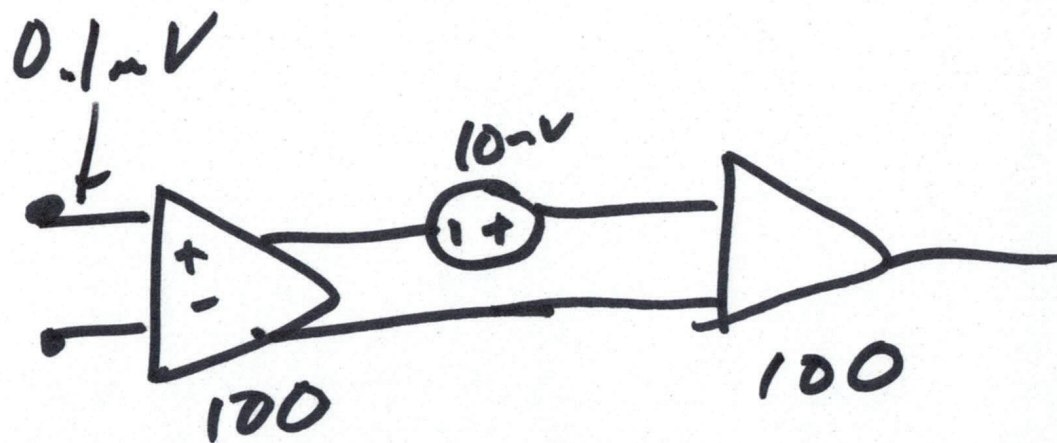
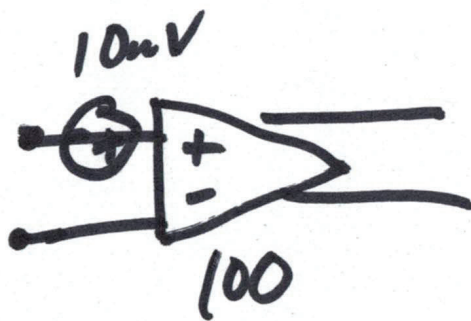


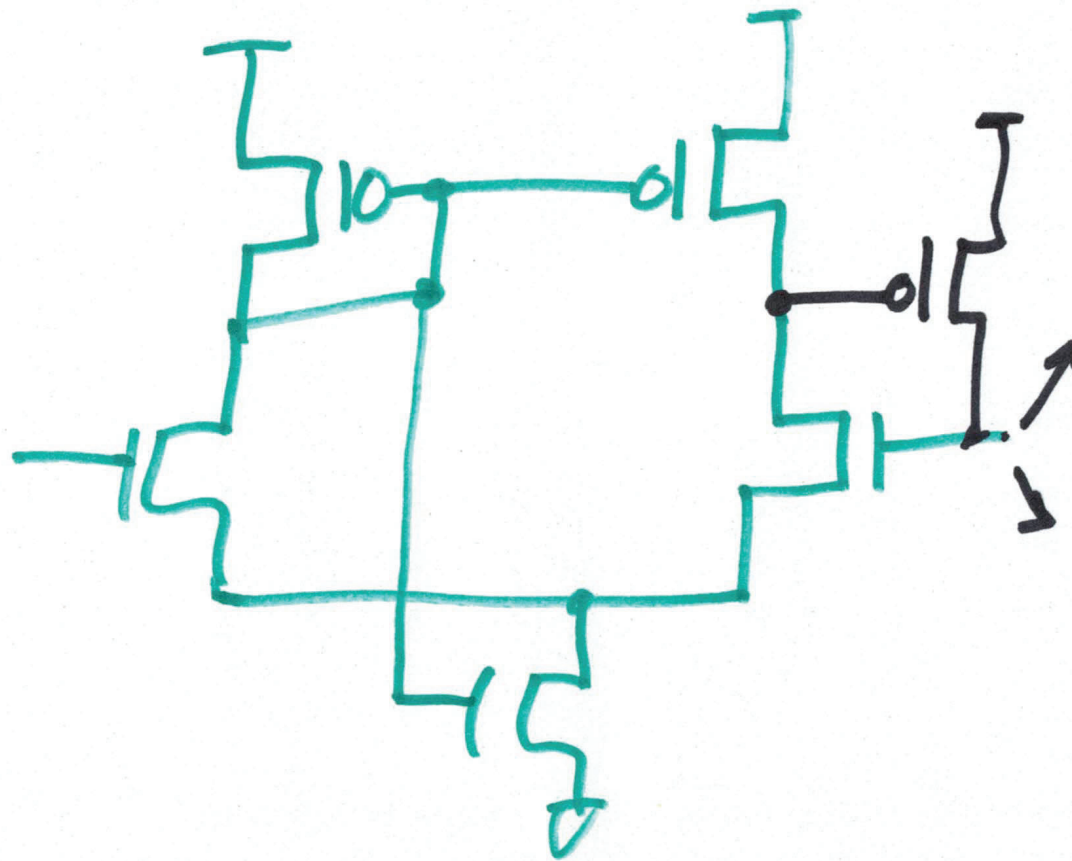
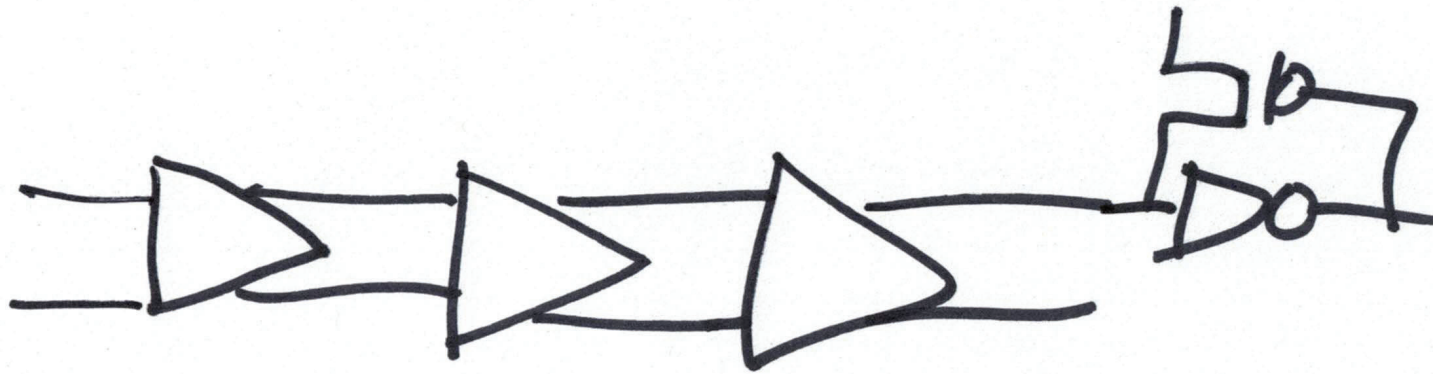
EE 421 / ECG 621

Digital IC Design

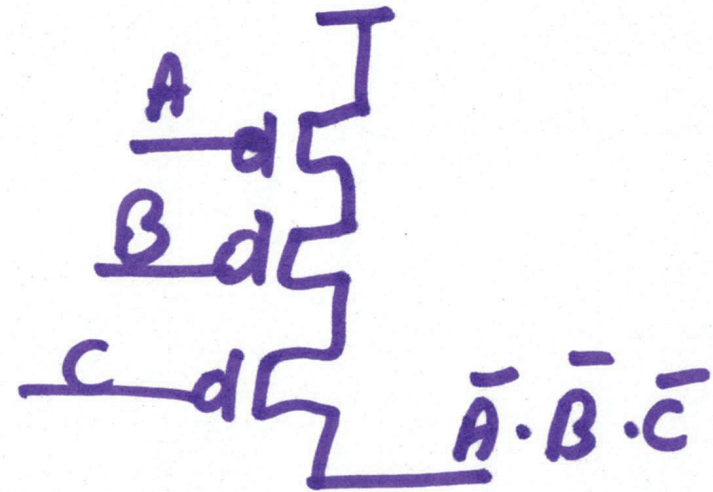
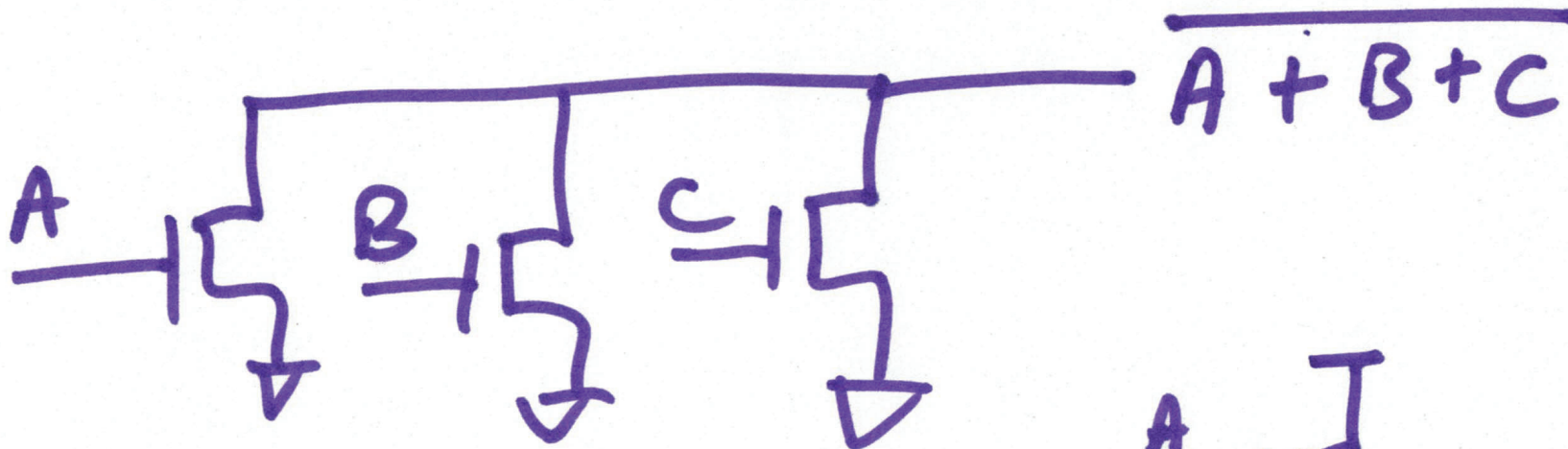
Nov. 4, 2020

Lecture 20





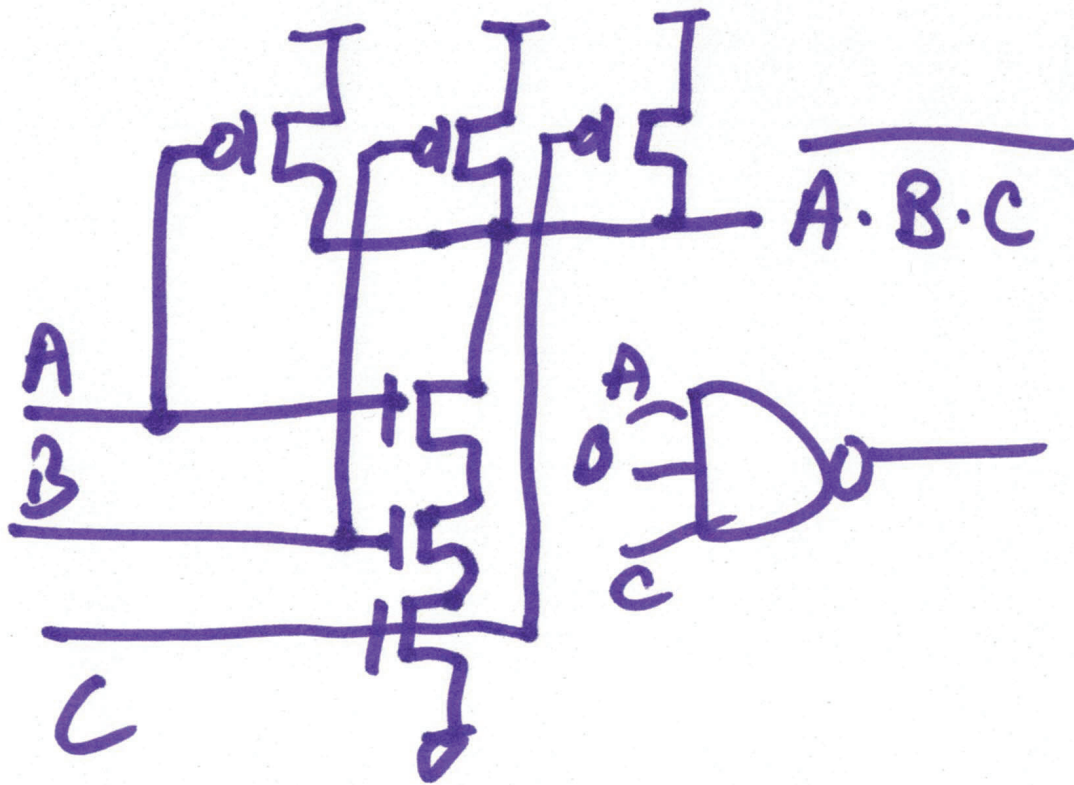
NOR



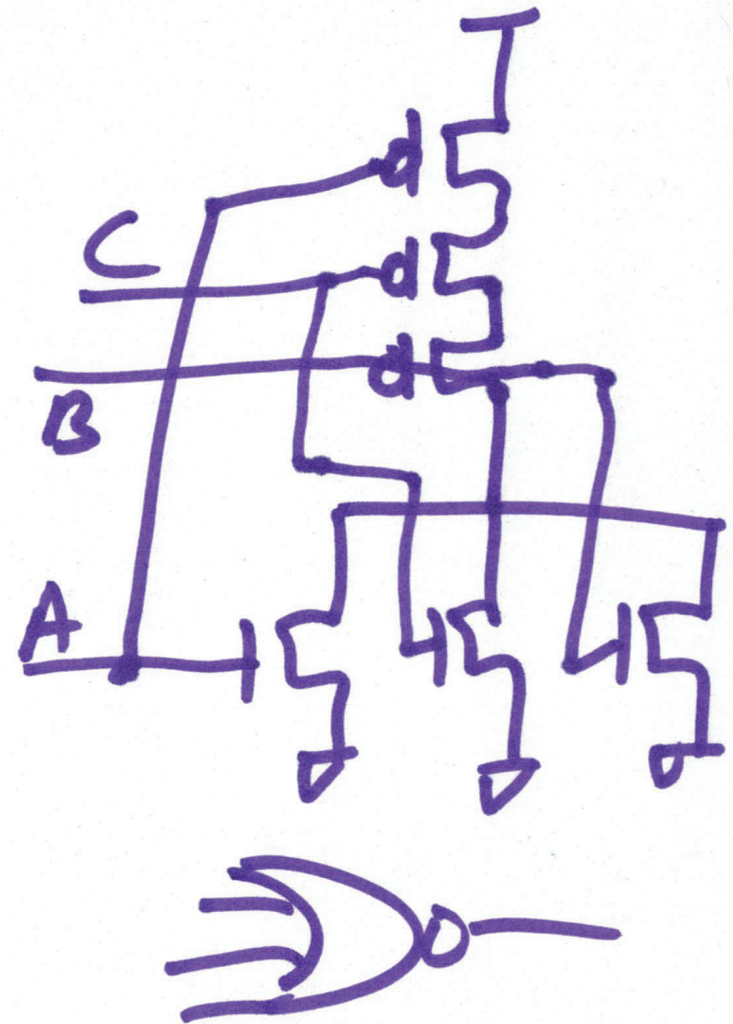
$$\overline{\overline{\overline{A \cdot B \cdot C}}} = \overline{A + B + C}$$

3)

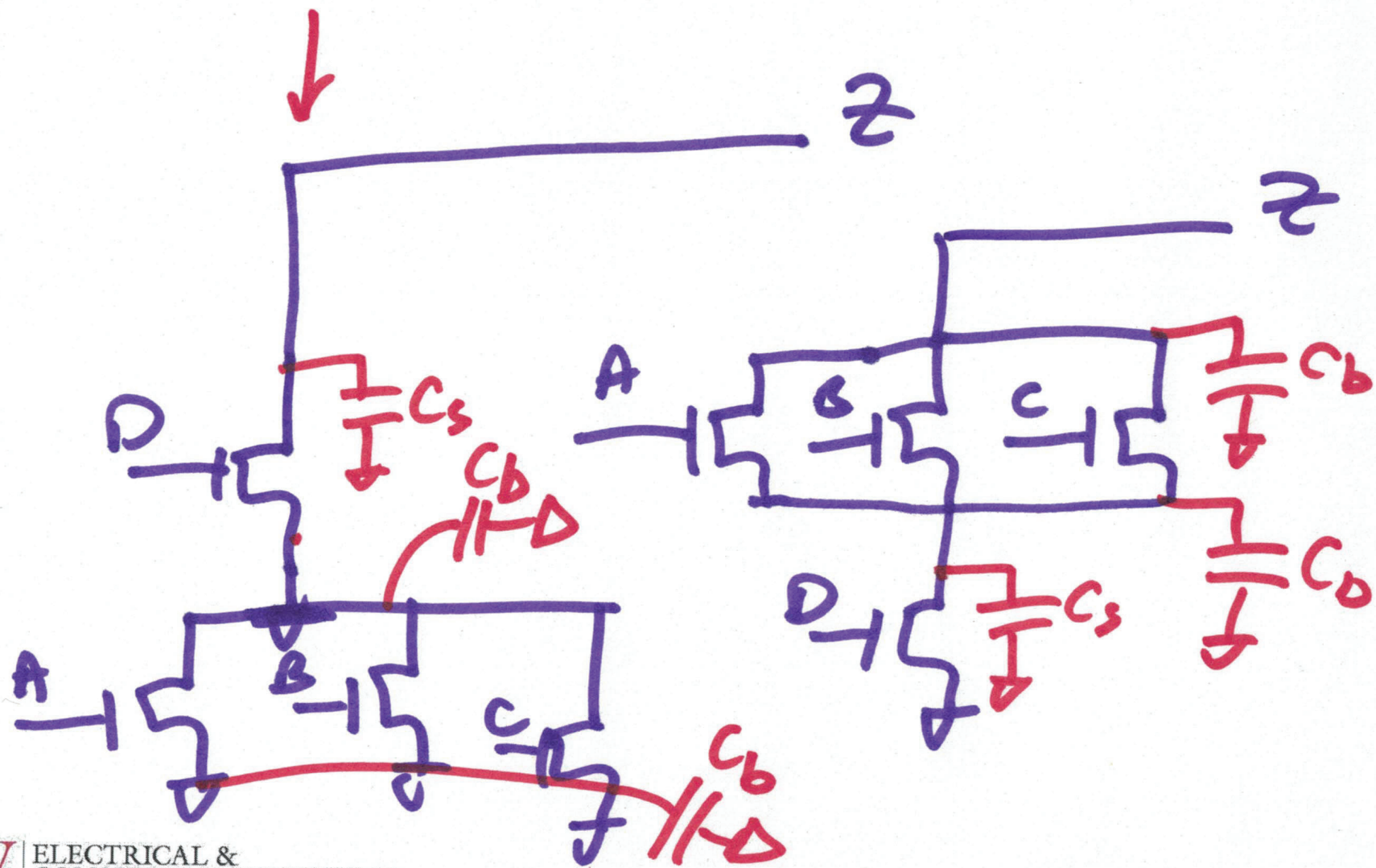
NAND



NOR

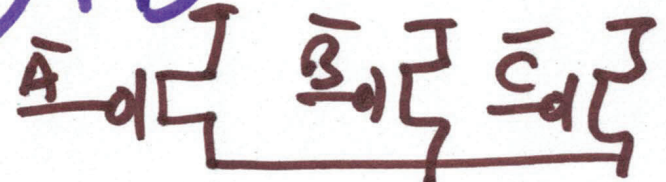
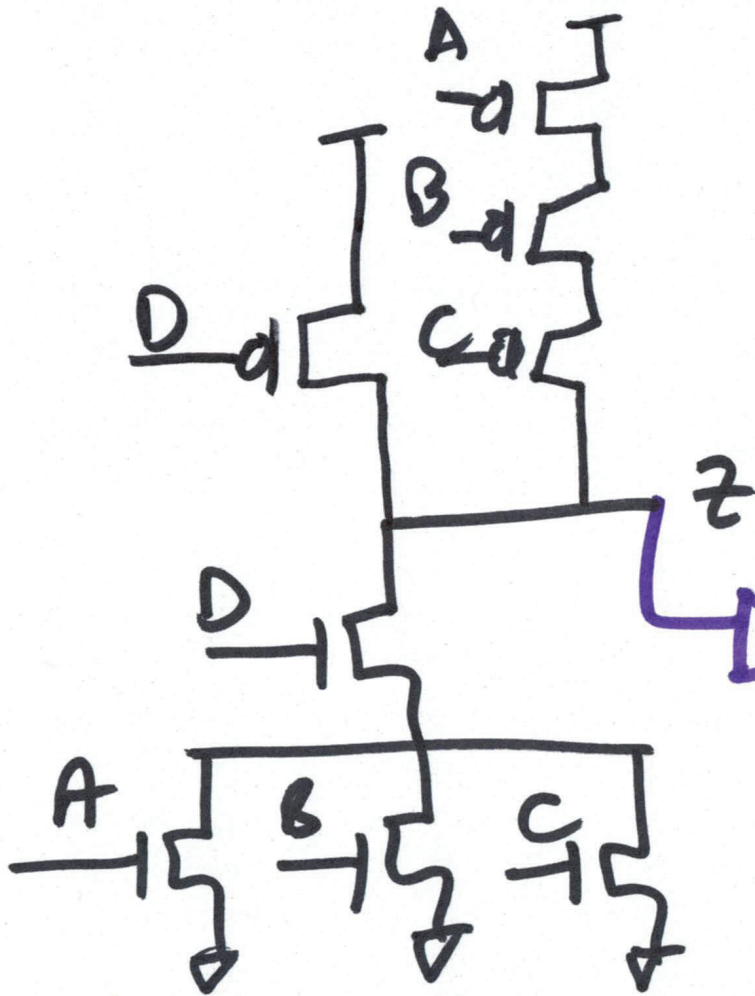
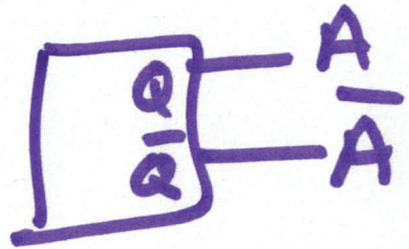


$$Z = \overline{(A + B + C) \cdot D}$$

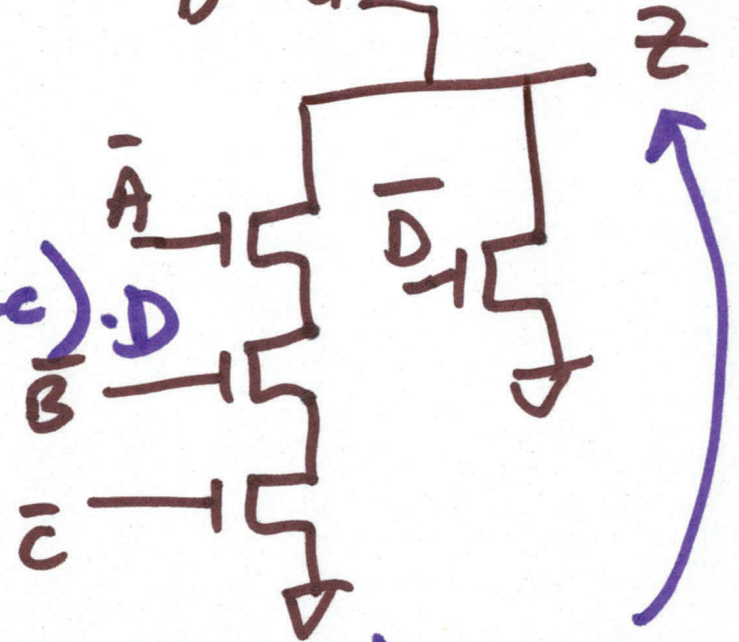


$$z = \overline{(A+B+C)} \cdot D$$

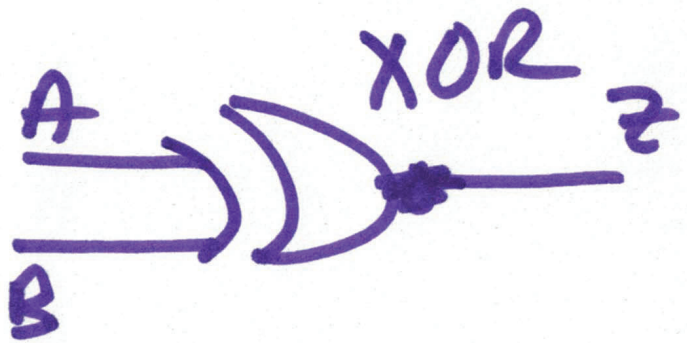
$$(\bar{A} \cdot \bar{B} \cdot \bar{C}) + \bar{D}$$



$$(A+B+C) \cdot D$$

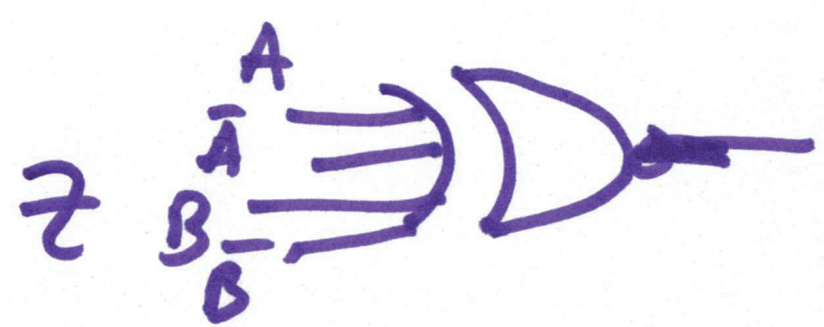
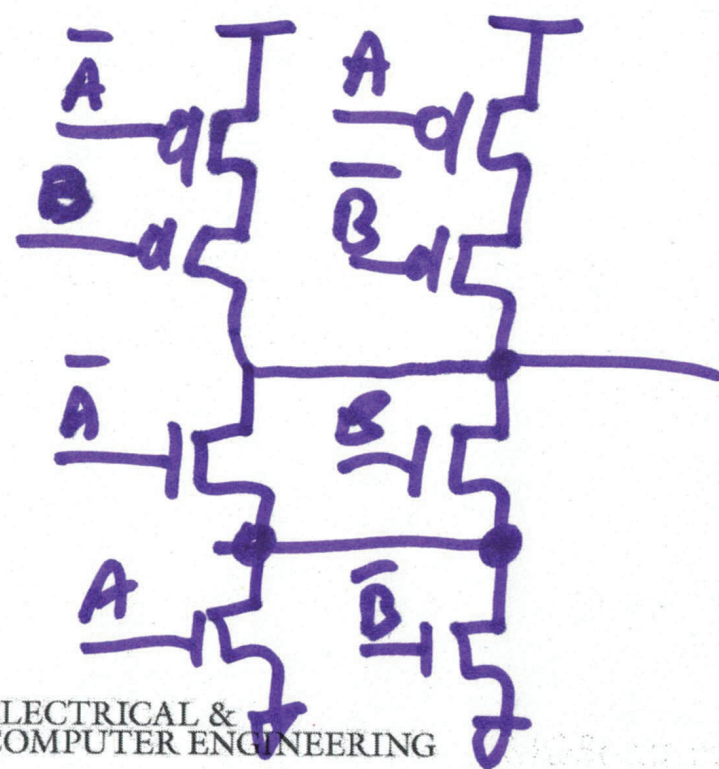


$$D \cdot (A+B+C) = z$$

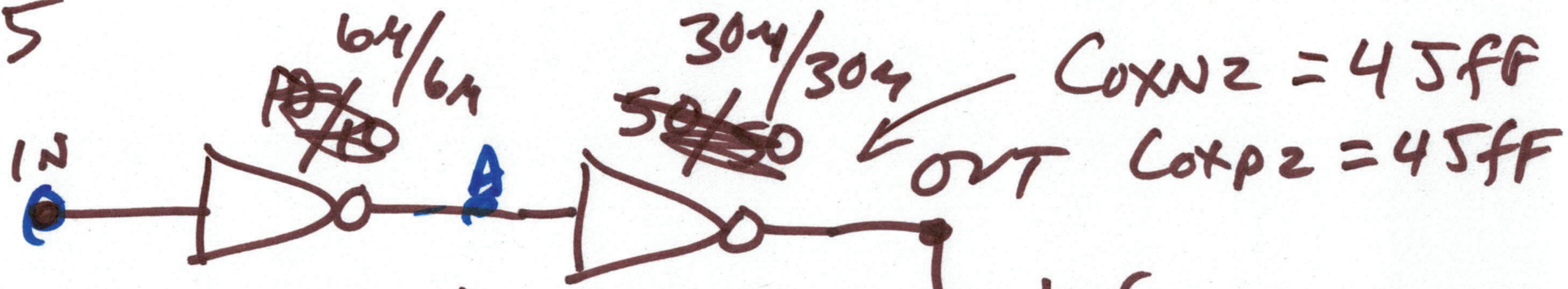


A	B	Z
0	0	0
0	1	1
1	0	1
1	1	0

$$Z = \bar{A}B + \bar{B}A$$



C5



$$R_{p1} = 40k \cdot \frac{.6}{6}$$

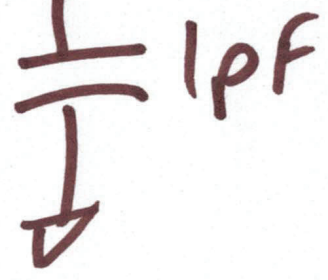
$$R_{p1} = 4k$$

$$R_{n1} = 20k \cdot \frac{.6}{6}$$

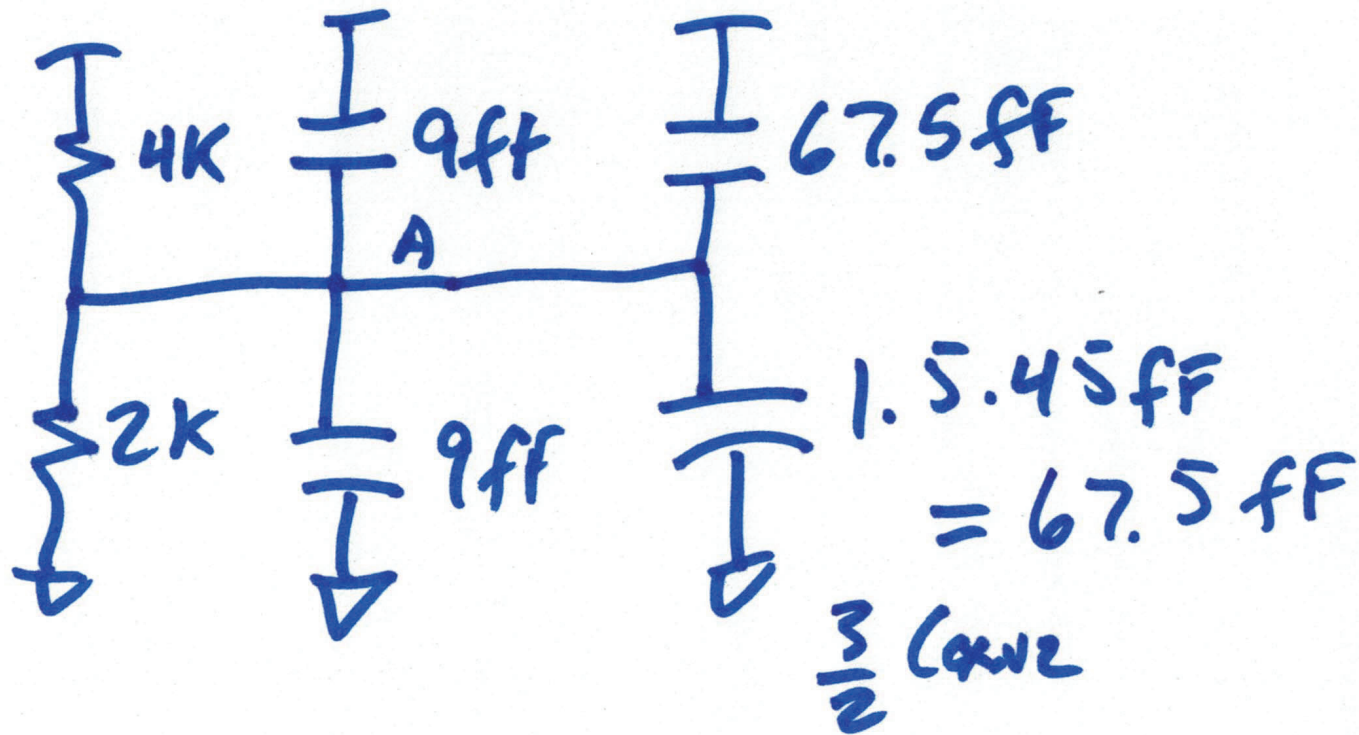
$$= 2k$$

$$R_{p2} = 800$$

$$R_{n2} = 400$$



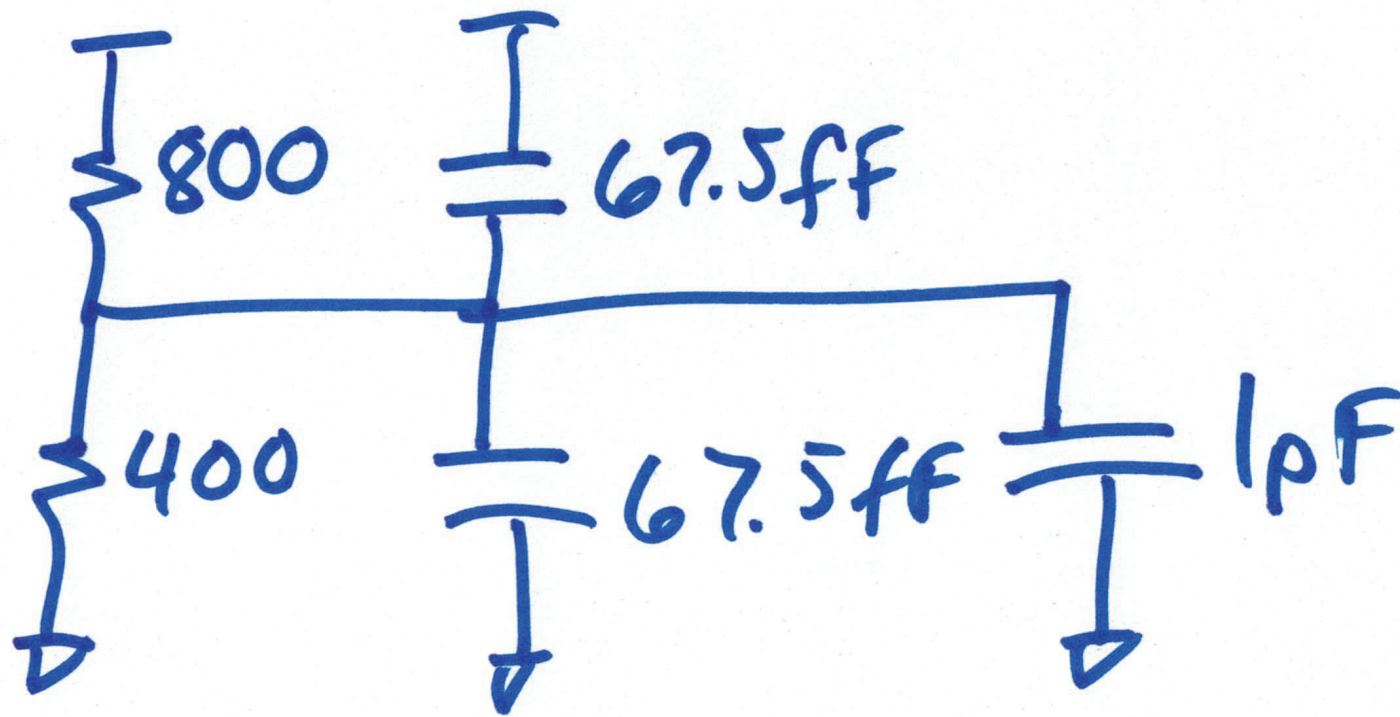
$$C_{oxN1} = \frac{2.5fF}{.6\mu \cdot .6\mu} = 9fF = C_{oxP1}$$



$$t_{PLH} = 0.7 \cdot 4k \cdot (9ff + 9ff + 67.5ff + 67.5ff)$$

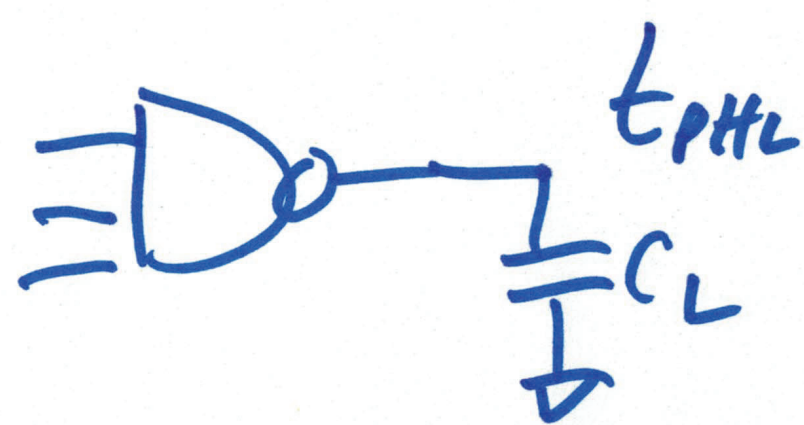
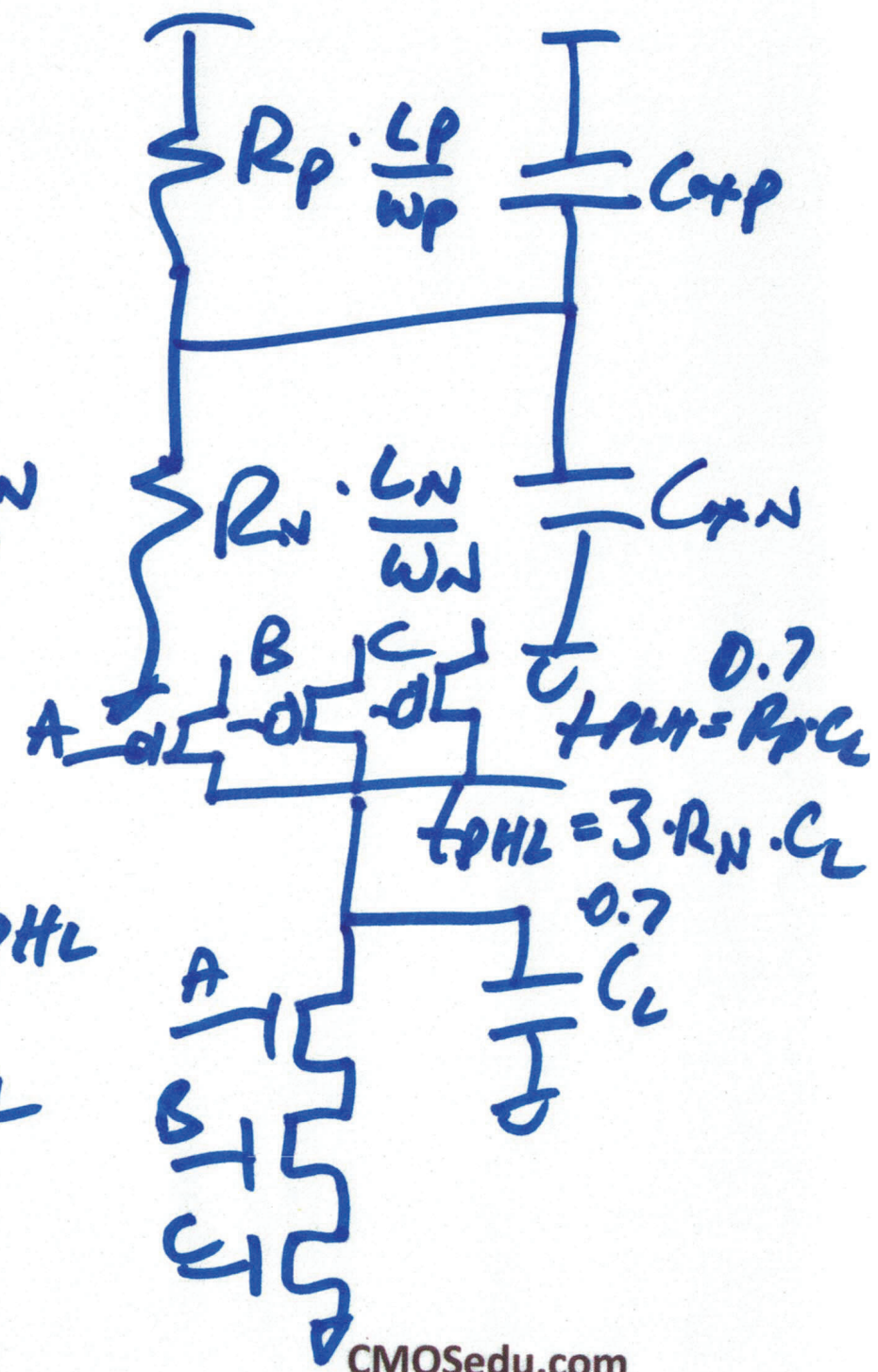
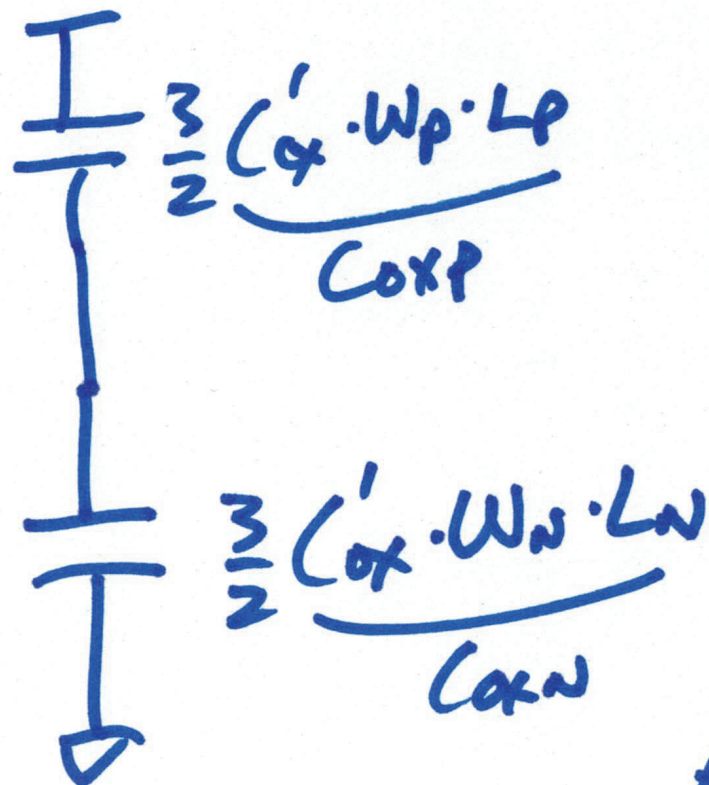
$$= 0.7 \cdot 4k \cdot 153f = \underline{\underline{428ps}}$$

$$t_{PHL} = 0.7 \cdot 2k \cdot 153ff = \underline{\underline{214ps}}$$



$$t_{PHL} = 0.7 \cdot 400 (67.5 \text{ fF} + 67.5 \text{ fF} + 1 \text{ pF})$$

$$t_{PLH} = 2 \cdot t_{PHL}$$



11)