ECE 320 - Homework #9

MOSFET Switches, CMOS logic. Due Monday, March 23rd

MOSFET Switch

The characteristics for a MOSFET are

- Part: AOI4286
- Current - 100V, 4A continuous. 35W
- Rds On (Max) @ Id, Vgs 68mOhm @ 5A, 10V
- Vgs(th) (Max) @ Id 2.9V @ 250µA

1) Determine the transconductance gain, kn

Ohmic region so

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

$$V_{ds} = 5A \cdot 68m\Omega = 0.34V$$

$$5A = k_n\left(10V - 2.9V - \frac{0.34V}{2}\right)0.34V$$

$$k_n = 2.122\ \frac{A}{V^2}$$

2) Determine the voltages for the following circuit for

Vin = Vg = 0V: Off Region

$$I_{ds} = 0$$

$$V_{ds} = 20V$$

Vin = Vg = 5V: Saturated Region (guess)

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

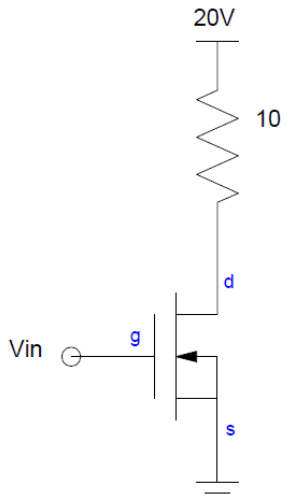
$$I_{ds} = \frac{2.122}{2}(5 - 2.9)^2$$

$$I_{ds} = 4.679A$$

which is more than is possible. Guess Ohmic

$$I_{ds} = 2.122\left(5 - 2.9 - \frac{V_{ds}}{2}\right)V_{ds}$$

$$V_{ds} + 10I_{ds} = 20$$



Solving

$$V_{ds} = 0.496V,$$

$$I_{ds} = 1.950A,$$

$$R_{ds} = \frac{V_{ds}}{I} = 0.254\Omega$$

Vin = Vg = 10V (assume ohmic)

$$I_{ds} = 2.122\left(10 - 2.9 - \frac{V_{ds}}{2}\right)V_{ds}$$

$$V_{ds} + 10I_{ds} = 20$$

Solving

$$V_{ds} = 0.133V$$

$$I_{ds} = 1.987A$$

$$R_{ds} = \frac{V_{ds}}{I_{ds}} = 0.067\Omega$$

3) Design a circuit using this MOSFET to turn on and off a DC servo motor. Assume the DC motor draws 200mA @ 10V.

No change - just use the previous circuit.

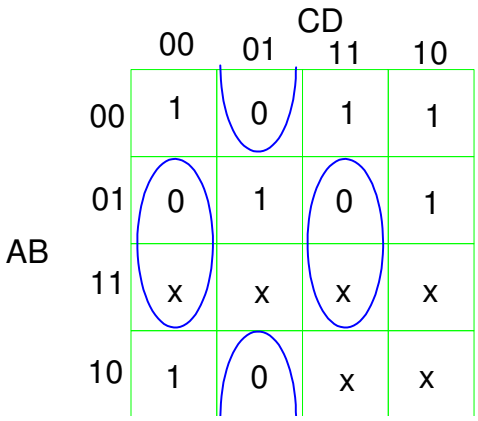
MOSFET's make pretty versitile switches.

CMOS Logic

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

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

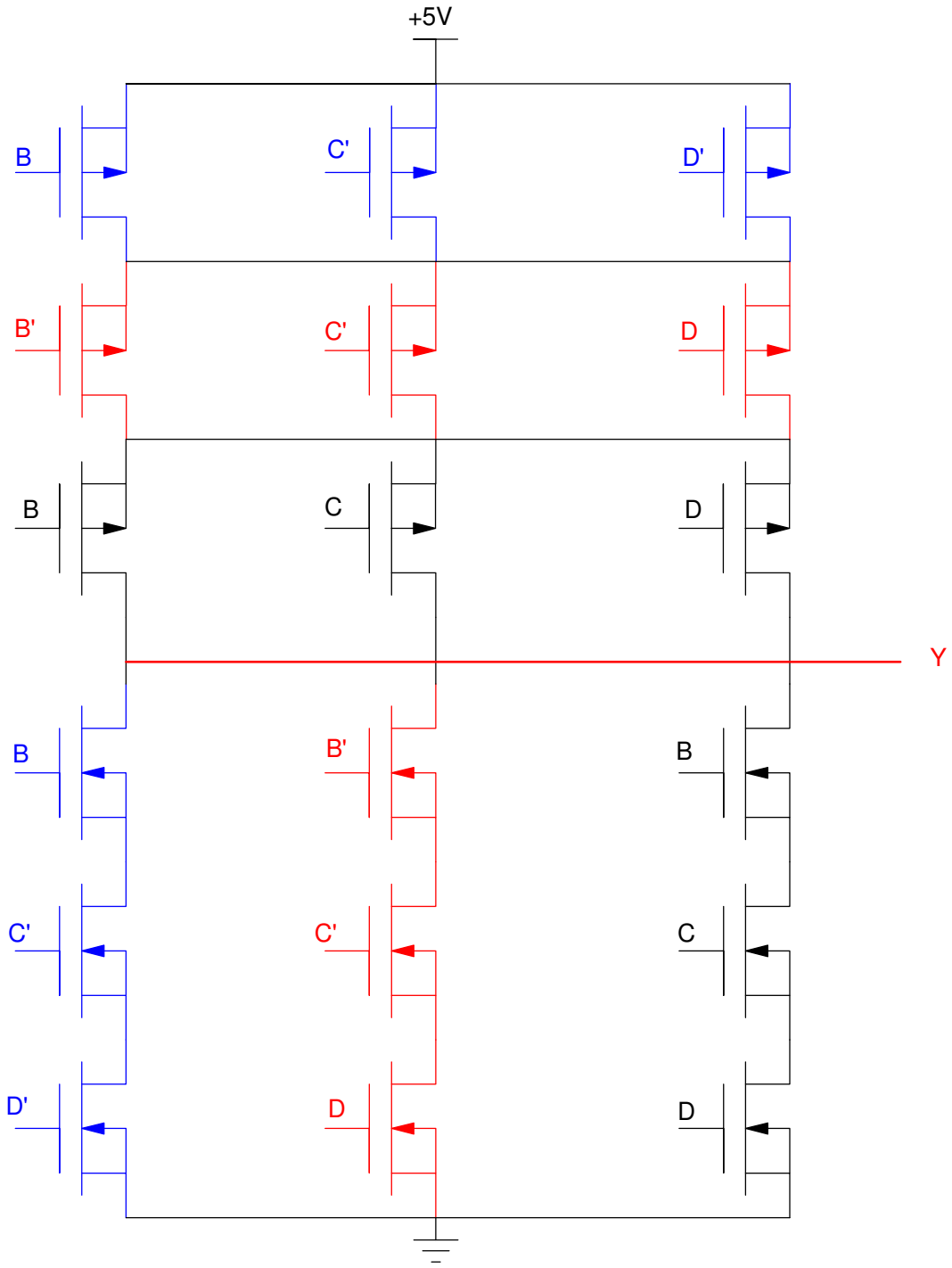
Circle the zeros (only takes 3 terms)



$$\overline{d} = B\overline{C}\,\overline{D} + \overline{B}\,\overline{C}D + BCD$$

$$d = \left(\overline{B} + C + D\right)\left(B + C + \overline{D}\right)\left(\overline{B} + \overline{C} + \overline{D}\right)$$

Using CMOS logic



$$d(A,B,C,D) = \left(\overline{B} + C + D\right)\left(B + C + \overline{D}\right)\left(\overline{B} + \overline{C} + \overline{D}\right)$$