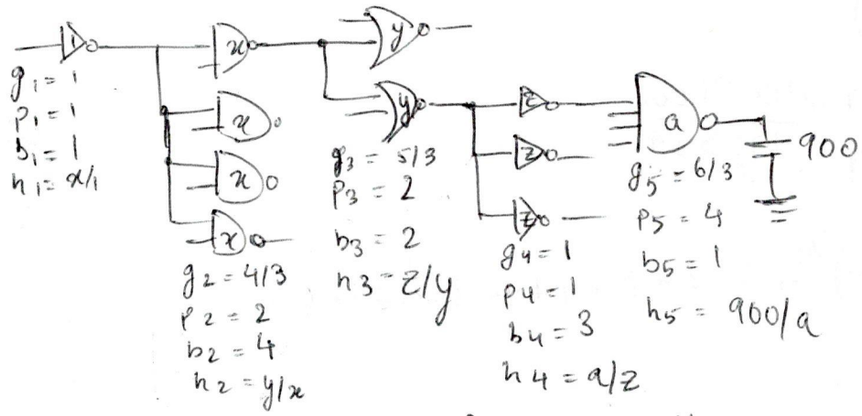
(Q-2)



a)

$G_T = (1)(4/3)(5/3)(1)(6/3)$

$G = 4.4445$

$B = (1)(4)(2)(3)(1)$

$B = 24$

$H = \left(\frac{x}{1}\right)\left(\frac{y}{x}\right)\left(\frac{z}{y}\right)\left(\frac{a}{z}\right)\left(\frac{900}{a}\right)$

$H = 900$

$F = GBH$

$F = 96000$

$F^{1/5} = (96000)^{1/5} = 9.918$

$F = (9.918 \times 5) + 1 + 2 + 2 + 1 + 4$

$F = 59.593$

$D_{min} = 59.593$

$g_5 b_5 h_5 = (6/3)(1)\left(\frac{900}{a}\right) = 9.918$

$a = 181.47$

$g_4 b_4 h_4 = (1)(3)\left(\frac{a}{z}\right) = 9.918$

$z = 54.89$

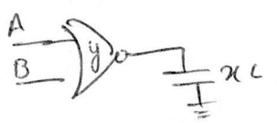
$g_3 b_3 h_3 = \left(\frac{5}{3}\right)(2)\left(\frac{z}{y}\right) = 9.918$

$y = 18.44$

$g_2 b_2 h_2 = \left(\frac{4}{3}\right)(4)\left(\frac{y}{x}\right) = 9.918$

$x = 9.92$

b) 2-input NOR



$y = 18.44$

PMOS: $18.44 \times \frac{4}{5}$

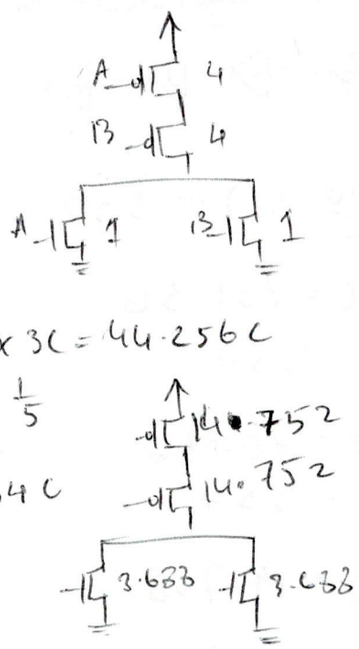
$= 14.752$

width $= 14.752 \times 3C = 44.256C$

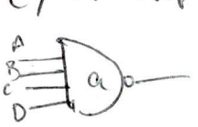
NMOS $= 18.44 \times \frac{1}{5}$

$= 3.688$

width $= 11.064C$



c) 4-input NAND



$a = 181.47$

PMOS $= 181.47 \times \frac{2}{6}$

$= 60.49$

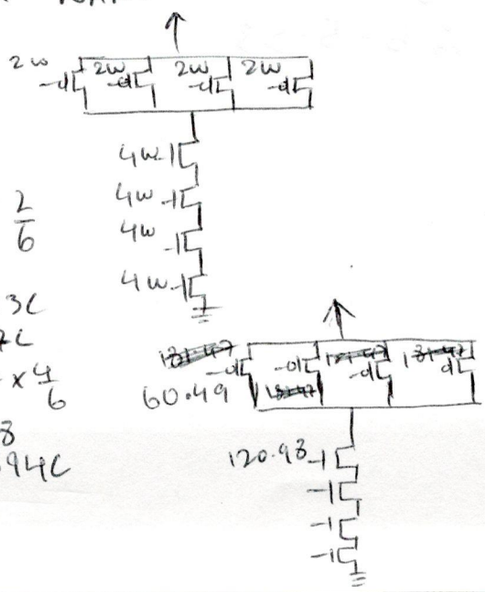
width $= 60.49 \times 3C$

$= 181.47C$

NMOS $= 181.47 \times \frac{4}{6}$

$= 120.98$

width $= 362.94C$



(d) Optimum Path Delay

$(F)^{1/N} = (96000)^{1/N}$

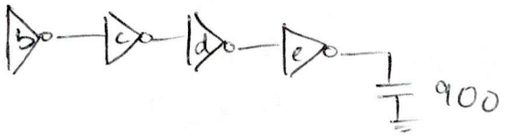
$(96000)^{1/N} = 3.59 \Rightarrow \frac{\log 96000}{\log 3.59}$

$N \approx 8.97 = 9$

$D_{min} = (9)(96000)^{1/9} + 1+2+2+1+4+1+1+1+1$

$D_{min} = 46.19$

(e) 4 more stages should be added in part d to achieve optimal delay



$(96000)^{1/9} = 3.57$

$\frac{900}{e}(1) = 3.57$

$\therefore e = 251.56$

$\frac{e}{d} = 3.57$

$\therefore d = 70.46$

$\frac{d}{c} = 3.57$

$\therefore c = 19.738$

$\frac{c}{b} = 3.57$

$\therefore b = 5.53$