

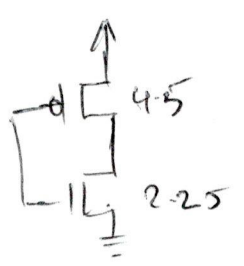
Q-4) a) Pull up

$$\frac{2R}{9} \times 2 = \frac{4R}{9}$$

Pull down

$$\frac{R}{5} \times 3 = \frac{3}{5} R$$

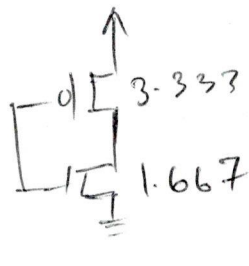
Pull up logic effort & parasitic delay



$$g_u = \frac{14}{2.25 + 4.5} = 2.07$$

$$p_u = \frac{9 + 5 + 5}{4.5 + 2.25} = 2.81$$

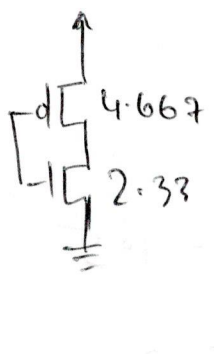
Pull down



$$g_d = \frac{14}{3.333 + 1.667} = 2.8$$

$$p_d = \frac{19}{3.333 + 1.667} = 3.8$$

b) Pull ~~up~~ down logic effort & parasitic delay



$$R \times \frac{2}{7} = 0.423$$

$$g_d = \frac{7}{4.67 + 2.33} = 1$$

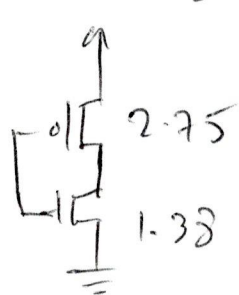
$$p_d = \frac{7 + 7 + 2}{4.67 + 2.33} = 2.28$$

Pull up logic effort & parasitic delay N/A

c) Pull up logic effort & parasitic delay N/A

Pull down logic effort & parasitic delay

$$\frac{3R}{5} + \frac{R}{3} = 0.725$$

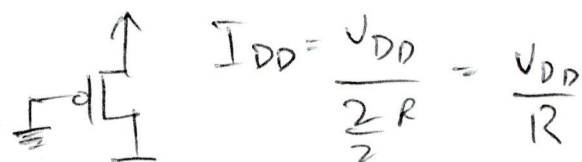


$$\frac{1}{0.725} = 1.38$$

$$g_d = \frac{5}{2.75 + 1.38} = 1.21$$

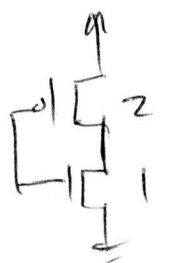
$$P_d = \frac{5 + 5 + 1}{2.75 + 1.38} = 2.66$$

d) $R \rightarrow$ resistance



$$I_{DD} = \frac{V_{DD}}{\frac{2}{3}R} = \frac{V_{DD}}{R}$$

Pull up logic effort & parasitic delay



$$g_u = \frac{9}{3} = 3$$

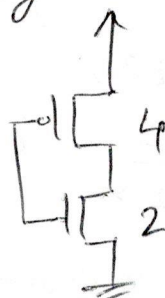
$$P_u = \frac{9 + 9 + 2}{3} = 6.667$$

Pull down logic effort & parasitic delay

$$\frac{3R}{3}$$

$$I_{Gnd} = \frac{V_{DD}}{R/3} = \frac{3V_{DD}}{R}$$

$$I_{Gnd} - I_{DD} = \frac{3V_{DD}}{R} - \frac{V_{DD}}{R} = \frac{2V_{DD}}{R}$$



$$g_d = \frac{9}{6} = 1.5$$

$$P_d = \frac{9 + 9 + 2}{6}$$

$$P_d = 3.33$$