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TPK 5170 - DESIGN AND RELIABILITY ANALYSIS OF DIGITALIZED SAFETY SYSTEMS

First exercise

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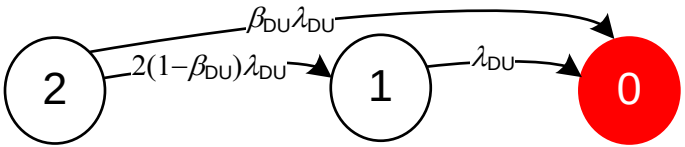
Problem 1

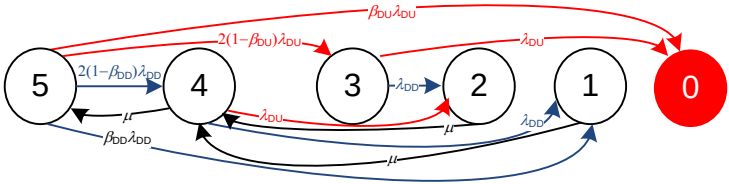
The following figure shows the Markov diagram for a 1oo2 system considering DU-failures only (DU=Dangerous Undetectable, detected only by proof tests):



Assume $\tau = 730, \lambda_{DU} = 0.0001, \text{ and } \beta_{DU} = 0.05$. Find the PFD by numerical integration and compare with $\mathrm{PFD} = (\lambda_{DU} + tau)^2/3 + \beta_{DU}\lambda_{DU}\tau/2$

Problem 2

Consider the Markov diagram with both DD & DU failures:



where the following system states are defined: 5: Both components OK, 4: One OK, one DD-failure, 3: One OK, one DU-failure, 2: One DU-failure and one DD-failure, 1: Two DD-failures, and 0: Two DU-failures. Assume $\tau = 730, \lambda_{\mathrm{DU}} = 0.0001, \beta_{\mathrm{DU}} = 0.05, \lambda_{\mathrm{DD}} = 0.001, \beta_{\mathrm{DD}} = 0.05$ and $\mu = 1/24$. Find the PFD by numerical integration find the extra contribution due to DD failures. Also, do individual calculations for DU and DD failures, and add the contributions. Do you get the same result?

Problem 3

Find the PFH for the situation in described in problem 2

For all problems you may use: ▸ Excel file with VBA code

- Hint 1: Get familiar with matrix manipulation, and in particular how to solve $\mathbf{P}(t + \Delta t) \approx \mathbf{P}(t) \cdot [\mathbf{A}\Delta t + \mathbf{I}]$ either by VBA or your favourite programming language
- Hint 2: In the supported Excel file there is an example how to calculate PFD for a 2oo3 system both using Simpson's rule and the simple Trapezodial rule.

Thank you for your attention