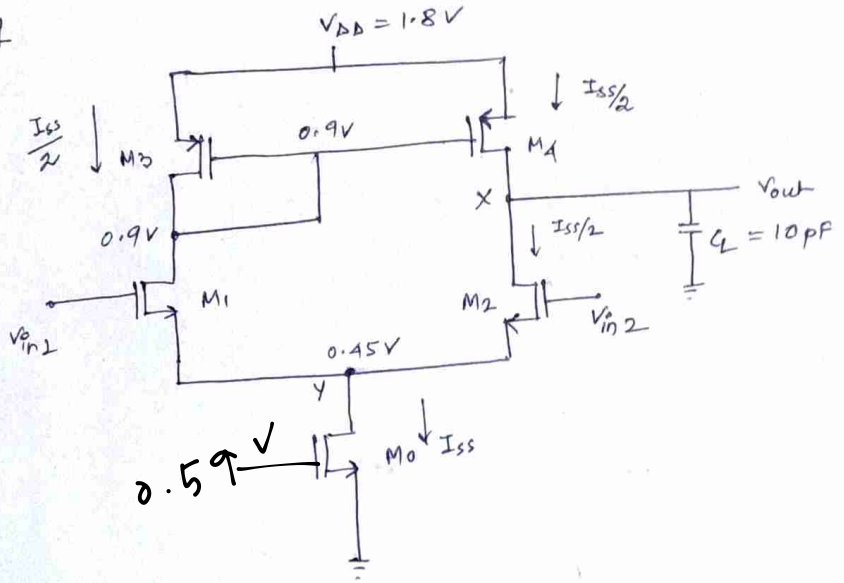
Differential Amp with Active load using PDM (potential Division Method) :-

Designing using PDM



Specification : Technode → gpdk 180nm L = 500nm (≈ 3 × 180 nm)

A_v = 40 dB , SlewRate = 5V/μsec , Gain_BW = 5MHz.

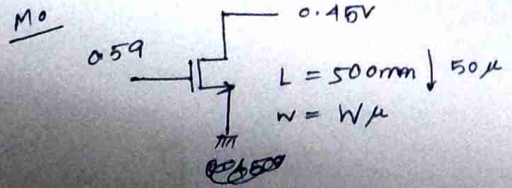
$V_{out} = \frac{V_{DD}}{2} = 0.9$ ∴ $V_Y = 0.45$ $V_X = V_{out} = 0.9$ volt.

I_{ss} = Slew Rate × C_L

= 5V/μse × 10pF = 50μA. , $\frac{I_{ss}}{2} = 25\mu A$.

Transistor sizing.

M_0

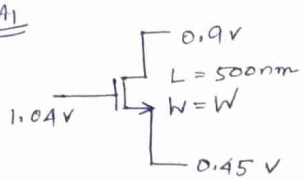


$V_A = V_S + V_{TH} + 5\% V_{DD}$.

= 0 + 500m + 90m = 590mV

vary W → 400n to 50μ from I_D vs W @ I_D = 50μA $W_0 = 10.04\mu$

M1



$V_G = V_S + V_{th} + 5\% V_{DD}$

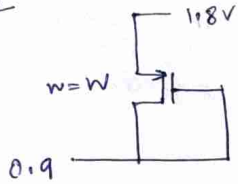
$= 450m + 590m = 1.04\ V.$

from I_D vs W at $I_D = 25\mu A$ $\quad W_1 = 5.04\ \mu$

so, $\boxed{W_1 = W_2 = 5.04\ \mu m}$

PMOS

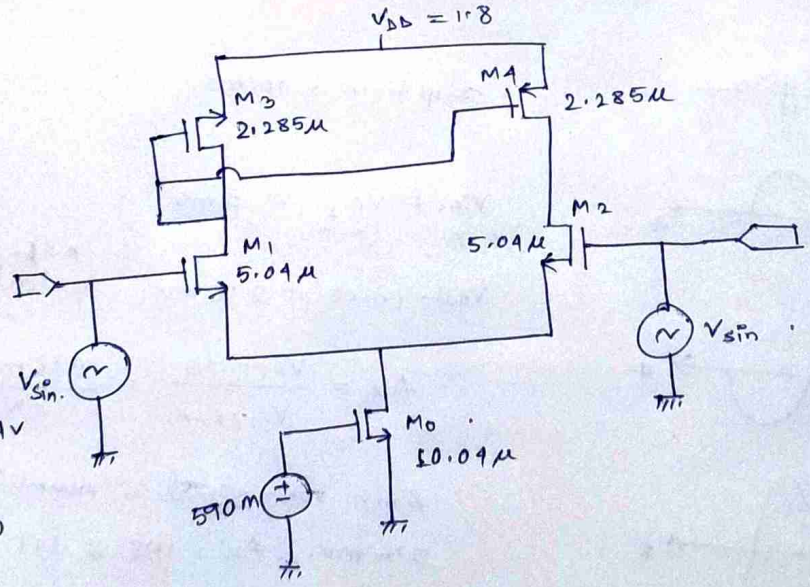
M3



$V_G = 0.9$

from I_D vs W at $I_D = 25\mu A$ $\boxed{W_3 = 2.285\mu}$

$\boxed{W_3 = W_4 = 2.285\mu}$



dc mag = 1.04V
ac mag = 1V
ac phase = 0
Amp = 1mV
Freq = 1KHz.
Initial sinusoidal phase = 0

dc mag = 1.04V
ac mag = 1V
ac phase = 180
Amp = 1mV
freq = 1KHz.
Initial sinusoidal phase = 180°

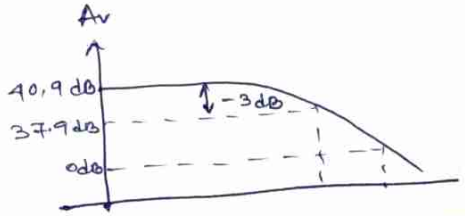
Observation :

1) DC analysis.

Run dummy dc analysis to check where potential is dividing aconding to the PDM analysis.

2) AC ~~transient~~ Analysis :

freq sweep 1 – 10 GHz.



$f_{3dB} = 111.379$ KHz. from plot

$f_{0dB} = 12.67$ MHz.

~~$f_{3dB} = 113.77$ KHz~~

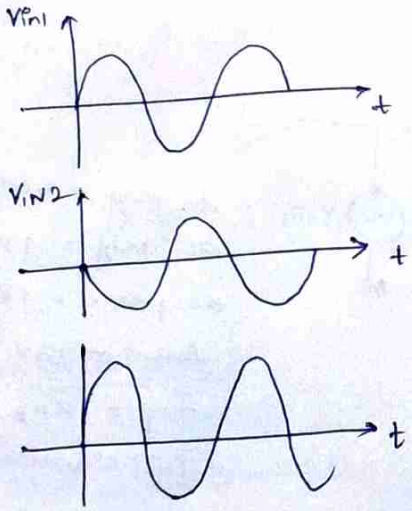
~~$f_{0dB} = 12.67$ MHz~~

from plot

$Av\ (dB) = 40.9143 \approx 41$

$Av\ (Mag) = 112.1$

3) Transient - Analysis :



Stop time = 10 ms.

$V_{in_1}\ (p\text{-}p) \cong V_{in_2}\ (p\text{-}p) = 2mv$

$V_{out\ (p\text{-}p)} = 216$ mv

ADE calculate from calculator tool

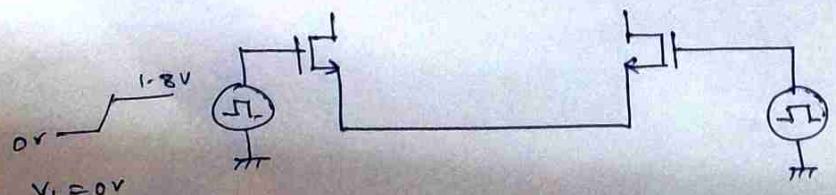
$$Av = \frac{V_{o(p\text{-}p)}}{V_{in(p\text{-}p)}} = \frac{216m}{2m} = 108$$

2mv volt signal is amplified to 216 mv. $A_V = 108 \approx 111$

4) Slew Rate :

Replace V_{SIN} by V_{pulse}.

Stop time = 10ns.



$V_1 = 0V$

$V_2 = 1.8V$

Period = 20ns.

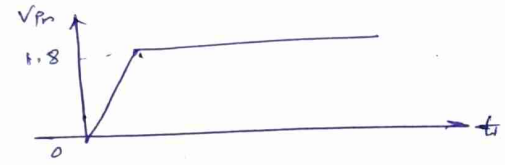
pulse width = 10ns

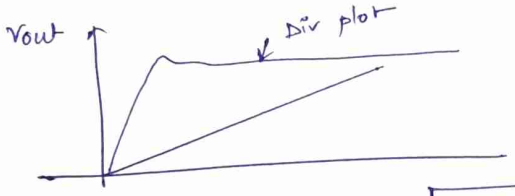
$V_1 = 1.8V$

$V_2 = 0V$

Period = 20ns

pulse width = 10ns.





finding derivative using

from Div plot ⇒ **Slew Rate = 6.96 M = 6.96 V/μsec**