2.
A system is constructed of 3 identical components set up in parallel. The reliability of each component is R = 0.79. There is a wish to decrease the number of components to 2 but keep same reliability of the system. What level of component reliability is necessary for the new components?

(3p)

3:
The following data have been collected from a production process:

MTBF = 1375 h

MTTR = 6.2 h

$\bar{M}_{PM}$ = 1.2 h

$MTBM_{PM}$ = 265 h

MTW(A) = 0.5 h

MLDT = 0.8 h

Calculate A_i, A_a and A_o.

(2p)

Calculations:

2

Original: R_{sys} = 1-(1-0.79)^3= 0.990739

New: R_{sys} = 1-(1-x)^2=0.990739
1-(1-0.990739)$^{0.5}$= x
x = 0.90377

3

Ai = MTBF/MTBF+MTTR = 1375 / (1375+6.2) = 0.9955

Mdash = ((1.2/265) + (6.2/1375))/(1/265+1/1375) = 2.01

MTBM = 1/(1/265+1/1375) = 222.18

Aa = MTBM/MTBM+Mdash = 222.18/(222.18 + 2.01) = 0.991

MDT = Mdash + MTW = 2.01 + 0.5 + 0.8 = 3.31

Ao = MTBM/MTBM+MTW = 222.18/(222.18 + 3.31) = 0.985

Equations:

$$R(t) = e^{-\int_0^t z(x)dx} \Rightarrow R(t) = e^{-\lambda t} \qquad [1]$$

$$\mu = \int_0^\infty R(t)dt = MTBF \Rightarrow MTBF = \frac{1}{\lambda} \qquad [2]$$

$$R(t) = e^{-\lambda t_m} = 0.5 \qquad [3]$$

$$R_s(t) = \prod_{j=1}^{n} R_j(t) = R_1(t) \cdot R_2(t) \cdot \ldots \cdot R_n(t) \qquad [4]$$

$$R_p(t) = 1 - \prod_{j=1}^{n} (1 - R_j(t)) = 1 - (1 - R_1(t)) \cdot (1 - R_2(t)) \cdot \ldots \cdot (1 - R_n(t)) \qquad [5]$$

$$f = \frac{1}{MTBM_{PM}} \qquad [6]$$

$$\bar{M} = \frac{\lambda \cdot \bar{M}_{CM} + f \cdot \bar{M}_{PM}}{\lambda + f} \qquad [7]$$

$$MTBM = \frac{1}{1/MTBM_{CM} + 1/MTBM_{PM}} \qquad [8]$$

$$MLDT = \frac{\lambda \cdot MLDT_{CM} + f \cdot MLDT_{PM}}{\lambda + f} \qquad [9]$$

$$MTW(A) = \frac{\lambda \cdot MTW(A)_{CM} + f \cdot MTW(A)_{PM}}{\lambda + f} \qquad [10]$$

$$MTW = MLDT + MTW(A) \qquad [11]$$

$$MDT = MTW + \bar{M} \qquad [12]$$

$$MDT = \frac{\lambda \cdot (MTW(A)_{CM} + MLDT_{CM} + \bar{M}_{CM}) + f \cdot (MTW(A)_{PM} + MLDT_{PM} + \bar{M}_{PM})}{\lambda + f} \qquad [13]$$

$$A_k = A_i = \frac{MTBF}{MTBF + MTTR} \quad [14] \qquad A_m = A_a = \frac{MTBM}{MTBM + \bar{M}} \quad [15]$$

$$A_o = \frac{MTBM}{MTBM + MDT} \quad [16]$$

OEE-calculations:

$$\textbf{Planning factor} = \frac{\textbf{Scheduled work time – planning related stop time}}{\textbf{Scheduled production time}}$$

$$\textbf{Availability} = \frac{\textbf{Planned production time – unplanned stop time}}{\textbf{Planned production time}}$$

$$\textbf{Performance rate} = \frac{\textbf{Bought cycle time x items produced}}{\textbf{Available operative time}}$$

$$\textbf{Quality rate} = \frac{\textbf{Items produced – defect items}}{\textbf{Items produced}}$$

PfOEE = Pf x A x P x Q

OEE = A x P x Q

Performance rate when producing products with different cycle times:

$$P = \frac{\sum CT_T \times P}{AOT}$$

CT_T = Theoretical cycle time
P = Quantity produced items
AOT = Available operative time