

Q1) The power consumption stays the same at 20W and the micro-processor becomes 40% faster to 5.6GHz in the next technology node based on the perfect Dennard scaling.

Q2) $V_{IL} = 0.75V$; $V_{IH} = 1.25V$; $V_{OL} = 0V$; $V_{OH} = 2V$

Noise margin high = $0.75V$

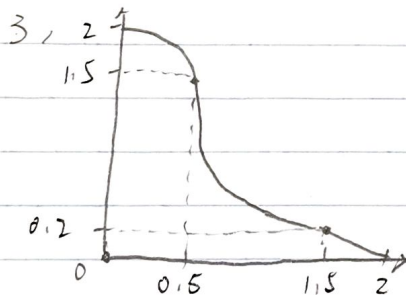
Noise margin low = $0.75V$.

Q3) 1. NAND gate.

2. a) Let two inputs be the same.

b) Use one blackbox with input A and B, then use the output of the blackbox as the both inputs for another blackbox.

c) Let A be the two inputs for one blackbox, B be the two inputs for another blackbox, and let the two outputs from these two blackbox be the input of the third blackbox.



4. Propagation delay is 5 microseconds.

Q4) 1. $C_0 = 1$, $C_1 = 0$, $C_2 = 1$, $C_3 = 0$.

2. Yes, any arbitrary 2 input logic only has 4 possible inputs, the above architecture has all the possible combination as inputs to an OR gate with a control $C_1 \sim C_4$.

Q5)

2) $\text{not}((\text{not}A \text{ and } B) \text{ and } (C \text{ xor } D)) \text{ and } \text{not}(E \text{ or } F)$
 $= \sim((\sim A B)(C \oplus D)) \sim (E + F)$
 $= \sim C \sim D + CD + \sim B + \sim F + E + A$
 $= \text{not } C \text{ and not } D \text{ or } C \text{ and } D \text{ or not } B \text{ or } F \text{ or } E \text{ or } A$

$$\begin{aligned} \text{Q6) 1. } & ((\bar{A})(\bar{B}) + C)(A+B)(\bar{B} + AC) \\ &= ((\bar{A})(\bar{B}) + C)(A+B)((\bar{B})(\bar{A}C)) \\ &= ((\bar{A})(\bar{B}) + C)(A+B)((\bar{B})(\bar{A} + \bar{C})) \\ &= (((\bar{A})(\bar{B}) + C)(A) + ((\bar{A})(\bar{B}) + C)(B))((\bar{A})(\bar{B}) + (\bar{C})(\bar{B})) \\ &= (\bar{A}A\bar{B} + AC + \bar{A}B\bar{B} + BC)(\bar{A}\bar{B} + B\bar{C}) \\ &= (AC + BC)(\bar{A}\bar{B} + B\bar{C}) \\ &= \bar{A}B(AC + BC) + B\bar{C}(AC + BC) \\ &= (\bar{A}BAC + \bar{A}BBC) + (ACB\bar{C} + B\bar{C}BC) \\ &= \bar{A}BC \end{aligned}$$

$$\begin{aligned} 2. \quad & (\bar{A})(\bar{B}) + AB + \bar{A}B \\ &= (\bar{A})(\bar{B}) + (B(A + \bar{A})) \\ &= (\bar{A})(\bar{B}) + B \\ &= (\bar{A} + B)(\bar{B} + B) \\ &= \bar{A} + B \end{aligned}$$

$$\begin{aligned} 3, \quad & \bar{A}(A+B) + (B+AA)(A+\bar{B}) \\ & = A\bar{A} + \bar{A}B + (A+B)(A+\bar{B}) \\ & = \bar{A}B + (A(A+B) + B(A+\bar{B})) \\ & = \bar{A}B + (A + (AB + B\bar{B})) \\ & = \bar{A}B + (A + AB) \\ & = A + \bar{A}B + AB \\ & = A + B(\bar{A} + A) \\ & = A + B \end{aligned}$$