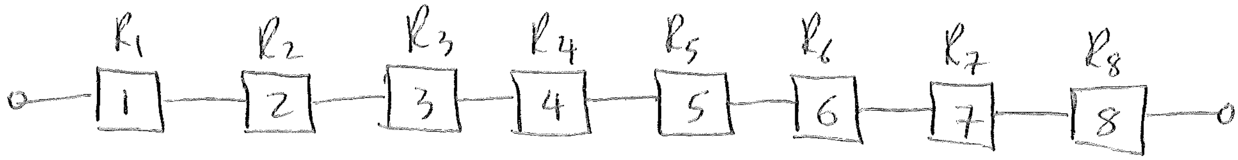
16.1



so we have 8 bulbs in series, so for the whole string to work, all of them must work.

For a series system,

$$R_s = \prod_{i=1}^{n} R_i$$

$$= R_1 * R_2 * R_3 \ldots * R_n$$

So in our case

$$R_s = R_1 * R_2 * R_3 * \ldots * R_8$$

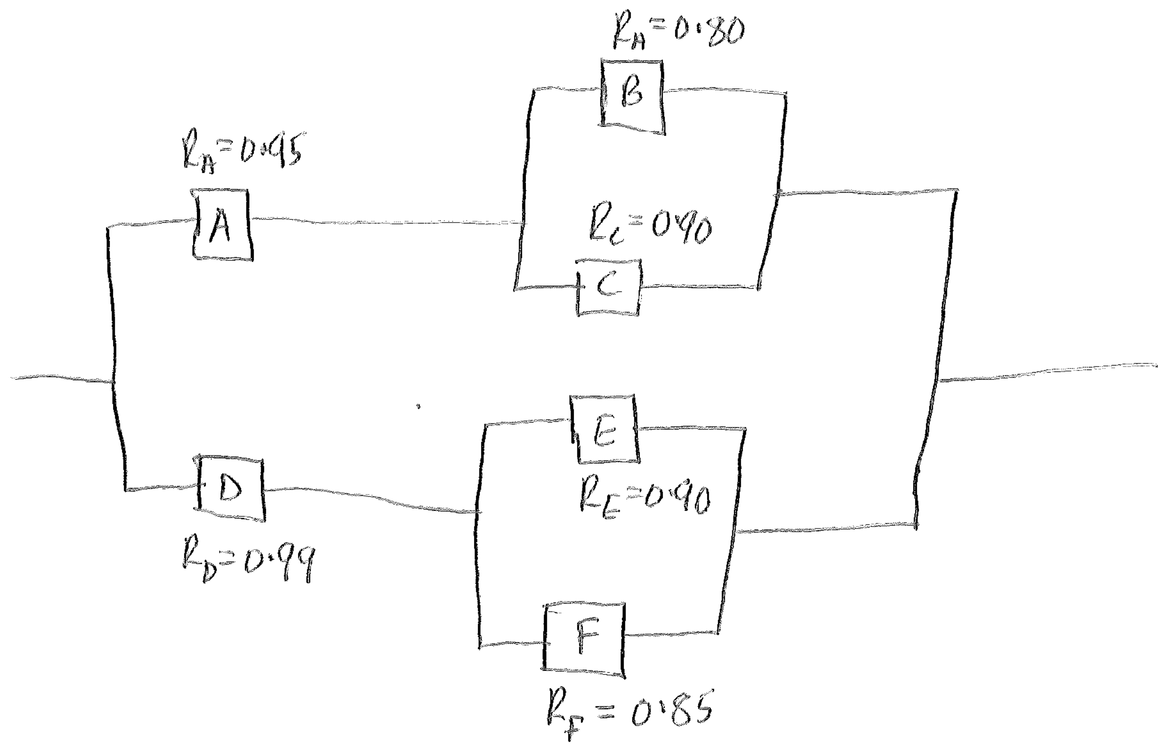
If each bulb has the same reliability (R), then

$$R_s = R^8$$

$$0.95 = R^8$$

$$R = 0.9936$$

16.3



For parallel ~~series~~ systems

B-C ; $R_{BC} = 1 - (1-0.80)(1-0.90) = 0.98$

E-F ; $R_{EF} = 1 - (1-0.90)(1-0.85) = 0.985$

For A-B-C we have series system

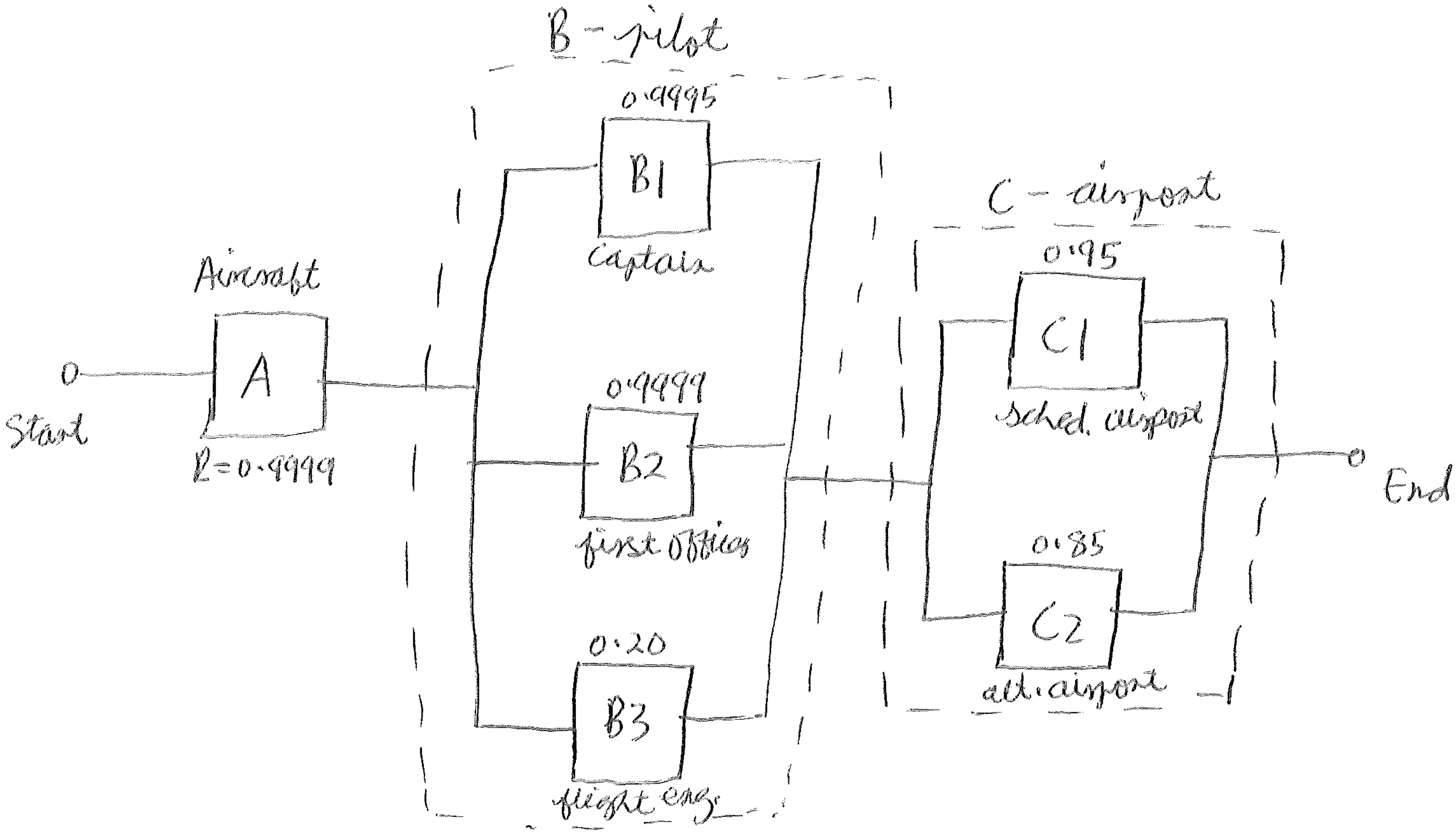
$R_{ABC} = 0.95 * 0.98 = 0.931$

$R_{DEF} = 0.99 * 0.985 = 0.97515$

for entire system

$R_{system} = 0.931 * 0.97515 = 0.9078$

16.4



a) $R_{system} = R_A * R_B * R_C$

$$= R_A * \left[1-(1-R_{B1})(1-R_{B2})(1-R_{B3})\right]$$

$$* \left[1-(1-R_{C1})(1-R_{C2})\right]$$

$$= 0.9999 * \left[1-(1-0.9995)(1-0.9999)(1-0.2)\right]$$

$$* \left[1-(1-0.95)(1-0.85)\right]$$

$=$

b)

$$R_B = 1 - (1-0.9995)(1-0.9999)(1-0.99) =$$

use to recalculate R_{system}

c)

$$R_B = 1 - (1-0.9995)(1-0.99) =$$

and recalculate R_{system}

d) $$R_C = 1 - (1-0.95)(1-0.85)(1-0.80) =$$

then recalculate R_{system}

Note: I will be using the notation in your book

16.7

a)

failure rate aka failure rate function

$$z(t) = \frac{f(t)}{R(t)}$$ [General equation for failure rate function]

so $$R(t) = \frac{f(t)}{z(t)}$$

where $R(t)$ is the reliability, or probability it survives to time t, $[1 - F(t)]$

$$z(t) = 0.02$$ (per thousand hours)

$$f(t) = z(t) \cdot e^{-\int_0^t z(x)dx}$$ [General equation for failure time distribution]

$$= 0.02\, e^{-\int_0^{20} z(20)dx}$$

$$= 0.02 \cdot e^{-\int_0^{20} 0.02dx}$$

$$= 0.02\, e^{-0.02[x]_0^{20}} = 0.02\, e^{-0.4}$$

so $$R(20{,}000 \text{ hours}) = \frac{0.02e^{-0.4}}{0.02} = 0.6703$$

b)

$$f(t) = Z(t)\, e^{-\int_0^t Z(x)dx}$$

$$= 0.02\, e^{-\int_0^5 0.02\,dx}$$

$$= 0.02\, e^{-0.02[x]_0^5}$$

$$= 0.02\, e^{-0.1}$$

survival up to 5,000 hours for this component, aka reliability at 5,000 hours is

$$R(5{,}000) = \frac{0.02\, e^{-0.1}}{0.02} = 0.9048$$

If we have four of these in a series system

$$R_{system} = (0.9048)^4 = 0.6703$$