ECE 5205 Homework assignment # 9 (turn in by 4-24-2013)

1) **DIBL and Short Channel Effect**: Consider problem 4 homework assignment #8: n-channel Silicon MOSFET N_A=3x10^{16} cm-3 with a) Tox=450A, L=1.25μm, and r_j=0.5 μm; calculate the threshold voltage shift due to short-channel effects. Calculate the threshold voltage lowering (relative to long channel VT) for V_d=0.1V and for V_d=3.5V. Use the formula (1) given below. (5 points)

2) **Short Channel Effect:** There is an empirical formula for L_{min} (minimum "long" channel gate) given below (eq. 2). By how much would the L_{min} be increased when you double the substrate doping reduce the oxide thickness by 30%? Assume that the junction depth x_j has been reduced also by 30% by virtue of the higher substrate doping. (4 points)

3) **Reverse Channel Effect:** Consider n-channel MOSFET with t_{ox}=350A. The threshold voltage adjust implant after inert anneal results with a peak concentration of 3x10^{17} cm^{-3} 0.25 μm below the surface and a surface concentration of 4x10^{16} cm-3. For V_T calculation assume that the V_T adjust implant is equivalent to an effective uniform substrate doping of 7x10^{16} cm^{-3}. The same V_T adjust profile when subjected to oxidation enhanced diffusion during the same anneal results in a profile with a peak concentration of 2x10^{17} cm^{-3} 0.25 μm below a surface and a surface concentration of 7x10^{16} cm^{-3}. For V_T calculation assume that the V_T adjust implant is equivalent to an effective uniform substrate doping of 1x10^{17} cm^{-3}. Make sketches of the two profiles and equivalent uniform substrate doping. What is the maximum positive ΔV_T for the reverse short channel effect? (6 points)

4) **Channel conductance and transconductance:** For the MOSFET shown in Figure below tox=470A, L=0.27 μm, W=8.6 μm, VT=0.3V, find the transconductance in saturation g_{msat} at Vds=1.5 V, and the output (or channel) conductance in saturation g_{dsat} at Vgs=1.8 V. Calculate the output resistance that corresponds to g_{dsat} . (3 points)

5) **Channel length modulation:** For which case do you think the channel length modulation is more pronounced, for a short channel or long channel transistor? Justify your response. (2 points)

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$$\Delta V_{T0} = \frac{1}{C_{ox}}\sqrt{2q\varepsilon_{Si}N_A|2\psi_B|}\times\frac{x_j}{2L}\left[\left(\sqrt{1+\frac{2x_{dS}}{x_j}}-1\right)+\left(\sqrt{1+\frac{2x_{dD}}{x_j}}-1\right)\right] \quad \text{eq.(1)}$$

$$L_{\min} = 0.9\cdot[t_{ox}x_j(x_{dS}+x_{dD})^2]^{1/3} \qquad eq(2)$$

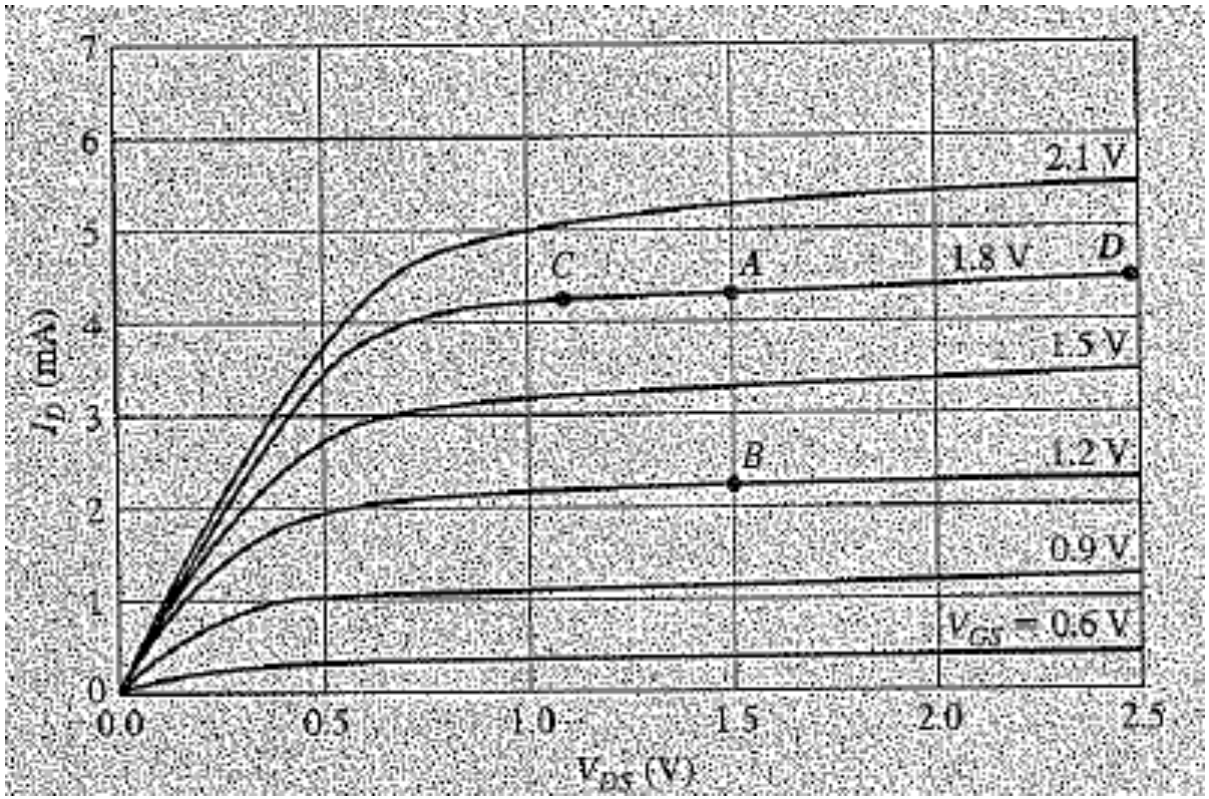

Figure to Problem 4