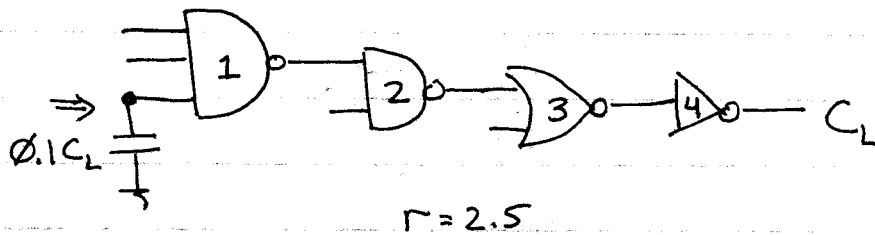


8.8



Minimize Delay Using Logical Effort

$$G = g_1 g_2 g_3 g_4 = \left(\frac{3+r}{1+r}\right) \left(\frac{2+r}{1+r}\right) \left(\frac{1+r}{1+r}\right) (1) = 3.46$$

$$H = \frac{C_L}{0.1C_L} = 10$$

$$F = GH = 34.6$$

$$\hat{f} = F^{1/4} = (GH)^{1/4} = 2.42$$

$$h_4 = \frac{\hat{f}}{g_4} = \frac{2.42}{1} = 2.42 = \frac{C_L}{C_{in4}} \Rightarrow C_{in4} = \frac{C_L}{2.42} = S_4 C_{in} (1+r)$$

$$S_4 = 0.118 \frac{C_L}{C_{in}}$$

$$h_3 = \frac{\hat{f}}{g_3} = \frac{2.42}{1.71} = 1.41 = \frac{C_{in4}}{C_{in3}} \Rightarrow C_{in3} = \frac{C_{in4}}{1.41} = S_3 C_{in} (1+2r)$$

$$S_3 = 0.118 \frac{C_{in4}}{C_{in}} = 0.05 \frac{C_L}{C_{in}}$$

$$h_2 = \frac{\hat{f}}{g_2} = \frac{2.42}{1.28} = 1.88 = \frac{C_{in3}}{C_{in2}} \Rightarrow C_{in2} = \frac{C_{in3}}{1.88} = S_2 C_{in} (2+r)$$

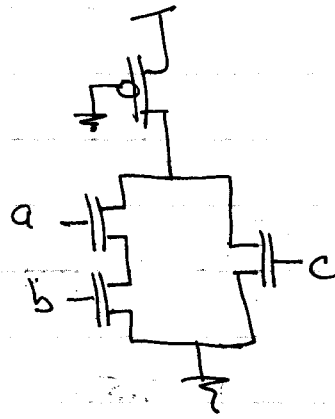
$$S_2 = 0.118 \frac{C_{in3}}{C_{in}} = 0.03 \frac{C_L}{C_{in}}$$

$$h_1 = \frac{\hat{f}}{g_1} = \frac{2.42}{1.57} = 1.54 \Rightarrow S_1 = 0.118 \frac{C_{in2}}{C_{in}} = 0.018 \frac{C_L}{C_{in}}$$

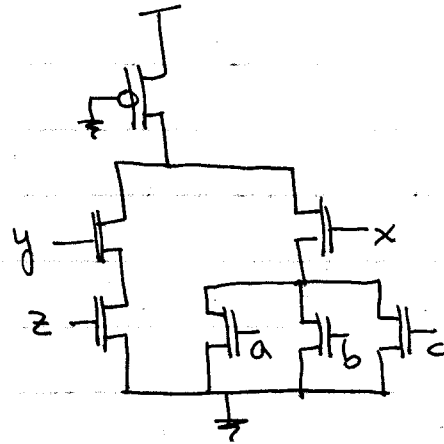
Set $S_4 = 1$ for ref inverter $\Rightarrow \frac{C_L}{C_{in}} = 8.47$

$$S_3 = 0.423 \quad S_2 = 0.254 \quad S_1 = 0.152$$

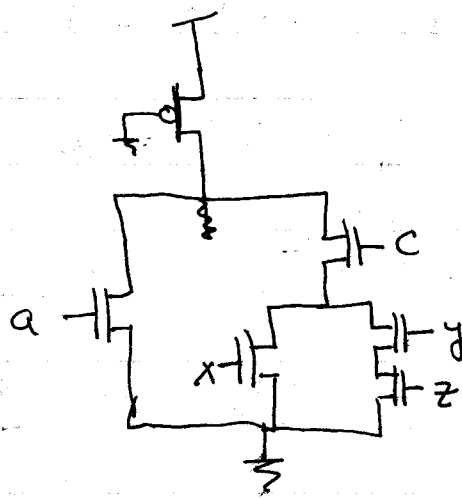
9.5) (a) $f = \overline{a \cdot b + c}$



(b) $f = \overline{(a+b+c) \cdot x + y \cdot z}$



(c) $f = \overline{a + (c \cdot (x + (y \cdot z)))}$



9.12) $f = a(b+c+d)$

