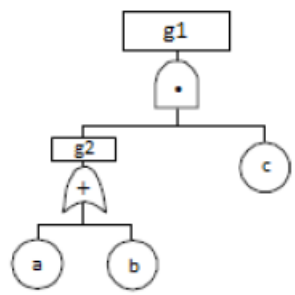
1. A binary decision diagram (BDD) can form a binary tree, which is obtained by means of a truth table, for example. Such a tree may be simplified as follows:

   1. Aggregate leaf nodes 0 and 1 and reorganize the links consequently.
   2. Aggregate nodes with the same name when they present the same logic leading to the child nodes. Reorganize the links consequently. Use this rule from the leaf nodes downwards.
   3. Remove the unnecessary nodes: If branches 0 and 1 lead to the same child node, remove the parent node. reorganize the links consequently.

   Using the above method, build the corresponding BDD of the following Fault Tree.

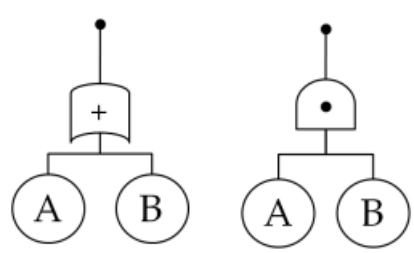


2. Define the exact probability of the top event of the following Fault Tree where:

   (a) Failure probability when component B depends on the component A:
   $P(A) = 0.5$, $P(B|A) = 0.7$ and $P(B|\overline{A}) = 0.3$.

   (b) The component failures are independent
   $P(A) = 0.5$, $P(B) = 0.5$.

   (c) Failure dependency is not modelled explicitly, but failure probabilities at (b) are given and β-factor is equal to 0.05.



3. (Modified Modarres 4.30) Consider a cut set of a system as following

$$T = A \cdot B \cdot C + A \cdot B \cdot D.$$

If the total unreliability of $P(A) = P(B) = P(C) = P(D) = 10^{-3}$ and the components are independent.

(a) Define the system failure probability given no common cause failure.

(b) Assume that k components present common cause failure where the probabilities of the common failures are equal. For example, in case of a common failure of coupled components ($k = 2$), the failure probabilities are equal to Q_2. Quantify the system failure probability including these contributions.

(c) Apply the β-factor model with $\beta = 0.05$.

4. (Modarres 3.8) In a cement production factory, a system such as the one shown below is used to provide cooling water to the outside of the furnace. Develop an MLD for this system.

System bounds	Components $S_1, \ldots, S_{12}$
Top event	Cooling from legs 1 and 2
Assumptions	Only one of the pumps or legs is sufficient to provide the necessary cooling.
	Only one of the tanks is sufficient as a source.