theta_i}\right)^{\beta_i}\right) \quad \text{---------- (4)}$$

so the hazard function of serial system each component has Weibull distribution

~~$$\lambda(t) = \frac{\prod_{i=1}^{n} f(t)}{\prod R(t)}$$~~

$$\lambda_s(t) = \frac{\prod_{i=1}^{n} f(t)}{\prod_{i=1}^{n} R_s(t)}$$

$$= \frac{\exp\left\{-\sum_{i=1}^{n}\left(\frac{t}{\theta_i}\right)^{\beta_i}\right\}\left[\sum_{i=1}^{n} \frac{\beta_i}{\theta_i}\left(\frac{t}{\theta_i}\right)^{\beta_i - 1}\right]}{\exp\left(-\sum_{i=1}^{n}\left(\frac{t}{\theta_i}\right)^{\beta_i}\right)}$$

$$\lambda_s(t) = \sum_{i=1}^{n} \frac{\beta_i}{\theta_i}\left(\frac{t}{\theta_i}\right)^{\beta_i - 1} \quad \text{---------- (5)}$$

The functional form of eq. (5) indicates that the system does not exhibit Weibull-type failure although every component has a

79/ a Weibull Failure distribution

البيانات العالية للمعادلة (5) تشير الى ان النظام
لا يسلك مثل توزيع ويبل على الرغم من ان توزيع
الفشل لكل مركبة هو ويبل

ex: Consider a four component system of which the components are independent and identically distributed with CFR. if $R_s(t) = 0.95$ is the specified reliability, find the individual component MTTF (connecte in series)

اربع مركبات تتوزع توزيعاً اسياً وهي مستقلة ومتماثلة
وكانت معولية النظام عند الزمن 100 ساعة تساوي 0.95
جد معدل العمر الزمني المتوقع للفشل لكل مركبة

sol:

$$R_s(100) = e^{-n\lambda_s(t)}$$

$$0.95 = e^{-4*100*\lambda_s}$$

$$-\ln 0.95 = 400\lambda_s \Rightarrow \lambda_s = \frac{-\ln 0.95}{400}$$

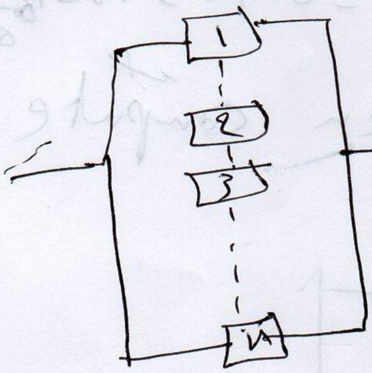
$$\lambda_s = 0.000128$$

$$MTTF_s = \frac{1}{0.000128} = 7812.5$$

$$MTTF_s = \frac{1}{\sum_{i=1}^{n} \lambda_i} = \frac{1}{\sum_{i=1}^{4} 1/MTTF_i}$$

4.2 Parallel configuration ربط التوازي

Two or more component are in parallel or redundant configuration if all units must fail for the system fail



- system reliability for n parallel and independent is found by taking 1 minus the prob. that all n component does not fail.

system contain 2 component in parallel (independent)

$$R_s = P(E_1 \cup E_2) = 1 - P(E_1 \cup E_2)^c$$

$$= 1 - P(E_1^c \cap E_2^c)$$

$$\Rightarrow R_s = 1 - P(E_1^c) \cdot P(E_2^c) \quad (\text{independent})$$

$$R_s = 1 - ((1-R_1)(1-R_2))$$

for n components

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

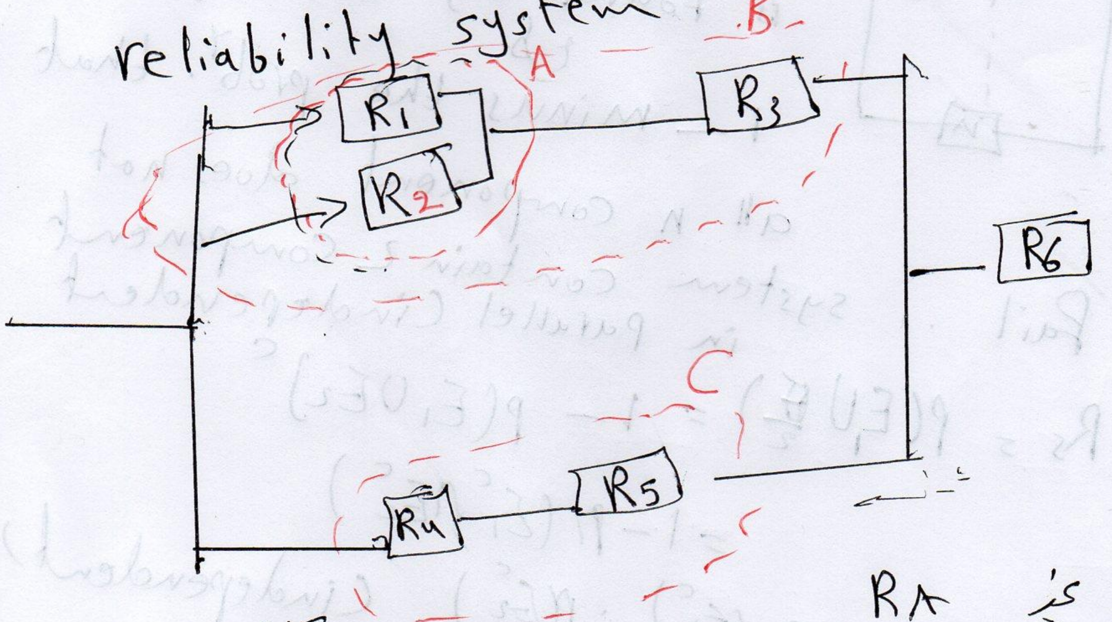
#4

توازي توالي

Combined series – parallel system

الانظمة المختلطة توازي وتوالي

system contain components in both serial and parallel. The figure below represent a system comprised of component in a combined series and parallel relationship. If $R_1 = R_2 = 0.90$, $R_3 = R_6 = 0.98$ and $R_4 = R_5 = 0.99$, then compute reliability system



RA مركبتان مرتبطان على التوازي

$$RA = 1 - (1 - R_1)(1 - R_2)$$
$$= 1 - (0.10)^2$$
$$RA = 0.99$$

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مرتبطان ع التوالي

$R_B = R_A \cdot R_3$

$R_B = 0.99 * 0.98$

$\Rightarrow R_B = 0.9702$

$R_C = R_4 \cdot R_5$ مركبتان مرتبطتان ع التوالي

$R_C = 0.99 * 0.99$

$R_C = 0.980$

$R_d = 1 - (1 - R_C)(1 - R_B)$

$R_d = 1 - (1 - 0.9801)(1 - 0.9702)$

$R_d = 1 - (0.0199)(0.0298)$

$R_d = 1 - 0.00059302$

$R_d = 0.99940698$

$R_s = R_d * R_6$

$R_s = 0.994098 * 0.98$

$R_s = 0.97941$