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ASSIGNMENT

Course Name: VLSI Design

Course Code: CSE-451

Submitted To

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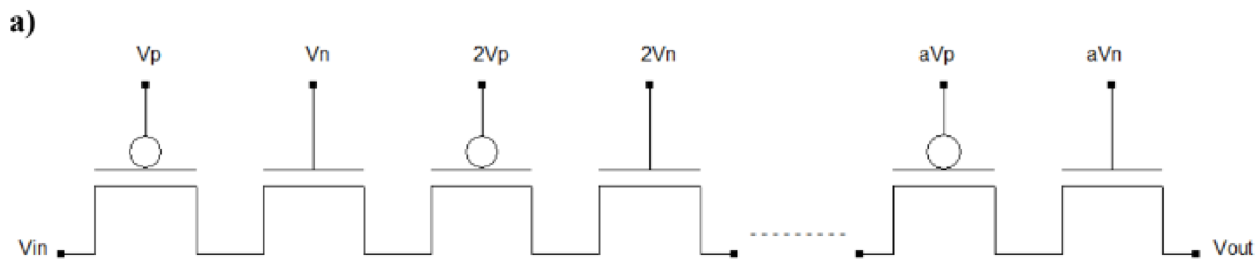


For PMOS transistor 1, with respect to Vp and Vtp:

In order to have Vout=Vin,

We know that,

$$Vg = Vp < Vin - |Vtp|$$

⇨ $-Vin < -Vp - |Vtp|$
⇨ $Vin > Vp + |Vtp|$

Similarly, for PMOS transistor 2, with respect to 2Vp and Vtp:

$$Vg = 2Vp < Vin - |Vtp|$$

⇨ $-Vin < -2Vp - |Vtp|$
⇨ $Vin > 2Vp + |Vtp|$

For the last PMOS transistor, with respect to aVp and Vtp:

$$Vg = aVp < Vin - |Vtp|$$

⇨ $-Vin < -aVp - |Vtp|$
⇨ $Vin > aVp + |Vtp|$

For NMOS transistor 1, with respect to Vn and Vtn:

$$Vg = Vn > Vin + Vtn$$

⇨ $-Vin > -Vn + Vtn$
⇨ $Vin < Vn - Vtn$

For NMOS transistor 2, with respect to 2Vn and Vtn:

$$Vg = 2Vn > Vin + Vtn$$

- ⇨ $-Vin > -2Vn + Vtn$
- ⇨ $Vin < 2Vn - Vtn$

For the last NMOS transistor, with respect to aVn and Vtn:

$$Vg = aVn > Vin + Vtn$$

- ⇨ $-Vin > -aVn + Vtn$
- ⇨ $Vin < aVn - Vtn$

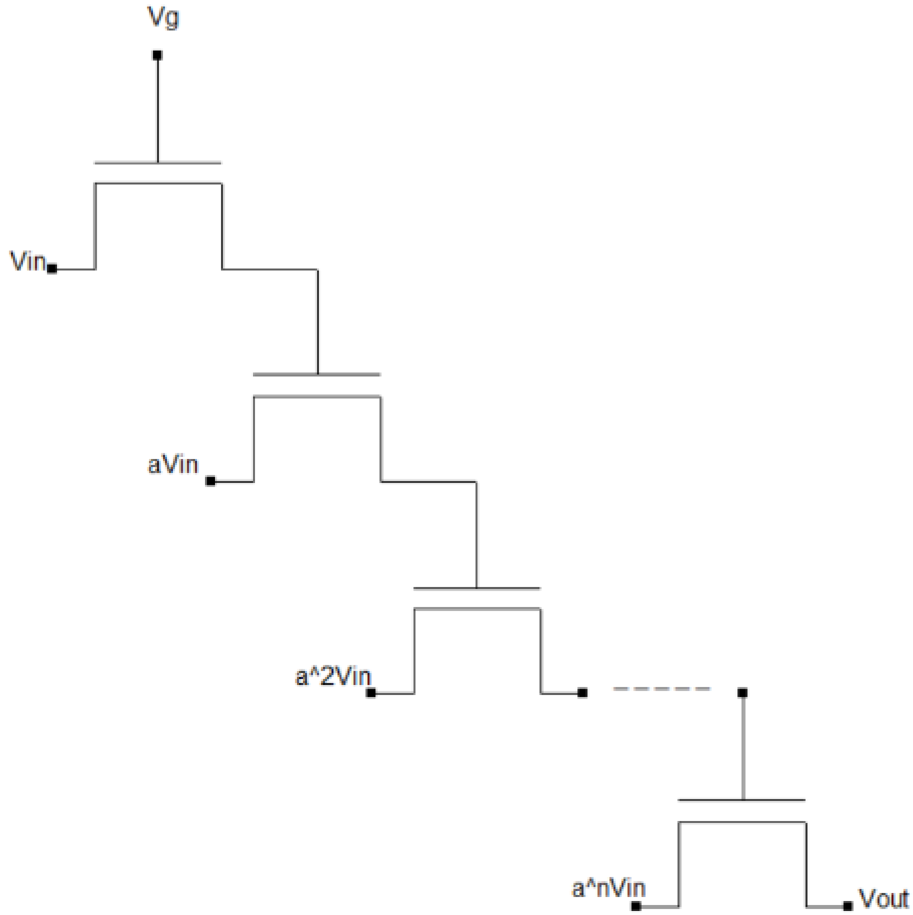
So, we get,

$$aVp + |Vtp| < Vin < aVn - Vtn$$

$Where, a = 1,2, \dots \dots \dots, a$

(Ans.)

b)



For transistor 1,

$Vg > Vin + Vtn$

- ⇨ $-Vin > -Vg + Vtn$
- ⇨ $Vin < Vg - Vtn$
- ⇨ $Vout < Vg - Vtn \;\; [As\, Vin = Vout]$

As Vo of transistor 1= Vg of transistor 2,

We get, for transistor 2:

$Vg > aVin + Vtn$

- ⇨ $Vg - Vtn > aVin + Vtn$
- ⇨ $-aVin > Vtn + Vtn - Vg$

⇨ $aVin < -2Vtn + Vg$

⇨ $Vin < \frac{-2Vtn+Vg}{a}$

⇨ $Vin < \frac{Vg-2Vtn}{a}$

⇨ $Vout < \frac{Vg-2Vtn}{a}$

As Vo of transistor 2 = Vg of transistor 3,

So, for transistor 3,

$$\frac{Vg - 2Vtn}{a} > a^2Vin + Vtn$$

⇨ $-a^2Vin > -\frac{Vg-2Vtn}{a} + Vtn$

⇨ $a^2Vin < \frac{Vg-2Vtn}{a} - Vtn = \frac{Vg-2Vtn-aVtn}{a}$

⇨ $Vin < \frac{Vg-2Vtn-aVtn}{a^3}$

⇨ $Vout < \frac{Vg-2Vtn-aVtn}{a^3}$

For nth transistor,

By induction method we get,

$$Vin < \frac{Vg - 2Vtn - aVtn - a^3Vtn - \cdots \ldots \ldots \ldots - a^x - a^{x+n-1}}{a^{2n+x-1}}$$

So, we get,

$$Vin < \frac{Vg - 2Vtn - aVtn - a^3Vtn - \cdots \ldots \ldots \ldots - a^x - a^{x+n-1}}{a^{2n+x-1}}$$

$Where, n = 1,2, \ldots \ldots \ldots \ldots, n$ (Ans.)