Problem 10.1

First we calculate component reliabilities:

Table 1: Data for reliability problem

Component	MTTF	MDT	p
Processing unit 1	4000	8	0.99800
Processing unit 2	6000	8	0.99867
Conveyor belt	1000	24	0.97656

The structure function is given by

$$\phi(\mathbf{x}) = x_{\mathrm{PU1}}x_{\mathrm{PU2}}x_{\mathrm{CB1}} + x_{\mathrm{PU1}}x_{\mathrm{PU2}}x_{\mathrm{CB2}} - x_{\mathrm{PU1}}x_{\mathrm{PU2}}x_{\mathrm{CB1}}x_{\mathrm{CB2}}$$

and the system reliability:

$$P_{\mathrm{S}} = h(\mathbf{p}) = p_{\mathrm{PU1}}p_{\mathrm{PU2}}p_{\mathrm{CB1}} + p_{\mathrm{PU1}}p_{\mathrm{PU2}}p_{\mathrm{CB2}} - p_{\mathrm{PU1}}p_{\mathrm{PU2}}p_{\mathrm{CB1}}p_{\mathrm{CB2}} \approx 0.9961$$

Note, since both conveyor belts have the same reliability, we may write:

$$P_{\mathrm{S}} = h(\mathbf{p}) = p_{\mathrm{PU1}}p_{\mathrm{PU2}}\left(2p_{\mathrm{CB}} - p_{\mathrm{CB}}^2\right)$$

Similarly, if redundancy is implemented for processing unit 2 we have:

$$P_{\mathrm{S}} = h(\mathbf{p}) = p_{\mathrm{PU1}}\left(2p_{\mathrm{PU2}} - 2p_{\mathrm{PU2}}^2\right)\left(2p_{\mathrm{CB}} - p_{\mathrm{CB}}^2\right) \approx 0.9975$$

Unavailability is given by $U = 1 - P_{\mathrm{S}}$, and the expected number of hours per year not producing is given by $\mathrm{E(Hrs)} = 8760U = 8760(1 - P_{\mathrm{S}})$. It follows that the expected number of lost hours is reduced from 33 to 22 per year corresponding to 1.1 million NOKs. It pays off to install redundancy.