Report of Lab 3: MOSFET Responses Using OrCAD

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1 Lab Circuit

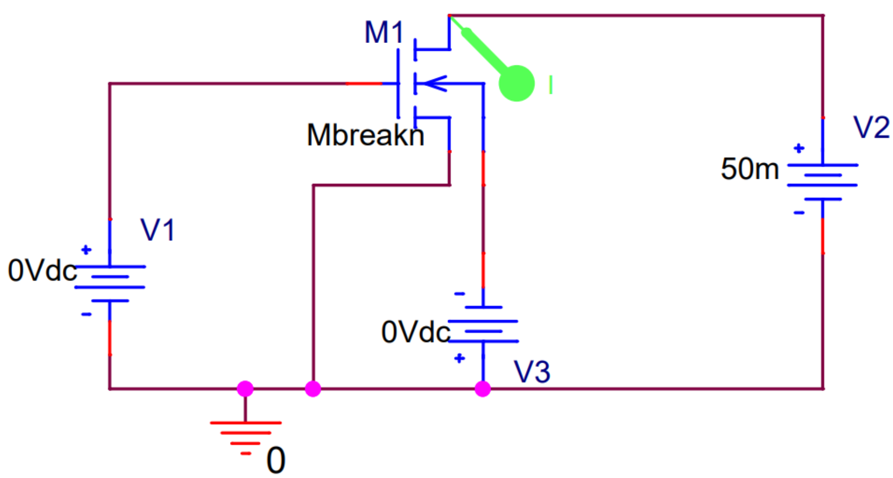
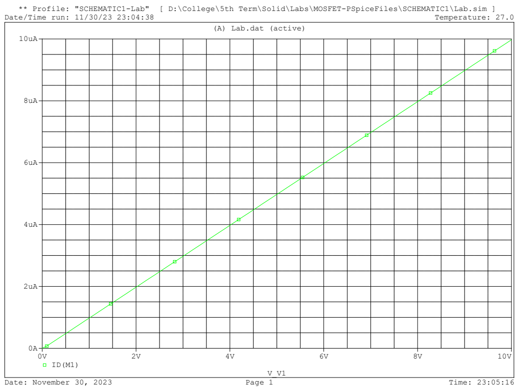
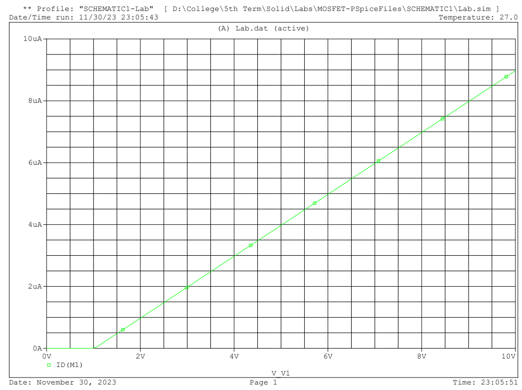


Figure 1: Circuit Schematic

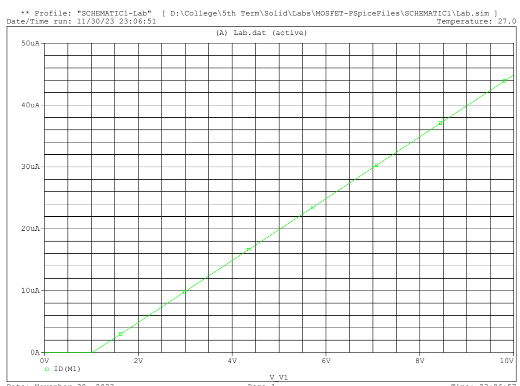
1.1 KP and VTO Change



(a) $LEVEL = 3, KP = 20 * 10^{-6}, VTO = 0$



(b) $LEVEL = 3, KP = 20 * 10^{-6}, VTO = 1$



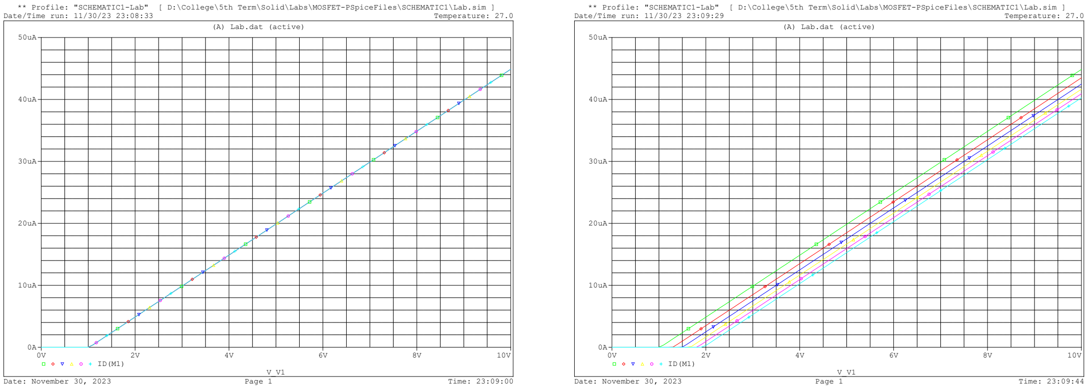
(c) $LEVEL = 3, KP = 100 * 10^{-6}, VTO = 1$

Figure 2: KP and VTO Change Plots

1.1.1 Discussion

Analyze the results obtained that all the three works in the Triode Region as $(V_{gs} > V_t)$ so due to relation $I_d = KP * \frac{W}{L} * V_{ds} * [(V_{gs} - V_t) - \frac{1}{2}]$ when KP increases the I_d increases as direct propositional and as V_t increase and it takes more time to increase I_d from zero (Cut-off Region) as V_{gs} increases because of the difference term $V_{gs} - V_t$ also the slope of the line is direct propositional with KP as relation $\frac{\partial I_d}{\partial V_{gs}} = KP * \frac{W}{L} * V_{ds}$

1.2 γ and ϕ Change with V_b Change



(a) $\gamma = 0$

(b) $\gamma = 0.6,\ \phi = 0.75$

Figure 3: γ and ϕ Change with V_b Change Plots

1.2.1 Discussion

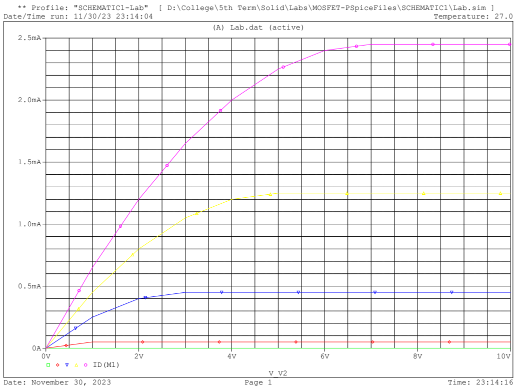
Analyze the results obtained that there a body effect shown and $\gamma \neq 0$ and $\phi \neq 0$ as

$$V_t = V_{to} + \gamma\ (\sqrt{\phi + V_{sb}} - \sqrt{\phi})$$

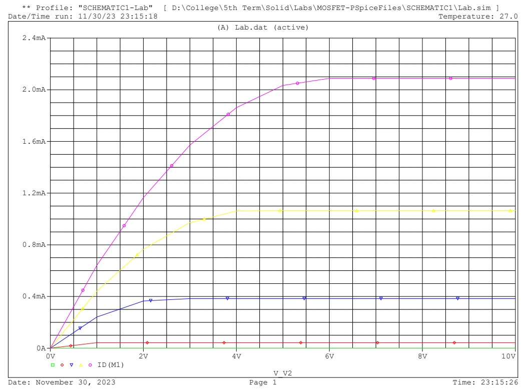
so when $\gamma = 0$, $V_t = V_{to}$ and V_t increases when γ increases also for ϕ so back to fig 2 we understand why each line shifted from other in fig 3b but is not in fig 3a.

$$I_d = KP * \frac{W}{L} * V_{ds} * [(V_{gs} - V_t) - \frac{1}{2}]$$

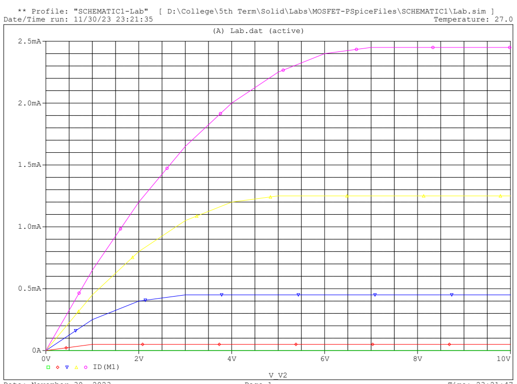
1.3 γ, ϕ and θ Change with V_{ds} Change



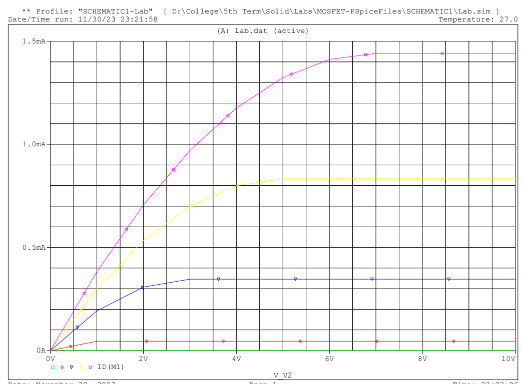
(a) $\gamma = 0$



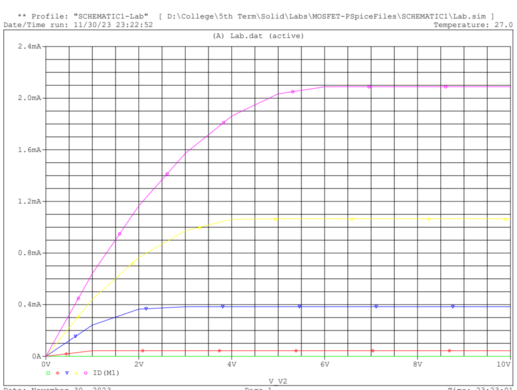
(b) $\gamma = 0.6,\ \phi = 0.75$



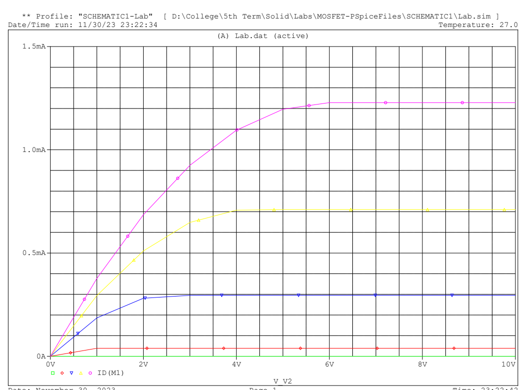
(c) $\gamma = 0,\ \theta = 0$



(d) $\gamma = 0,\ \theta = 0.1$



(e) $\gamma = 0.6,\ \phi = 0.75,\ \theta = 0$



(f) $\gamma = 0.6,\ \phi = 0.75,\ \theta = 0.1$

Figure 4: γ, ϕ and θ Change with V_{ds} Change Plots

1.3.1 Discussion

Analyze the results obtained that the effect of $\gamma,\ \phi,\ \theta$ on $V_t,\ I_d$ as following when increases γ or ϕ that V_t increases and I_d decreases in both modes as

in Triode Mode

$$I_d = KP * \frac{W}{L} * V_{ds} * [(V_{gs} - V_t) - \frac{1}{2}]$$

in Saturation Mode

$$I_d = \frac{1}{2} KP * \frac{W}{L} * (V_{gs} - V_t)^2$$

The relations said that I_d decreases when V_t Increases and V_t relation to γ and ϕ come from previously explained relation in fig 3

$$V_t = V_{to} + \gamma\ (\sqrt{\phi + V_{sb}} - \sqrt{\phi})$$

Also for θ increases we can understand the decreases of I_d when we look to the mobility relation

$$\mu = \frac{\mu_o}{1 + \theta\ (V_{gs} - V_t)}$$

and for considering that $KP = \mu C_{oX}$ so when we substitute the V_t and μ relations in relations of I_d in both modes, we get the full image of $\gamma,\ \phi,\ \theta$ effects on $V_t,\ I_d$

1.4 Difference between $\theta = 0$ and $\theta = 0.1$ with change V_{gs}

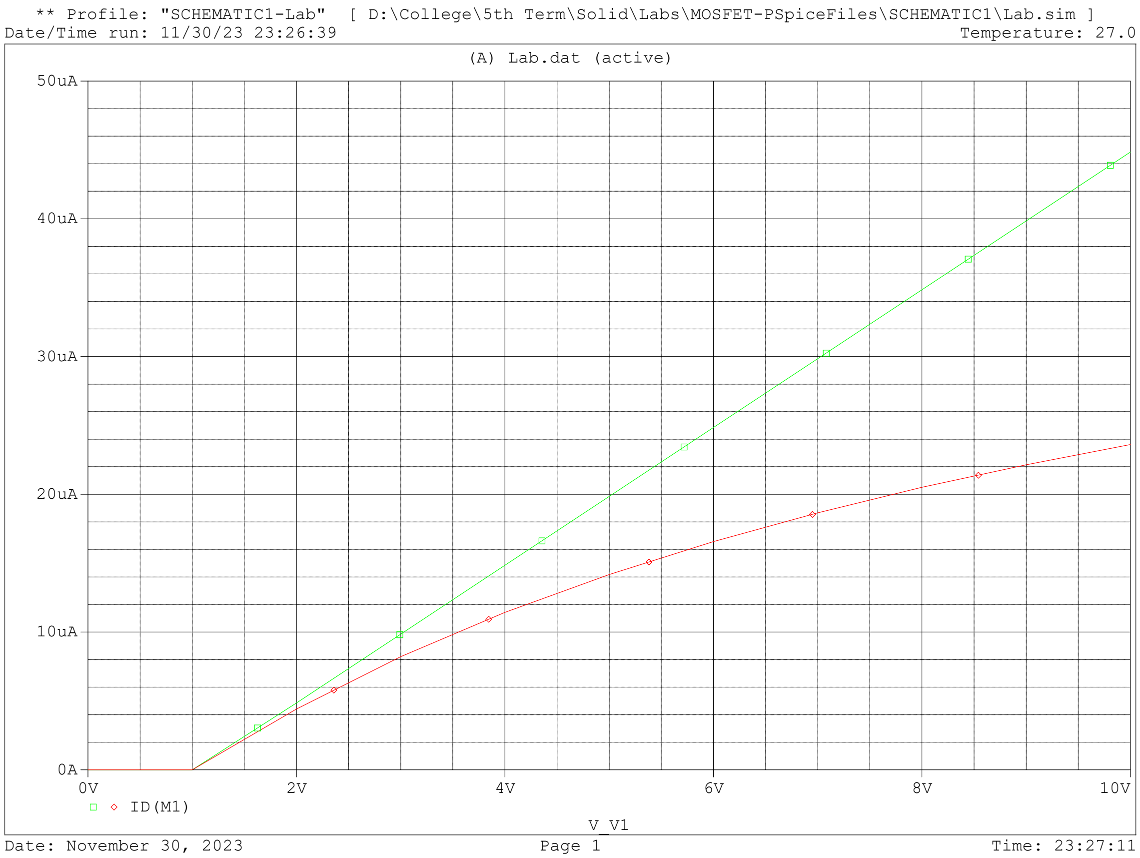


Figure 5: Difference between $\theta = 0$ and $\theta = 0.1$ with change V_{gs} Plots

1.4.1 Discussion

Analyze the results obtained we understand that more ϕ the less I_d and it be curved as the the mobility becomes a function of $V_{gs} - V_t$ in the relation $\mu = \frac{\mu_o}{1+\theta\ (V_{gs}-V_t)}$

So, the relation between ϕ and I_d is shown reverse propositional as expected due to Triode Mode relation becomes

$$I_d = \frac{\mu_o}{1+\theta\ (V_{gs}-V_t)} * C_{oX} * \frac{W}{L} * V_{ds} * [(V_{gs} - V_t) - \frac{1}{2}]$$