

HW3 Solutions

Q1

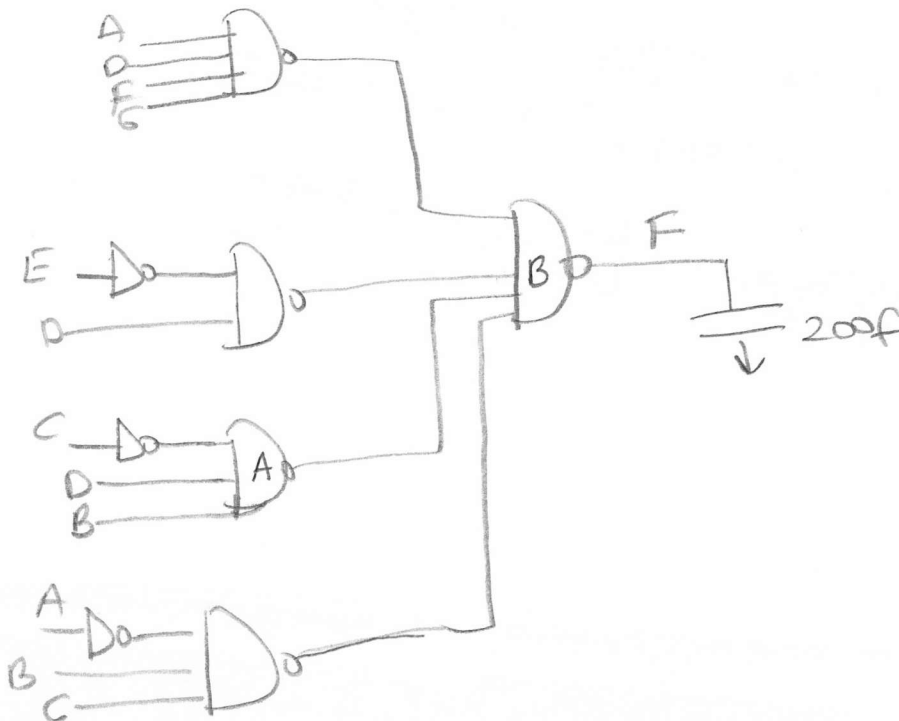
a

$$F = \frac{200f}{3f} = 67 \quad N_{opt} = 1.7 \log(F) = 3.1 \rightarrow 3 \text{ or } 4 \text{ stages}$$

Note: we don't know what type of gate the first gate in the path will be, so we assumed an inverter.

$$b) \quad \overline{F} = \overline{A BC + \bar{C} DB + \bar{D} E + A D F G}$$

$$\overline{F} = \overline{(A BC)} \cdot \overline{(\bar{C} DB)} \cdot \overline{(\bar{D} E)} \cdot \overline{(A D F G)} \rightarrow 3 \text{ stages for } \overline{F}$$



(2)

© Critical path

equal delay

$$\left. \begin{array}{l} C \rightarrow F \\ A \rightarrow F \end{array} \right\}$$

$$F = \frac{200f}{3f} = 67 \quad B = 1$$

$$G = (1) \left(\frac{5}{3}\right) \left(\frac{6}{3}\right) = 10/3$$

$$H = FBG = 233$$

$$h = \sqrt[3]{233} = 6$$

$$C_{inB} = \frac{200f \times (6/3)}{6} = 67fF$$

$$S_B = \frac{67f}{6f} = 11$$

$$C_{inA} = \frac{67f \times (5/3)}{6} = 18.5fF$$

$$S_A = \frac{18.5f}{5f} = 3.7$$

→ size others accordingly

$$\textcircled{d} \quad t_p = t_{p0} (1 + 3 + 4 + 3 \times 6) = 26t_{p0}$$

© Input C will switch

$$D = E = 1$$

$$A = B = C = 1$$

$$E = D = 1$$

$$F = 0$$

$$G = 1$$

$$ABCDEFG : \begin{array}{l} 1111101 \rightarrow \\ 1101101 \end{array}$$

will activate

C → F path

there are other combinations

Q2

$$\textcircled{a} \quad t_{px} = t_p \left[2 + 3 + 2 + 1 + \frac{4}{3} \times \frac{7}{4} + \frac{7}{3} \times \frac{9}{7} + \frac{4}{3} \times \frac{3}{4} + (1) \times \frac{200}{3} \right] \textcircled{3}$$

$$= 81 t_{p0}$$

$$1 \quad t_{pz} = \left[2 + 3 + 2 + \frac{7}{3} + \frac{9}{3} + \frac{5}{3} \times \frac{200}{5} \right] = 79 t_{p0}$$

$$\textcircled{b} \quad F = \frac{200}{4} \quad G = \frac{4}{3} \times \frac{7}{3} \times \frac{4}{3} = 4.15 \quad B = \frac{9}{4} = 2.25$$

$$H = 466.9 \quad h = 4.7$$

$$C_{nu} = \frac{200 \times 1}{4.7} = 42.5 f \quad C_{nv} = \frac{42.5 \times 4/3}{4.7} = 12.1 f$$

$$C_{nw} = \frac{(7/3)(12.1 + 5)}{4.7} = 8.5 f$$

(4)

$$B_{\text{new}} = \frac{12.1 + 5}{12.1} = 1.41 \quad \sqrt[4]{B_{\text{new}}} = 1.09$$

$$\sqrt[4]{B_{\text{old}}} = 1.22$$

↳ Iterate

$$B = 1.4 \quad G = 4.15 \quad F = 50 \rightarrow W = 4.1$$

$$C_{n-u} = \frac{200 \times 1}{4.1} = 48.8 f \quad C_{n-v} = \frac{48.8 \times 4/3}{4.1} = 15.9 f$$

$$C_{n-w} = \frac{(7/3)(15.9 + 5) f}{4.1} = 11.9 f$$

$$B_{\text{new}} = \frac{15.9 + 5}{15.9} = 1.3 \quad \sqrt[4]{B_{\text{new}}} = 1.07 \quad (\text{compare with } 1.09)$$

→ less than 10% change so stop

$$S_u = \frac{48.8}{3} = 16.3 \quad S_v = \frac{15.9 f}{4 f} = 4$$

$$S_w = \frac{11.9}{7} = 1.7$$

$$\textcircled{C} t_{pz} = t_{ps} \left[7 + \underbrace{\frac{4}{3} \times \frac{11.9}{4}}_4 + \underbrace{\frac{7}{3} \times \frac{20.9}{11.9}}_{4.1} + \underbrace{\frac{5}{3} \times \frac{200}{5}}_{66.7} \right] = 828 t_{ps}$$

$$t_{px} = t_{ps} [8 + 4 \times 4.1] = 24.4 t_{ps}$$