

Assigned: Lecture 1

Due: Lecture 4

A utility customer wants to know what his power availability is and how much it will cost. The system that supplies his facility is shown in Figure 1 and requires any two of three lines to maintain full production. The minimum protection required is basic relay protection at each terminal end. Using faulty tree analysis, determine the equipment and configuration will give the greatest incremental change in unavailability per investment dollar.

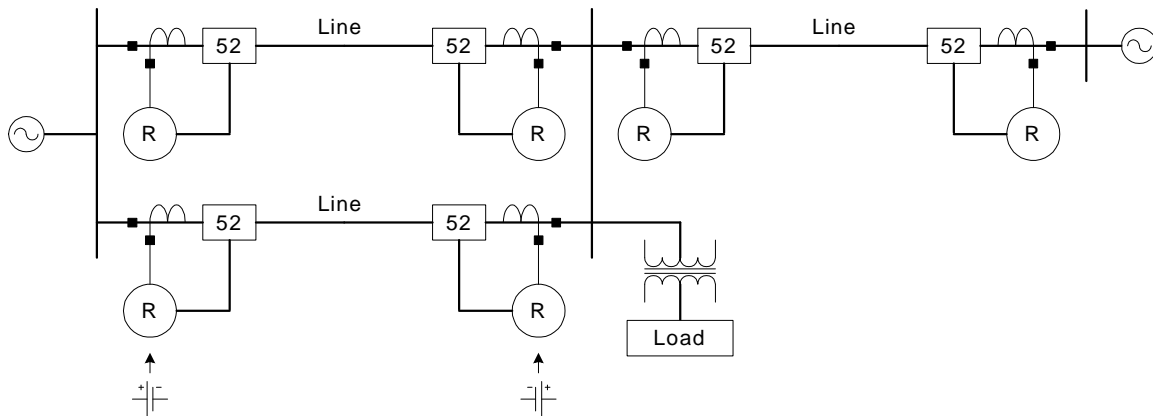


Figure 1. Power delivery system for commercial customer.

Table 1: Unavailability of Several Protection Components

Component	Unavailability $\times 10^6$	Cost
<i>Leased telephone line</i>	1000	\$30,00/line
<i>Circuit breaker</i>	300	\$250,000
<i>Analog microwave equipment</i>	200	\$50,000/terminal
<i>Protective relay misapplications</i>	100	
<i>Protective relay hardware</i>	100	\$15,000/terminal
<i>Tone equipment</i>	100	\$2000
<i>Microwave transmission channel</i>	100	\$3000
<i>Fiber Optic Channel</i>	100	\$5000
<i>Multiplexing Fiber Optic Transceiver</i>	100	\$1000
<i>DC power system</i>	50	\$3000
<i>Modem</i>	30	\$500
<i>Simple Fiber Optic Transceiver</i>	10	\$150,000/line
<i>Current transformer (per phase)</i>	10	\$5000
<i>Voltage transformer (per phase)</i>	10	\$5,000

Communications Options:

1. None
2. Direct fiber optics connection

3. Fiber optics channel with modem
4. Tone equipment with leased telephone line
5. Tone equipment with microwave channel

Equipment options:

1. Single protective relays at each terminal end
2. Redundant relays at one or more terminal ends
3. Independent DC supplies for redundant relays