In the name of god

Reza Adinepour
402131055
HW06

7.2 :

$$\begin{cases} 20h \longrightarrow 2^{v} \\ 160h \longrightarrow 1.8^{v} \\ 1250h \longrightarrow 1.6^{v} \\ 10\text{ years} \longrightarrow ? \end{cases}$$

in first step we can use this equation for find coefficient of a and K

$$T = K V^{-a} \longrightarrow \begin{cases} \text{I)}\ 20 = 2K^{-a} \\ \text{II)}\ 160 = 1.8K^{-a} \\ \text{III)}\ 1250 = 1.6K^{-a} \end{cases} \longrightarrow (\text{I}) \div (\text{II}) : \frac{20}{160} = \frac{2K^{-a}}{1.8K^{-a}}$$

$$\Rightarrow 0.125 = 1.11^{-a} \quad \text{OR} \quad 8 = 0.9^{-a}$$

$$\Rightarrow \frac{1}{8} = 0.9^{a} \Rightarrow a = \frac{\log(\frac{1}{8})}{\log(0.9)} \simeq \boxed{3.17} \ *$$

$$* \text{ in (I)} \longrightarrow 20 = 2 \times K^{-3.17} \Rightarrow K = \frac{20}{2^{-3.17}} = 20 \times 2^{3.17} \simeq \boxed{81}$$

Now we can calculate maximum operating voltage for 10 years :

$$10 \text{ years} : 10 \times 365^{day} \times 24^{h} = 87600^{h}$$

$$\Rightarrow 87600 = 81 \times V^{-3.17} \xrightarrow{\div 81} \frac{87600}{81} = V^{-3.17} \Rightarrow V^{-3.17} = 1081.5$$

$$\Rightarrow V^{3.17} = \frac{81}{87600} \Rightarrow \boxed{V \simeq 0.089}$$

7.3: The "5 9s" yield represent the ~~pse~~ percentage of parts or subsys that are expected to function with out failure. In this case, it is 0.99999. this means that only 0.00001 of units are expected to fail, or in other word the failure rate is 0.00001

$$\text{Reliability} = 1 - \text{CDF}(z) \implies \text{CDF}(z) = 1 - \text{Reliability}$$

$$= 1 - 0.99999 = 0.00001$$

$$\text{CDF}(z) = P(Z \leq z) = \int_{-\infty}^{z} \frac{1}{\sigma\sqrt{2\pi}} \cdot e^{-\frac{1}{2}\frac{t-\mu}{\sigma^2}} \, dt$$

Probability of 0.00001 Corresponds to a z-score of approximately -4.417. This means that the parameter leading to failure must be at least 4.417 standard divitions away from the mean in or to achieve a "5 9s" yield

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7.6:

inverter Delay : 10 ps

std = 1 ps

an 11 inverter in each rings

$$\implies \mu_{ro} = 11 \times 10^{ps} = 110^{ps}$$

Now we can find chip frequency:

$$f_{chip} = \frac{1}{\mu_{ro}} = \frac{1}{110^{ps}} \simeq \boxed{9.09^{GHZ}}$$

b) $$Z = \frac{\text{target delay} - \mu_{ro}}{\sigma_{ro}} \implies$$

for a yield of 97.7% the Z score is approximately

$$\text{target delay} = \mu_{ro} + Z \cdot \sigma_{ro} = 110^{ps} + 1.88 \times 1^{ps} \simeq \boxed{112.88^{ps}}$$

$$f_{target} = \frac{1}{\text{Target Delay}} = \frac{1}{112.88^{ps}} = \boxed{8.86^{GHZ}}$$