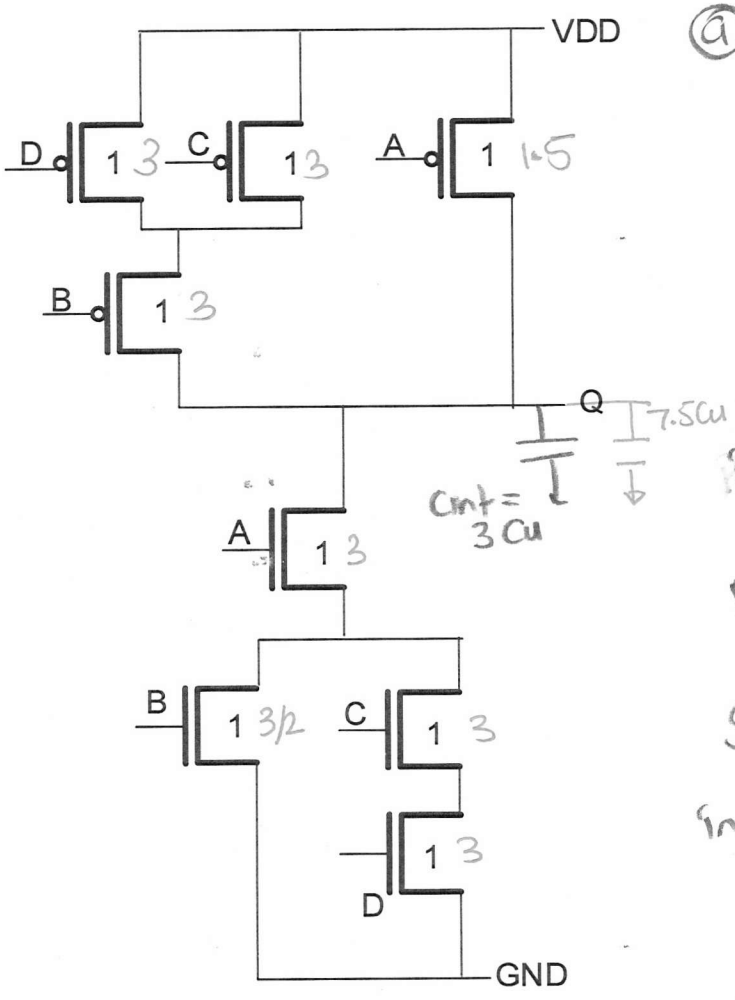
EEE 425

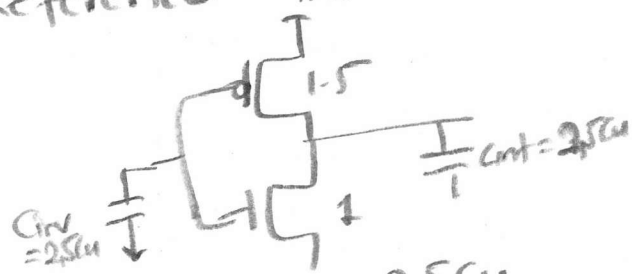
Homework #4

Q1. **A complex gate is given in the Figure where μ_n/μ_p=1.5.**

(a) Determine p_A, p_B, g_A, g_B for this gate given the sizing of the transistors.
(b) Re-size the transistors such that the resistance of pull-up and pull-down paths equals to unit resistance.
(c) Determine p_A, p_B, g_A, g_B for this gate given your sizes from part (b).



(a) Reference inv.



C_{inv} = 2.5Cu
R_{inv} = Ru

inp A
worst case resistance 3Ru

$$P_A = \frac{3R_u}{R_u} \times \frac{3C_u}{2.5C_u} = 3.6$$

$$g_A = \frac{3R_u}{R_u} \times \frac{2C_u}{2.5C_u} = 2.4$$

inp B
R_E = 3Ru (PMOS path)

$$P_B = \frac{3R_u}{R_u} \times \frac{3C_u}{2.5C_u} = 3.6$$

$$g_B = \frac{3R_u}{R_u} \times \frac{2C_u}{2.5C_u} = 2.4$$

(b)

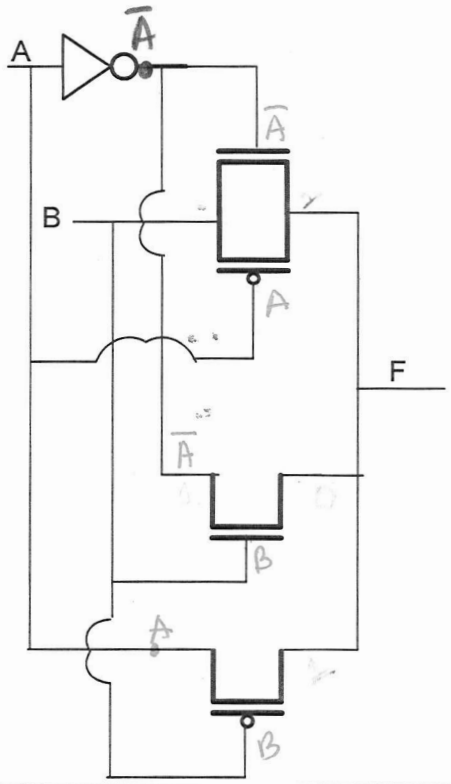
$$P_A = \frac{7.5C_u}{2.5C_u} = 3$$

$$g_A = \frac{4.5C_u}{2.5C_u} = 1.8$$

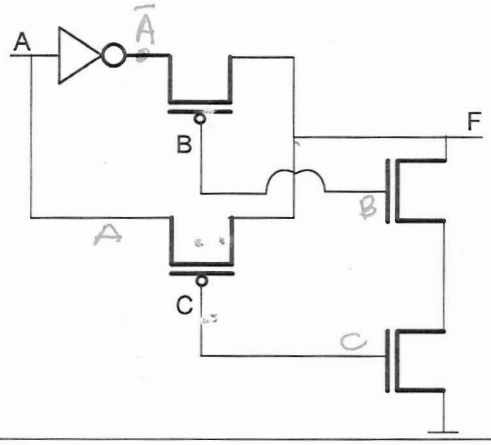
$$P_B = \frac{7.5C_u}{2.5C_u} = 3$$

$$g_B = \frac{4.5C_u}{2.5C_u} = 1.8$$

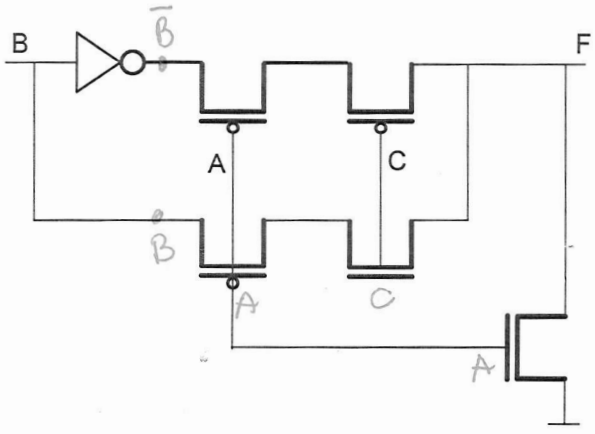
Q2. Three TG logic circuits are given below. Determine the truth table in the space given. If there is a contention, write X.



A	B	F
0	0	0
0	1	1
1	0	1
1	1	0



A	B	C	F
0	0	0	X
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	X
1	0	1	0
1	1	0	1
1	1	1	0



A	B	C	F
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Q3

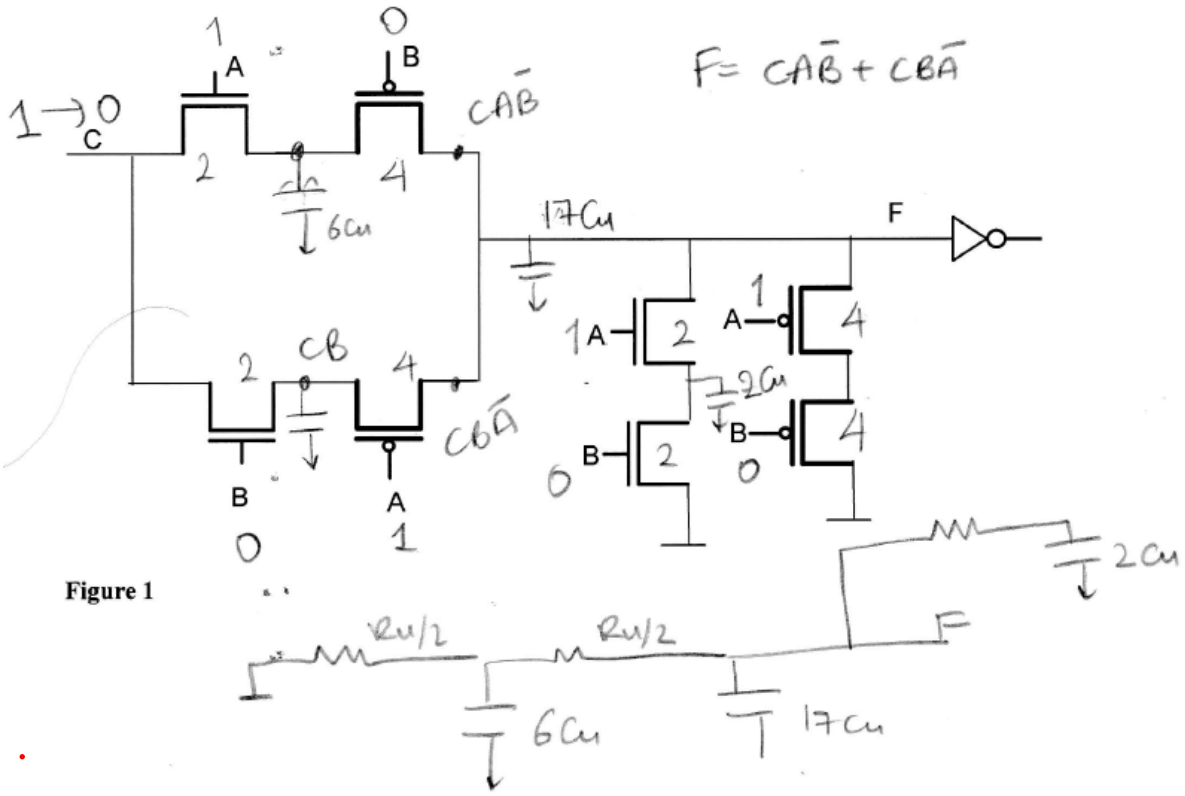


Figure 1

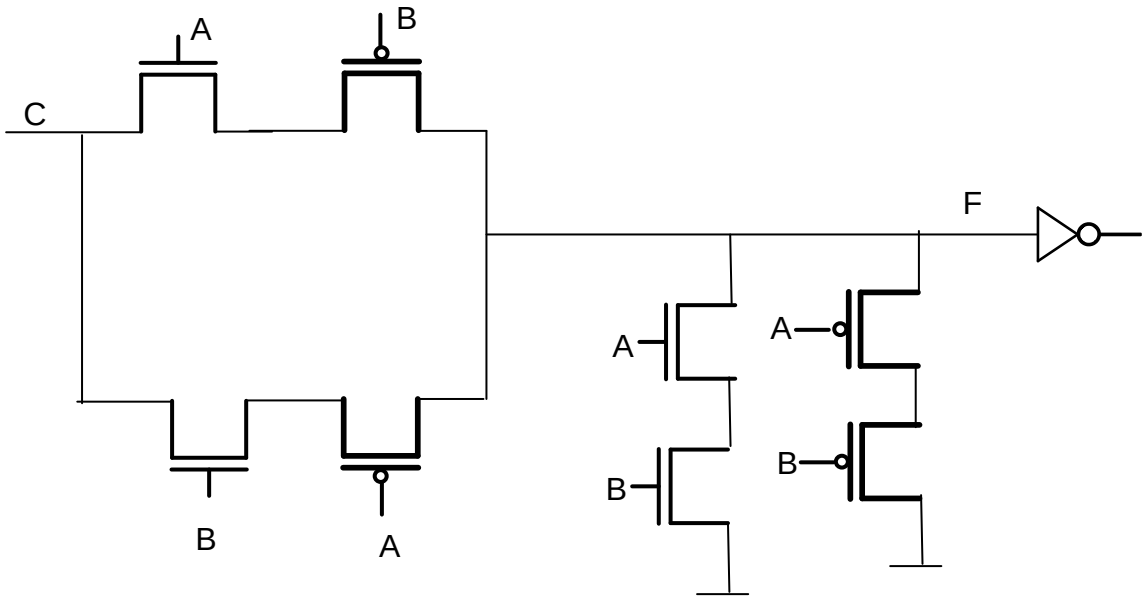
$$\tau = \frac{Ru}{2}(25Cu) + \frac{Ru}{2}(19Cu) = 22\,RuCu$$

$$t_d = 15\,RuCu$$

Q3. A PG circuit is given in the Figure. Threshold voltage for transistors is 0.6V. Supply voltage is 2.5V.

(a) Determine the logic function, F
(b) Assuming A, B, C are primary inputs, size the transistors such that all paths from output to GND/VDD have Ru resistance. μn/μp=2
(c) Draw the Elmore model for ABC: 101→100
(d) Determine the delay for ABC: 101→100 in terms of Ru, Cu.
(e) Find the voltage at node F for:

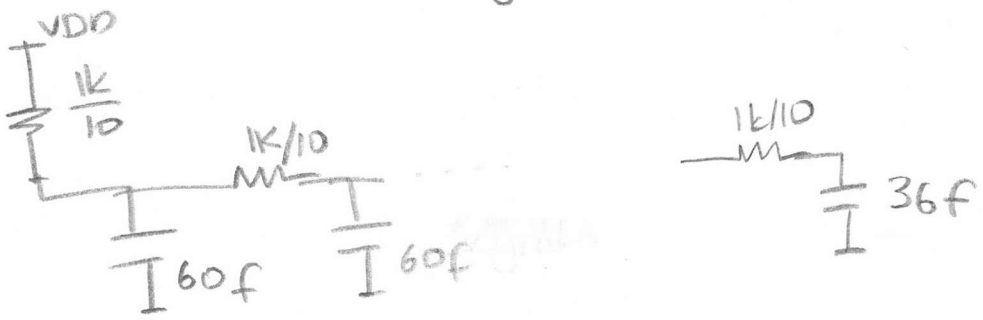
ABCX	VF
000	0.6V
110	0
011	1.9V
100	0.6V



Q4.

(a)

segment 1



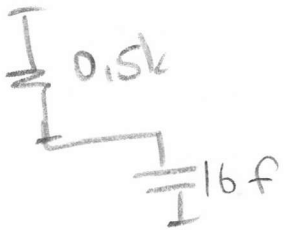
$\tau_1 = 36f \times 1k + 60f \times 0.9k + 60f \times 0.8k + \dots + 60f \times 0.1k$

$\tau_1 = 36ps + 60ps(0.9+0.8+0.7+\dots+0.1)$

$\frac{9 \times 10}{2} = 4.5$

$\tau_1 = 306ps$

Segment with Load

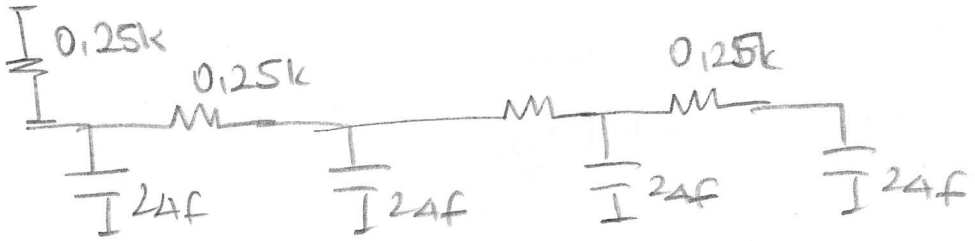


$\tau_2 = 8ps$ (this segment does not change)

$\tau = 314ps \quad t = 220ps$

(b) 4 segments

First 2



$T_1 = T_2 = 0.25k \times 24f (4+3+2+1) = 60ps$

3rd segment

$T_3 = 18f \times 1k + 24f \times (0.75k + 0.50k + 0.25k) = 54ps$

4th segment identical to part (a)

$\tau = (2 \times 60 + 54 + 8)ps = 182ps \qquad t = 127.4ps$