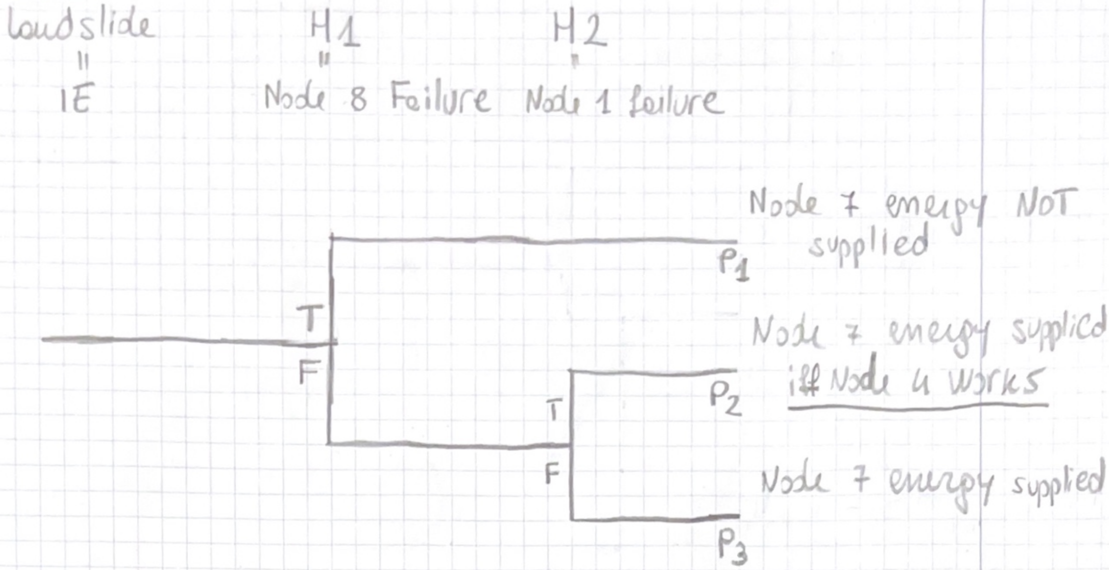
RESILIENCE OF CRITICAL INFRASTRUCTURES PROJECT

[redacted] – Tommaso Giorgeschi

Abstract: This exercise will include the analysis (both topological and with logical methods) of a system representing an electrig grid.
From the next page you will find the results of the analysis.
In the powerpoint presentation you will also find the description on what we have done and on the decisions taken.

PART 1

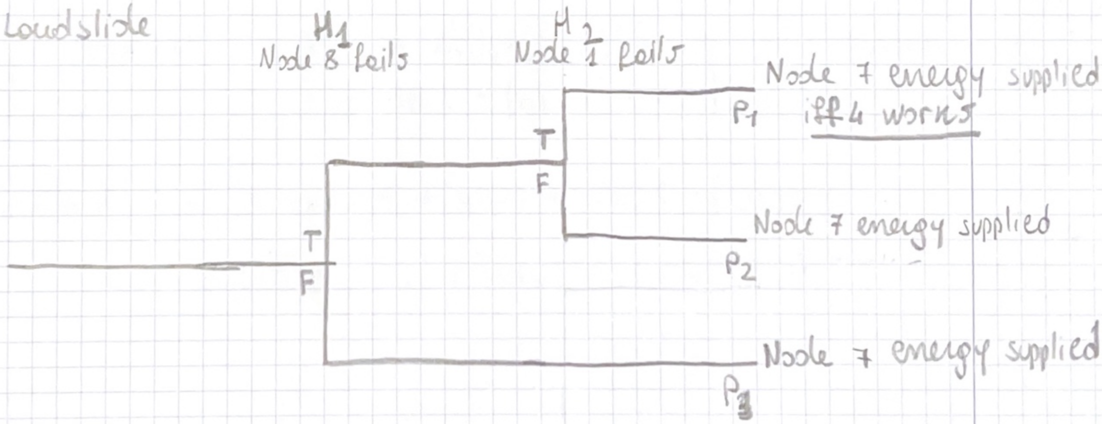


$$P_1 = \frac{4}{100} = 0.04$$

$$P_2 = \frac{96}{100} \cdot \frac{4}{100} = 0{,}0384$$

$$P_3 = \frac{96}{100} \cdot \frac{96}{100} = 0{,}9216$$

PART 2

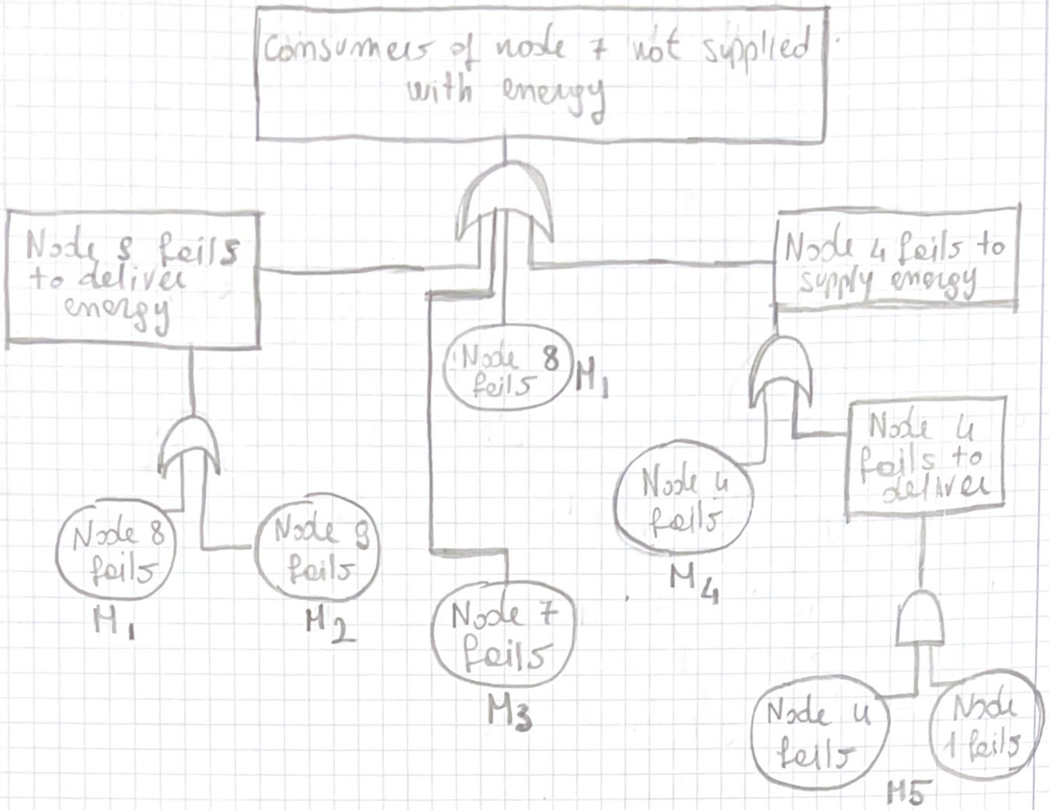


$$P_1 = \frac{4}{100} \cdot \frac{4}{100} = 0{,}0016$$

$$P_2 = \frac{4}{100} \cdot \frac{96}{100} = 0{,}0384$$

$$P_3 = \frac{96}{100} = 0{,}96$$

PART 3.a



MCS: $\{G8\}, \{N3\}, \{N4\}, \{N4, G1\}, \{N7\}$

Node random failure prob. $= 1-e^{-\lambda t} = 1-e^{-3\cdot10^{-4}\cdot10}$

$= 0.002995$

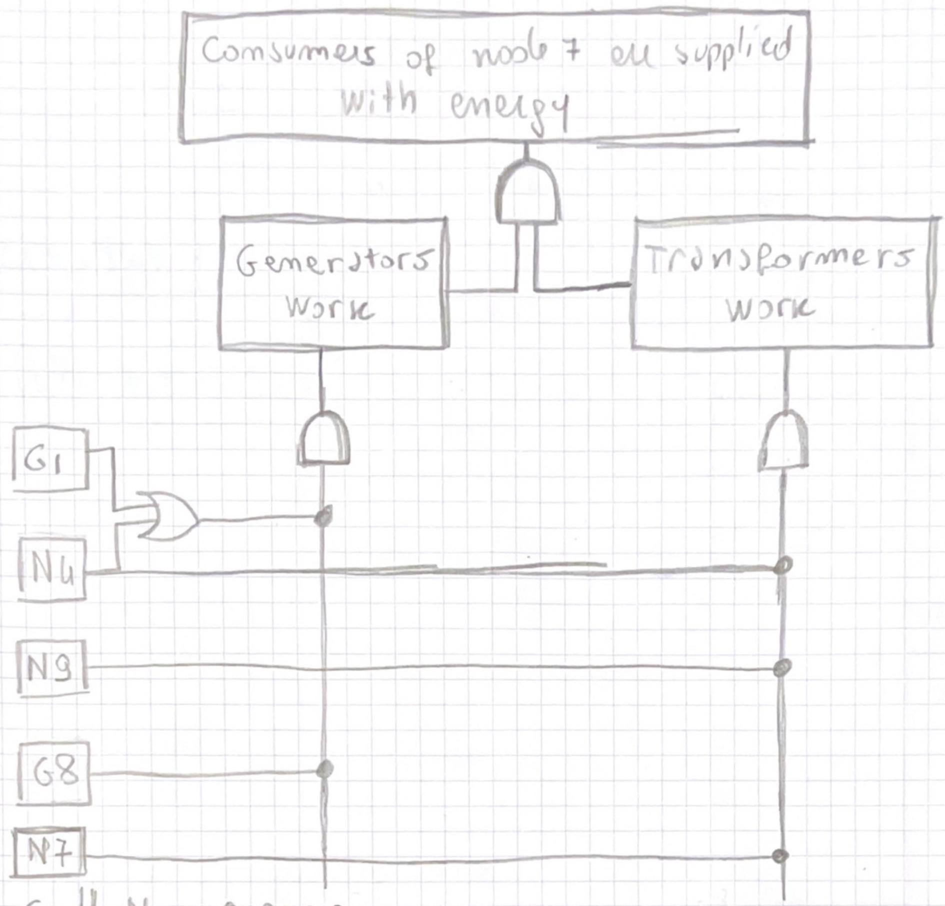
Generator x fails if landslide occurs

$= P(Nx|L)\cdot P(Y<10) = 3.824\cdot10^{-5}$

$P(\text{Node 7 fails}) = P(G8)+P(N3)+P(N4)+P(N4,G1)+P(N7)$

$= 1.145\cdot10^{-5} + \ldots = 9.0223\cdot10^{-3}$

PART 3.b



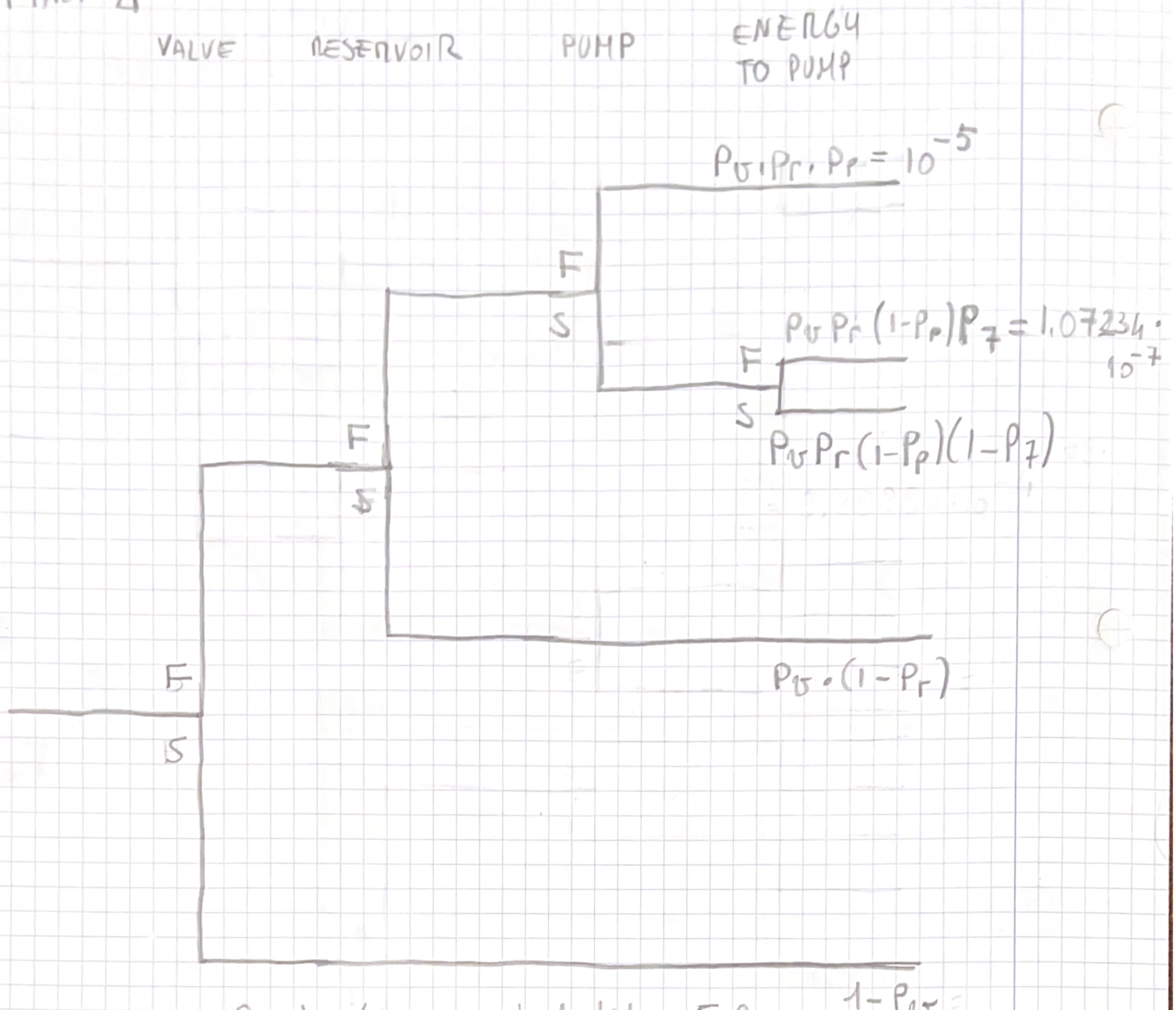
$G_1 \,||\, N_4 = 0.9999$

$G8 \,\&\&\, X_1 = 0.99996$

$N_4 \,\&\&\, N9 \,\&\&\, N7 = 0.99104$

$P(\text{top-event}) = 0.991$

PART 4



Overheating probability = Σ failure conditions = $1.0107 \cdot 10^{-5}$

PART 5

$$C_4^{D^{IN}} = \frac{\sum_{i \neq 4} a_{i4}}{N-1} = \frac{1}{9} \qquad C_4^{D^{OUT}} = \frac{\sum_{J \neq 4} a_{4J}}{N-1} = \frac{2}{9}$$

$$C_4^{C} = \frac{N-1}{\sum_{J \neq 4} d_{4J}} = \emptyset$$

because we have to consider distance to all nodes and some nodes are not reachable

$$C_4^B = \frac{1}{(N-1)(N-2)} \sum_{j,k} \frac{n_{jk}^{(i)}}{n_{jk}} = \frac{3/2}{72} = 0.0208$$

$$C_4^I = \frac{\Delta E(4)}{E} = \frac{14 - 10.5}{14} = 0.25$$

$$D = \begin{bmatrix} 0 & 1 & 1 & 1 & 2 & 2 & 2 & \infty & \infty & \infty \\ & 0 & 1 & \infty & 1 & 1 & \infty & \infty & \infty & \infty \\ & & 0 & - & - & - & - & - & - & - \\ & & & 0 & - & 1 & 1 & - & - & - \\ & & & & 0 & - & - & - & - & - \\ & & & & & 0 & - & - & - & - \\ & & & & & & 0 & - & - & - \\ & & & & & & 1 & 0 & 1 & 2 \\ & & & & & & 1 & 1 & 0 & 1 \\ & & & & & & & & & 0 \end{bmatrix} \qquad D\backslash 4 = \begin{bmatrix} 0 & 1 & 1 & - & 2 & 2 & - & - & - & - \\ & 0 & 1 & - & 1 & 1 & - & - & - & - \\ & & 0 & - & - & - & - & - & - & - \\ & & & 0 & - & - & - & - & - & - \\ & & & & 0 & - & - & - & - & - \\ & & & & & 0 & - & - & - & - \\ & & & & & & 0 & - & - & - \\ & & & & & & 1 & 0 & 1 & 2 \\ & & & & & & 1 & & 0 & 1 \\ & & & & & & & & & 0 \end{bmatrix}$$

References

[1] Slides of the course
[2] Probability slides of professor Zio