



Reliability Block Diagrams 2

Finding Minimal Path Sets
Using a General Algorithm
(Connectivity Matrix)

- **Algorithm to find minimal path sets using the connectivity matrix**
- The algorithm uses the connectivity matrix to systematically trace paths through the RBD.
- See following flowchart
- But note that when matching the components with edges the connectivity matrix needs to be checked to see how many paths exist.

- **Reminder of Connectivity Matrix $[c]$:**

$[c]$ $n \times n$ matrix where n - number of nodes on network

$c_{ij} = k$ where k is the number of edges from node i to node j .

- **Reminder of Edge Definition:**

The edges $z \rightarrow (i, j)$ are components such that if component z is working there is a path from i to j through z . If component z fails this path from i to j is broken.

Algorithm – Using Connectivity Matrix



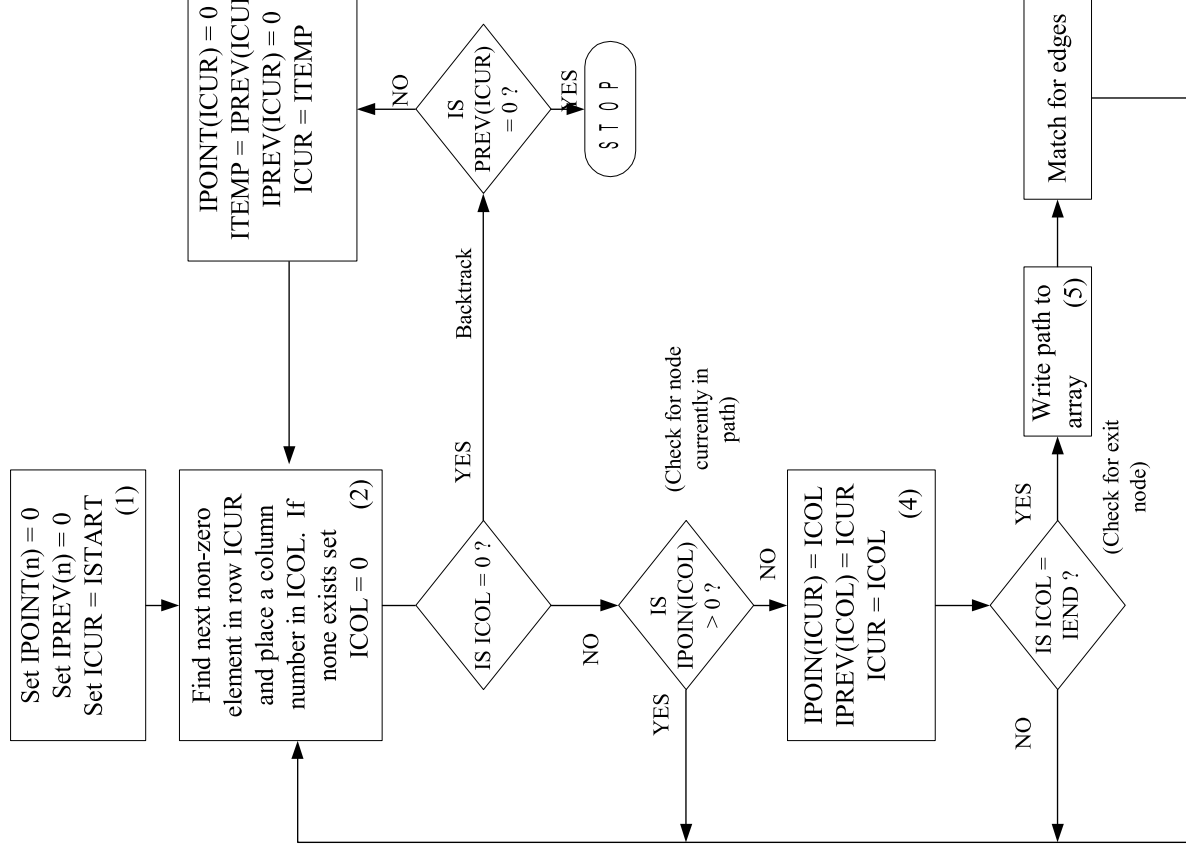
ISTART = start node

IEND = end node

ICUR = current node in
path being traced

IPOINT(n) = pointer at
next node in path

IPREV(n) = pointer at
previous node in path

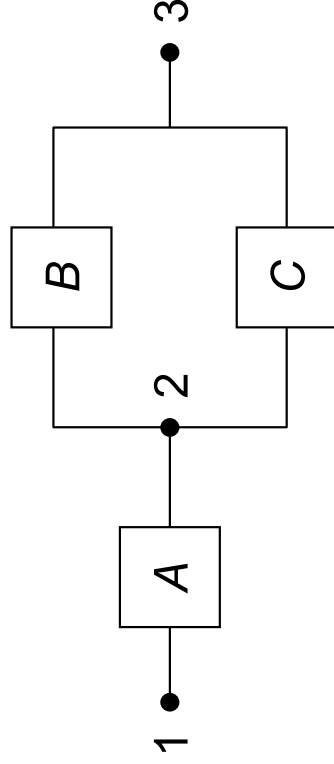


Example



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Incidence function:

$$f: A \rightarrow (1, 2)$$

$$B \rightarrow (2, 3)$$

$$C \rightarrow (2, 3)$$

Example

- **At Box (1):**

$$[c] = \begin{matrix} & \begin{matrix} 1 & 2 & 3 \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} & \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

$$\text{IPOIN} \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\text{ICUR} = 1$$

- **At Box (2):**

$$\text{ICOL} = 2$$

Example

- **At Box (4):**

$$\text{IPOIN} \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

$$\text{ICUR} = 2$$



Example

- **At Box (2):**

$$[c] = \begin{matrix} & 1 & 2 & 3 \\ \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} & \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

$$\text{IPOIN} \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

$$\text{ICUR} = 2$$

$$\text{ICOL} = 3$$

Example

- **At Box (4):**

$$\begin{array}{cc} \text{IPOIN} & \text{IPREV} \\ \left(\begin{array}{c} 2 \\ 3 \\ 0 \end{array} \right) & \left(\begin{array}{c} 0 \\ 1 \\ 2 \end{array} \right) \end{array}$$

$$\text{ICUR} = 3$$

- **At Box (5):**

Write $1 \rightarrow 2 \rightarrow 3$ (from IPOIN)



Example

- **At Box (2):**

$$[c] = \begin{matrix} & 1 & 2 & 3 \\ \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} & \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

$$\text{IPOIN} \begin{pmatrix} 2 \\ 3 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$$

$$\text{ICUR} = 3$$

$$\text{ICOL} = 0$$

$$\text{IPREV}(3) = 2 \neq 0$$



Example

- **At Box (3):**

$$\text{IPOIN} \begin{pmatrix} 2 \\ 3 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

$$\text{ITEMP} = \text{IPREV}(3) = 2$$

$$\text{ICUR} = 2$$



Example

- **At Box (2):**

$$[c] = \begin{matrix} & 1 & 2 & 3 \\ \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} & \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

$$\text{IPOIN} \begin{pmatrix} 2 \\ 3 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

$$\text{ICUR} = 2$$

$$\text{ICOL} = 0$$

$$\text{IPREV}(2) = 1 \neq 0$$



Example

- **At Box (3):**

$$\begin{array}{cc} \text{IPOIN} & \text{IPREV} \\ \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} & \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \end{array}$$

$$\begin{array}{l} \text{IPOIN}(2) = 0 \\ \text{ITEMP} = \text{IPREV}(2) = 1 \\ \text{IPREV}(2) = 0 \\ \text{ICUR} = 1 \end{array}$$



Example

- **At Box (2):**

$$[c] = \begin{matrix} & \begin{matrix} 1 & 2 & 3 \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} & \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 2 \\ 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

$$\text{IPOIN} \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}$$

$$\text{IPREV} \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\text{ICUR} = 1$$

$$\text{ICOL} = 0$$

$$\text{IPREV}(1) = 0$$

\Rightarrow STOP

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- Minimal path sets:
 - 1 AB
 - 2 AC