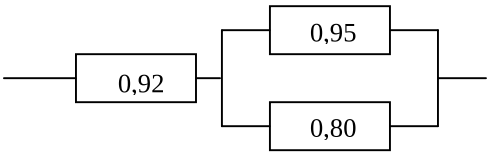
S-38.120 Telecommunication Switching Technology, Exercise 4

Brax/Ilvesmäki/Pulkkinen Friday 8.3.2002, 0915am, Lecture Hall S4

The answers are to be returned before the exercise begins (see the above date and time) either to the exercise assistant (in person or via email to piia@tct.hut.fi) or, preferably, to a box underneath the lab's noticeboard on G-wing 2nd floor. Since we aim to publish the results immediately after the exercise all late answers will be disregarded. Please, adhere to the deadline.

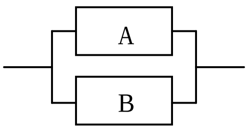
Task 1

What is the reliability of the system below? Where would you place a spare module to increase the reliability of the system in a maximum way and what is the new reliability you achieved?



Task 2

Standby active redundancy: Below there is a figure of a system with two redundant elements. Both the active element and the standby element are energized. For both sides the failure rate is λ and the repair rate is μ. When the active side fails, the standby side takes care of the load and the failed unit undergoes repairs. Draw the 3-state Markov model for the system and name the states. Form the equilibrium equations and solve the state probabilities for each of the three states (as functions of λ and μ). Note that if both of the units have failed the units are repaired consecutively (not simultaneously).



Task 3

For m parallel elements in which failure probabilities are independent and failure of one parallel path has no effect on the operation of surviving paths, reliability is, if all elements are identical, in the time-dependent case $R(t) = 1 - (q(t))^m$. Assuming exponential distribution for the time-to-failure density, $f(t) = \lambda e^{-\lambda t}$, where λ is the constant failure rate equal to $1/\theta$, where θ is the mean life, calculate the reliability equation R(t)

a) for an element with an exponential density function (do $\int_t^\infty$ to the time-to-failure density)

b) for two elements in parallel with equal λ.

Task 4 (related to Task 3)

The designer has the choice of the following two designs: 1) 2-element active parallel configuration with exponential failure densities and mean life of 14 hours/element 2) one element configuration with exponential failure density and mean life of 21 hours/element. Which of the designs should be chosen if the mission time was 5, 17.5 or 30 hours?