Appendix G: Non-Series-Parallel System Analysis

A complex system that is neither in series nor parallel is shown in Figure G-1. The reliability is evaluated using the theorem on total probability:

$$R_S(t) = R_S(\text{if } X \text{ is working})\, R_X(t) + R_S(\text{if } X \text{ fails})\, (1 - R_X(t)) \tag{G-1}$$

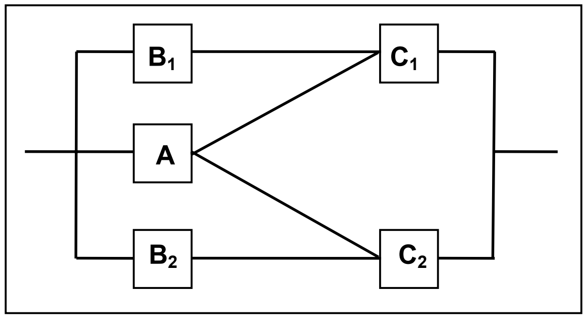

Figure G-1. A non-series-parallel system

Select a critical component. In this case, select component A. The system can function with or without it, and in each case the system resolves into a simpler system that is easily analyzed. If A works, it does not matter if B_1 or B_2 is working. The system can then be represented by the reliability block diagram in Figure G-2.

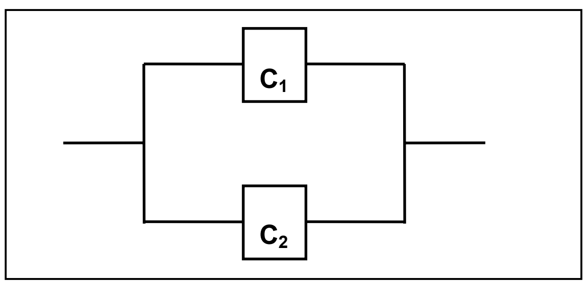

Figure G-2. Reduction of system with component A working

If component A does not work, the system can be reduced to Figure G-3.

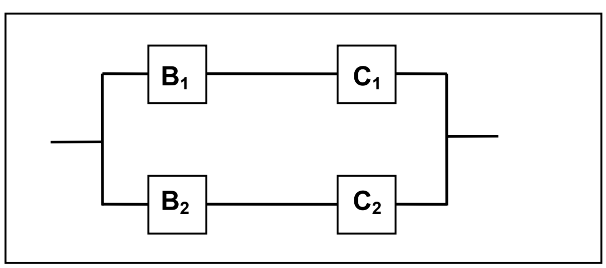

Figure G-3. Reduction of system with component A not working

Figure G-2 is evaluated as follows:

$$R_S(\text{if } A \text{ is working}) = 1 - \{[1 - R_{C1}(t)][1 - R_{C2}(t)]\} \tag{G-2}$$

Figure G-3 is resolved as

$$R_S(\text{if } A \text{ fails}) = 1 - (\{1 - [R_{B1}(t) * R_{C1}(t)]\} \{1 - [R_{B2}(t) * R_{C2}(t)]\}) \quad \text{(G-3)}$$

The total system reliability becomes

$$R_S(t) = R_S(\text{if } A \text{ is working})\, R_A(t) + R_S(\text{if } A \text{ fails})\, [1 - R_A(t)] \quad \text{(G-4)}$$