PROBABLISTIC RISK ASSESSMENT

Union, ∪ (OR)

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

where $P(A \cap B)$ is called a *joint probability*. If $A \cap B = \varnothing$ (null or empty set), then A & B are called mutually exclusive (or disjoint) events. And hence, $P(A \cap B) = P(\varnothing) = 0$. If A and B are mutually exclusive events, then

$$P(A \cup B) = P(A) + P(B)$$

Intersection, ∩ (AND)
The conditional probability of A given B is

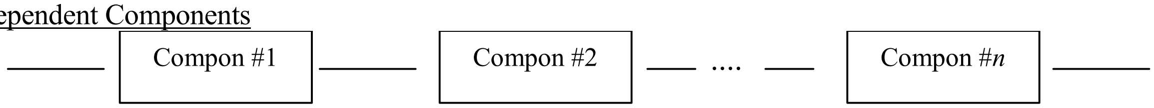
$$P(A|B) = \frac{P(A \cap B)}{P(B)} \qquad P(B) \neq 0$$

If A and B are independent, then

$$P(A \cap B) = P(A)\, P(B)$$

$$P(A|B) = P(A)$$

Independent Components



System Works : (Component #1 Works) AND (Comp #2 Works) AND ... AND (Comp #n Works)
AND = Intersection (∩)

If n events A_i are independent, then

$$P(SW) = P(A_1 \cap A_2 \cap \cdots \cap A_n) = P\left(\bigcap_{i=1}^{n} A_i\right) = \prod_{i=1}^{n} P(A_i)$$

System Fails : (Component #1 Fails) OR (Comp #2 Fails) OR ... OR (Comp #n Fails)
OR = Union (∪)

$$System\ Fails : \overline{System\ Works} \qquad P(SF) = 1 - P(SW)$$

Redundant Components
For a set of m redundant (parallel) components

System Works : (Component #1 Works) OR (Comp #2 Works) OR ... OR (Comp #m Works)
OR = Union (∪)

$$P(SW) = P(R_1 \cup R_2 \cup \cdots \cup R_m) = 1 - P(SF) = 1 - \prod_{k=1}^{m} [1 - P(R_k)]$$

System Fails : (Component #1 Fails) AND (Comp #2 Fails) AND ... AND (Comp #m Fails)
AND = Intersection (∩)

$$System\ Fails : \overline{System\ Works}$$

$$P(SF) = P\left(\overline{R}_1 \cap \overline{R}_2 \cap \cdots \cap \overline{R}_m\right) = \prod_{k=1}^{m} P(\overline{R}_k) = \prod_{k=1}^{m} [1 - P(R_k)]$$