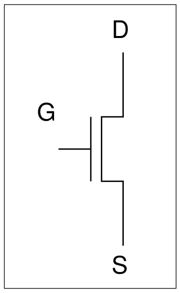
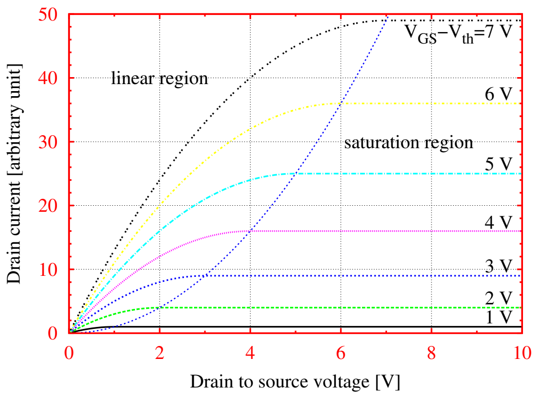
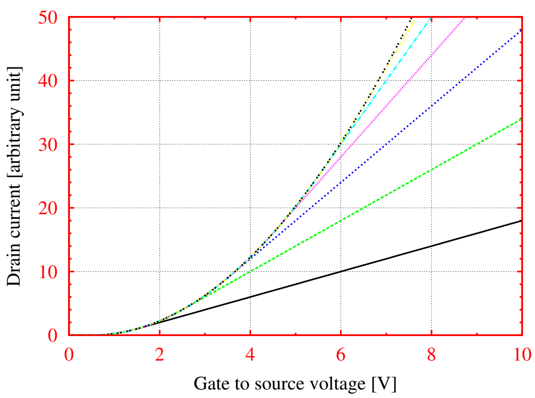
N-type MOSFET

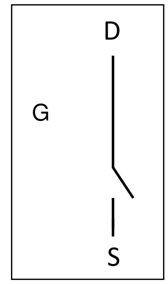


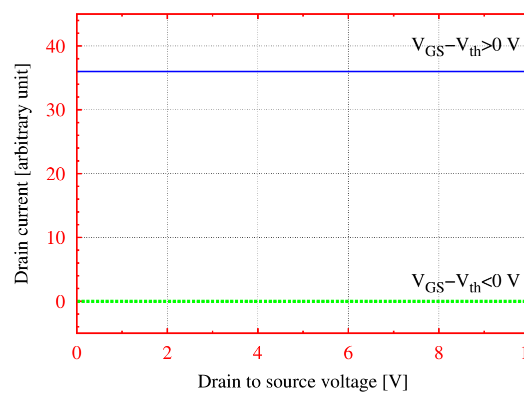




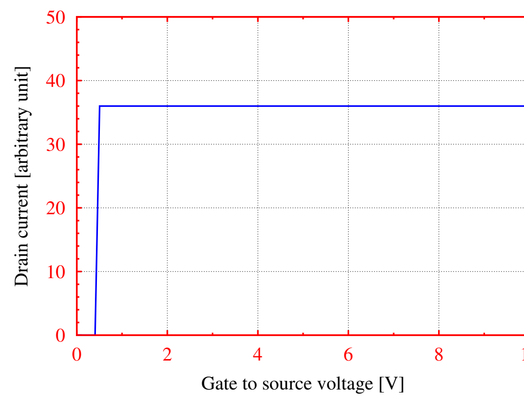
(even this is a simplified approximation)

Zero-Order Model





I_{ds} unbounded when $V_{gs} > V_{th}$



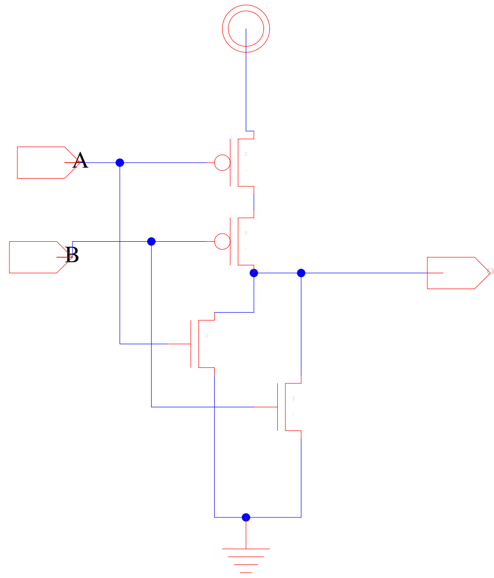
Step at $V_{gs} = V_{th}$

	NMOS	PMOS
Threshold	$V_{thn} > 0$	$V_{thp} < 0$ $V_{thp} \approx -V_{thn}$
Conduct	positive input $V_{gs} > V_{thn}$	negative input $V_{gs} < V_{thp}$
Drain	most positive terminal	most negative terminal
Source	most negative terminal (source of electrons)	most positive terminal (source of holes)

$$V_{gs} = V_g - V_s \quad (1)$$

1. What function does this circuit implement? (inputs are a and b)

   [N.B. crossing wires with no dot are **not** connected.]

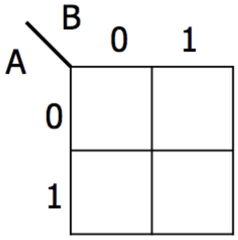


2. If $\overline{f} = a + b$, what is f in minimum-sum-of-products form?

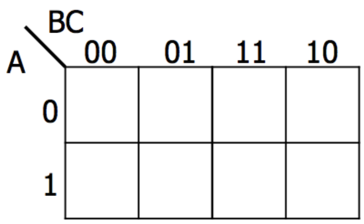
   [N.B. $\overline{f}$ = ~f = /f = (not f) = f']

3. Design gate to perform: $f = (\overline{a} + \overline{b}) \cdot \overline{c}$

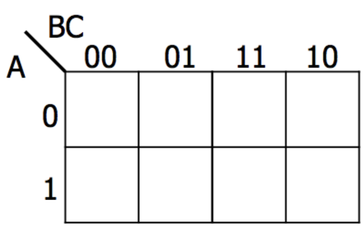
4. Simplify the boolean expression $Z = \overline{A} \cdot \overline{B} + A \cdot \overline{B} + \overline{A} \cdot B$ to the minimum sum of products with the 2-variable K-map:



5. Simplify the boolean expression $Z = \overline{A} \cdot \overline{B} \cdot \overline{C} + \overline{A} \cdot B + A \cdot B \cdot \overline{C} + A \cdot C$ to the minimum sum of products with the 3-variable K-map:



6. **Extra practice for outside of class:**
Simplify the boolean expression $Z = A \cdot B \cdot C + A \cdot B \cdot \overline{C} + \overline{A} \cdot B \cdot C$ to the minimum sum of products with the 3-variable K-map:



Simplify the truth table to the minimum sum of products with the 4-variable K-map:

A	B	C	D	Z
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0