CSE435 Introduction to EDA & Testing - Spring 2022

Homework Assignment #1

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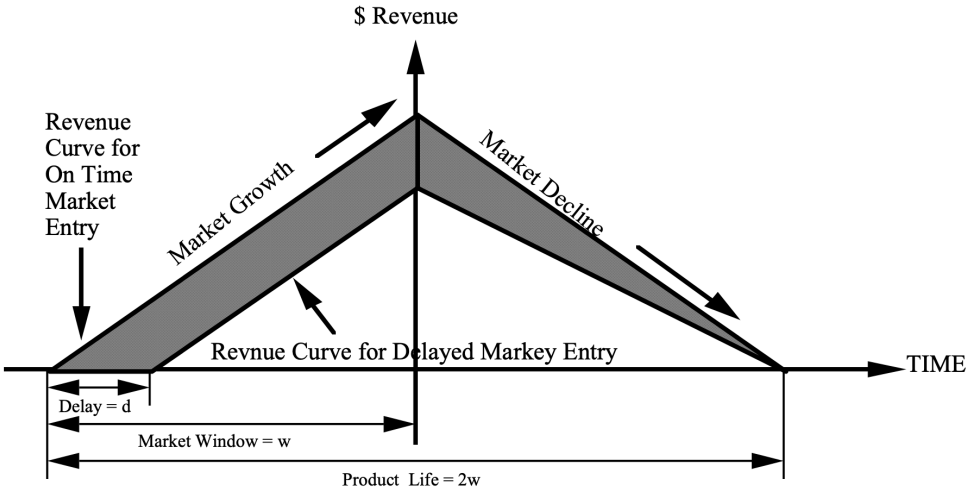
1. (25%) If the yield of good dice is 90%, and we want a defect level not to exceed 0.1%, what level of testing in terms of fault coverage must be achieved?

Solution: The defect level **DL** can be obtained by $\mathbf{DL} = 1 - \mathbf{Y}^{1-\mathbf{T}}$, where **Y** is the yield, indicating the manufacturing capability, and **T** is the fault coverage, indicating the testing capability.

$$\begin{aligned} 0.001 &\geq 1 - 0.9^{1-\mathbf{T}} \\ 0.9^{1-\mathbf{T}} &\geq 1 - 0.001 \\ 0.9^{1-\mathbf{T}} &\geq 0.999 \\ \log_{0.9} 0.9^{1-\mathbf{T}} &\leq \log_{0.9} 0.999 \\ 1 - \mathbf{T} &\leq 0.0095 \\ \mathbf{T} &\geq 0.9905 = 99.05\% \end{aligned}$$

Answer: The fault coverage **Y** must be at least 99.05%

2. (50%) Given the market entry time verse revenue curves as shown in Figure 1, fill in the following formula



(a) (25%) Lost Revenue = Total Expected Revenue * [ ]. The answer should be in term of d and w. d is the delay entry, $2w$ is the product life. The two market growth rates are the same.

Solution: The Lost Revenue **LR** equals to the absolute difference between the Total Expected Revenue **TER** and the Total Actual Revenue **TAR**. Denote the market growth rates as r, the Lost Revenue can be obtained by

$$\begin{aligned}
\textbf{TER} &= \frac{1}{2}(2w)(w)r = (w^2)r \\
\textbf{TAR} &= \frac{1}{2}(2w-d)(w-d)r = (w^2 - \frac{3}{2}wd + \frac{1}{2}d^2)r \\
\textbf{LR} &= \textbf{TER} - \textbf{TAR} \\
\textbf{LR} &= (\frac{3}{2}wd - \frac{1}{2}d^2)r \\
\textbf{LR} &= \textbf{TER} \times \frac{(\frac{3}{2}wd - \frac{1}{2}d^2)r}{\textbf{TER}} \\
\textbf{LR} &= \textbf{TER} \times \frac{\frac{3}{2}wd - \frac{1}{2}d^2}{w^2}
\end{aligned}$$

Answer: $(\frac{3}{2}wd - \frac{1}{2}d^2)/w^2$

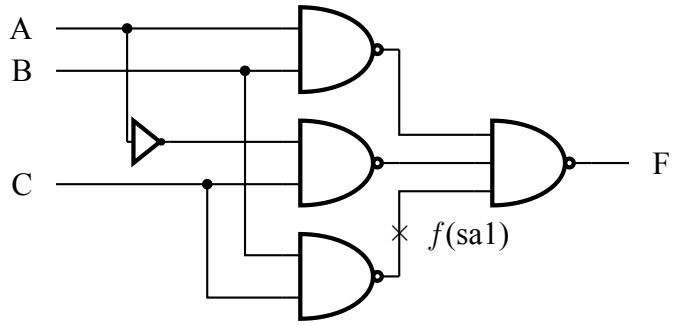
(b) (25%) Given a product with total expected revenue \$100M, product life is 20 months. What is the revenue loss due to the one month late to the market?

Solution: Substitute the given algebras inside the formula above.

$$\begin{aligned}
2w &= 20 \\
w &= 10 \\
d &= 1 \\
\textbf{LR} &= 100\text{M} \times (\frac{3}{2} \times 10 \times 1 - \frac{1}{2}1^2)/10^2 \\
\textbf{LR} &= 14.5\text{M}
\end{aligned}$$

Answer: 14.5M

3. (25%) Try to derive the test pattern for the fault f (sa1). Explain your result. Try to simplify the circuit.



Solution: In order to find the stuck-at-1 fault, the first and second (top-down order) inputs of the final **NAND** gate must be non-dominant, which is 1, and the third input must be 0. The third input's value of 0 indicates $\overline{B \cdot C} = 0$ and thus $B = C = 1$. We then need $A = 0$ to make the first input 1. However, we also want $A = 1$ to make the second input 1, which contradicts the requirement above. As a result, this fault is not discoverable, i.e., a redundant fault.

Answer: The test pattern does not exist.

Simplified circuit with stuck-at-1 fault: