ECE 320 - Homework #9

MOSFETs, MOSFET switch, CMOS logic. Due Monday, March 22nd

MOSFETs

1) The VI characteristics for an n-channel MOSFET is shown on the following page. Assume Vth = 1.0V

- Determine the transconductance gain, kn
- Label the off / saturated / ohmic regions in the curve below.

Pick a point in the ohmic region (A)

$$I_{ds} = k_n\left(V_{gs} - V_{th} - \frac{V_{ds}}{2}\right)V_{ds}$$

$$7.6mA = k_n\left(7V - 1V - \frac{2.4V}{2}\right)2.4V$$

$$k_n = 660\mu\ \frac{A}{V^2}$$

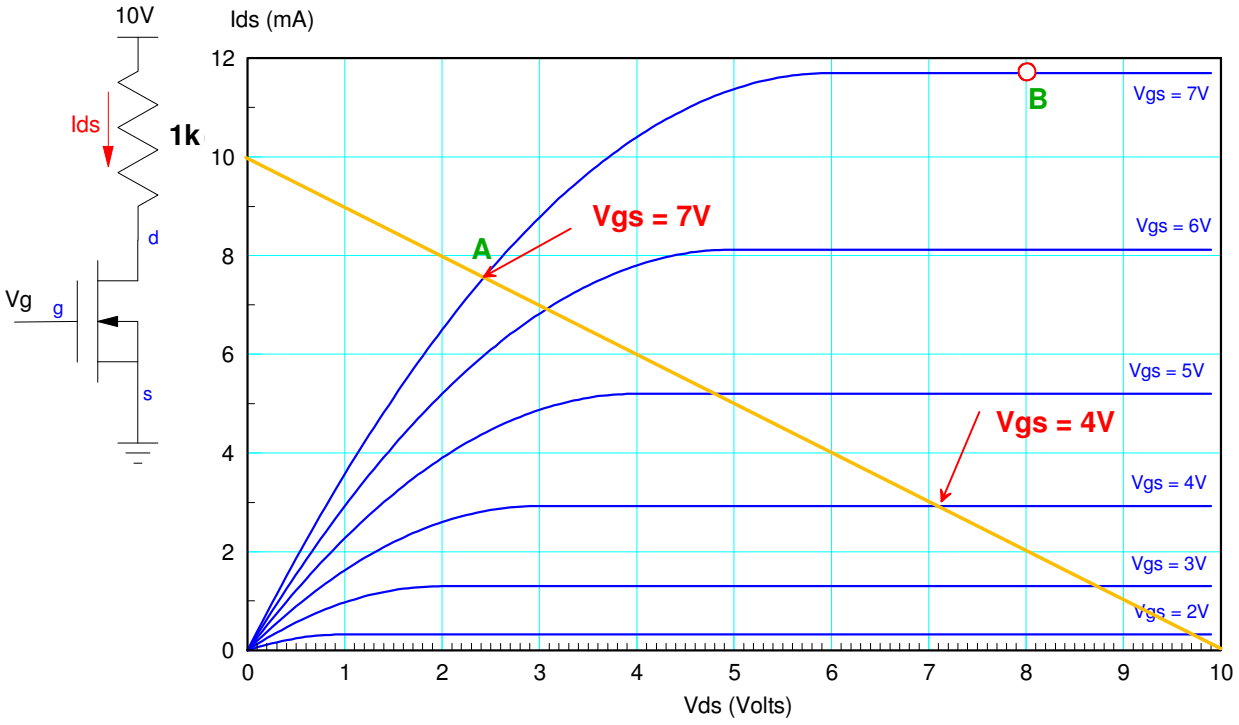
Pick a point in the saturated region (B)

$$I_{ds} = \frac{k_n}{2}(V_{gs} - V_{th})^2$$

$$11.8mA = \frac{k_n}{2}(7V - 1V)^2$$

$$k_n = 656\mu\ \frac{A}{V^2}$$

2) Draw the load line and mark the operating points for Vg = { 0V, 4V, 7V }



MOSFET Switch

One of the MOSFET's that CircuitLab has is an IRF1047. It's specifications are

- max(Ic) = 100A continuous
- Vgs(th) = 4V (max)
- Rds = 7.8mOhm @ Ids = 78A @ Vgs = 10V
- $0.53 each

3) Determine the transconductance gain, kn, for this MOSFET. Assume Vtn = 4.00V

In the ohmic region

$$I_{ds} = k_n\left(V_{gs} - V_{th} - \frac{V_{ds}}{2}\right)V_{ds}$$

$$V_{ds} = 0.0078\Omega \cdot 78A = 0.6084V$$

$$78A = k_n\left(10V - 4V - \frac{0.6084V}{2}\right)0.6084V$$

$$k_n = 22.501\ \frac{A}{V^2}$$

4) Determine the votlages and currents for the following circuit when Vg = 5V

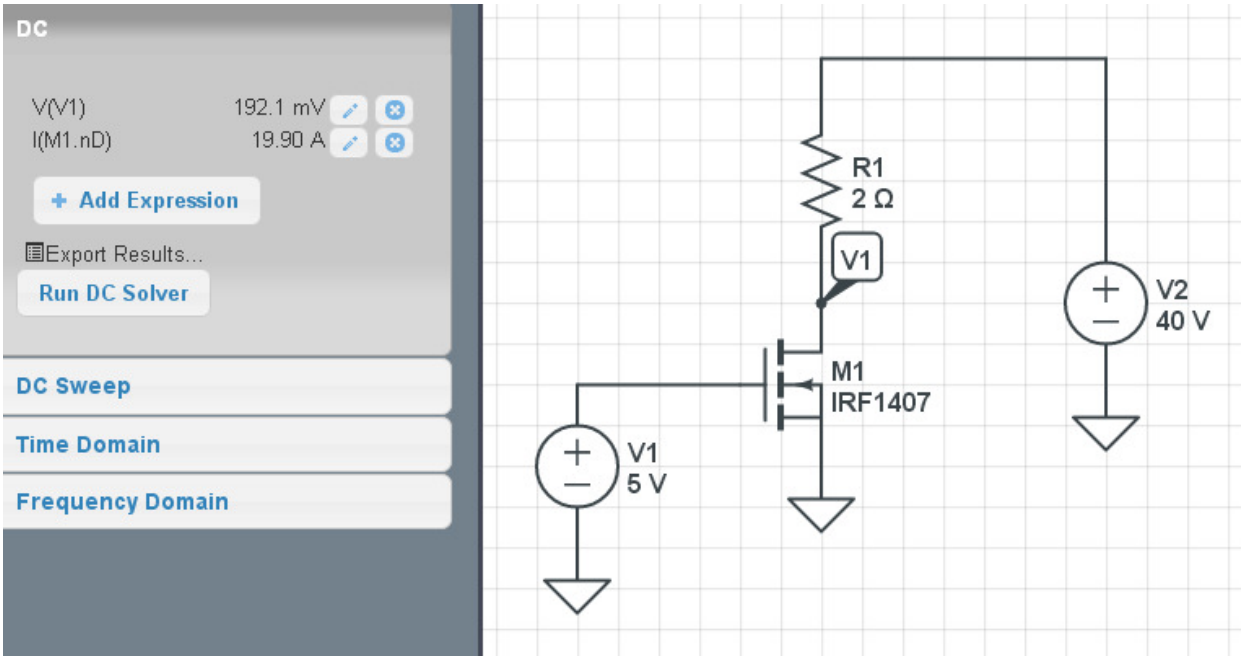
- Check your result in CircuitLab

Assume saturated

$$I_{ds} = \frac{22.501}{2}(5-4)^2$$

$$I_{ds} = 11.25A$$

$$V_{ds} = 40 - 2I_{ds} = 17.499V$$



5) Determine the votlages and currents for the following circuit when Vg = 10V

- Check your result in CircuitLab

Assume Ohmic

$$I_{ds} = k_n\left(V_{gs} - V_{th} - \frac{V_{ds}}{2}\right)V_{ds}$$

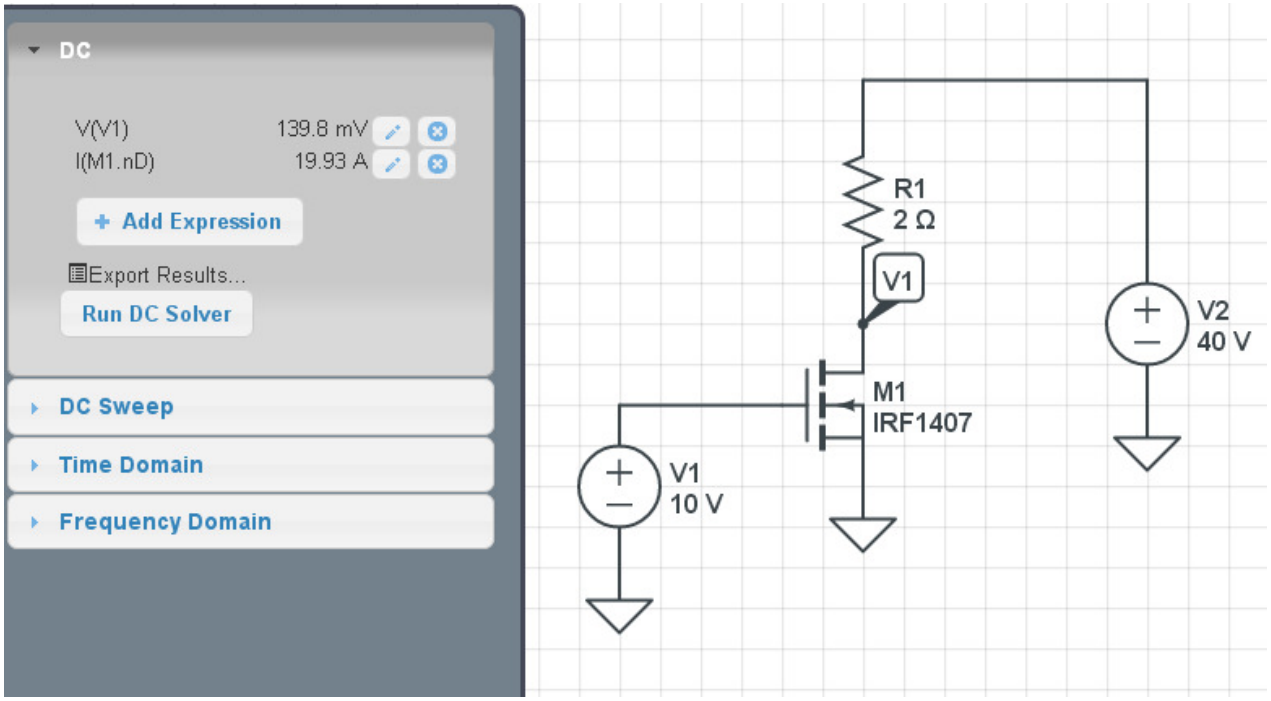
$$I_{ds} = 22.501\left(10 - 4 - \frac{V_{ds}}{2}\right)V_{ds}$$

$$V_{ds} + 2I_{ds} = 40$$

Solving

$$I_{ds} = 19.925A$$

$$V_{ds} = 0.149V$$



CMOS Logic

6) Design a CMOS gate to implement the function: f(A, B, C, D)

f(A,B,C,D)		CD			
		00	01	11	10
AB	00	1	0	0	0
	01	1	1	0	1
	11	x	x	x	x
	10	1	1	x	x

Circling the 0's is slightly easier than circling the 1's

$$Y' = CD + A'B'D + A'B'C$$