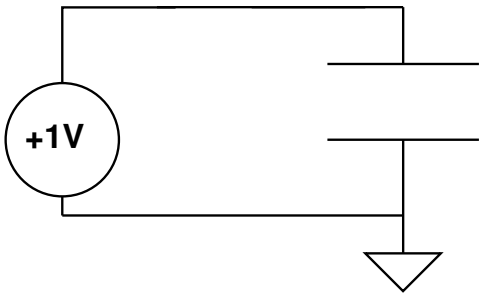
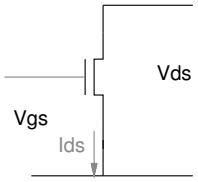
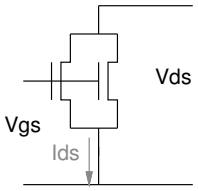
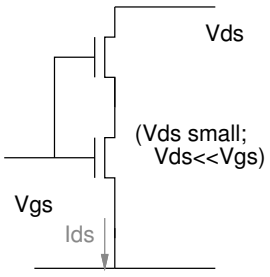
1. Below is a capacitor with a 1V bias voltage across it.

   (a) Draw the charge distribution and electric field for this parallel-plate capacitor.

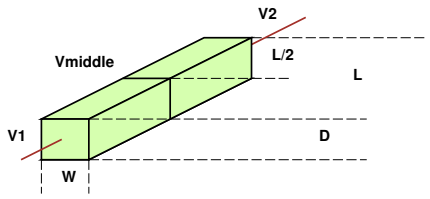


   (b) Assume the capacitor has a capacitance of 1F, what is the charge on the top plate? What is the charge on the bottom plate?

2. Fill in the missing currents:

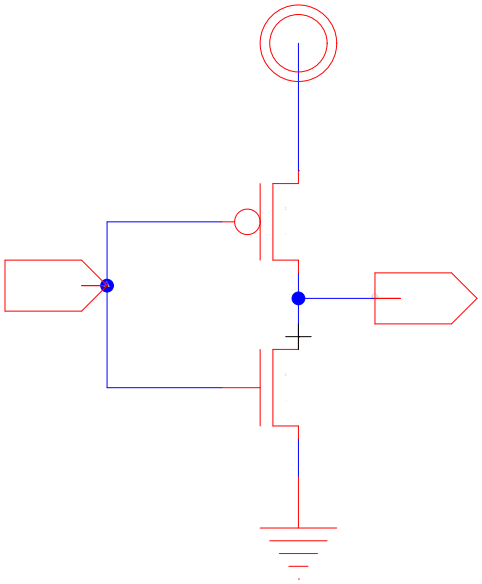
Circuit	**Current I_{ds}**
	$1\ \mu$ A (given)
	
	

3. Consider a resistor built from a resistive medium that is L units long in the direction of current flow, W units, and D units deep.



If we could insert a metal contact at $L/2$ and measured the voltage, how would that voltage (V_{middle}) relate to the endpoint voltages V_1 and V_2?

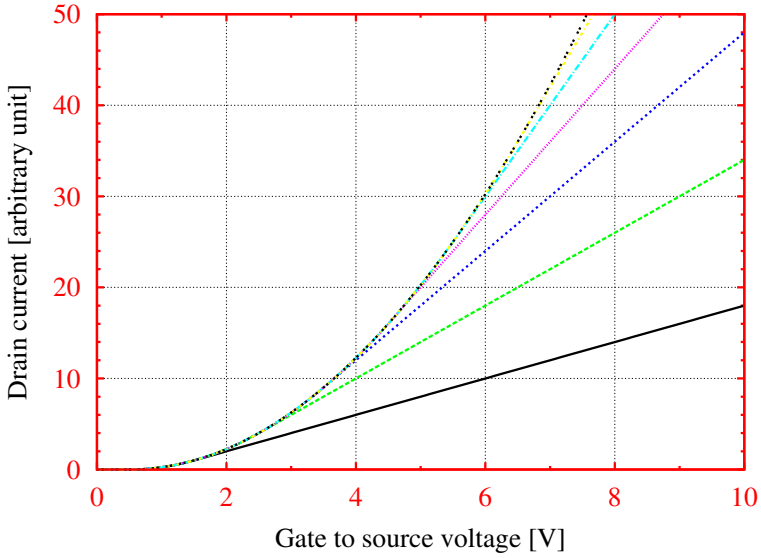
4. What current flows in the inverter in steady state? Think about the region of operation of the devices for each input case.

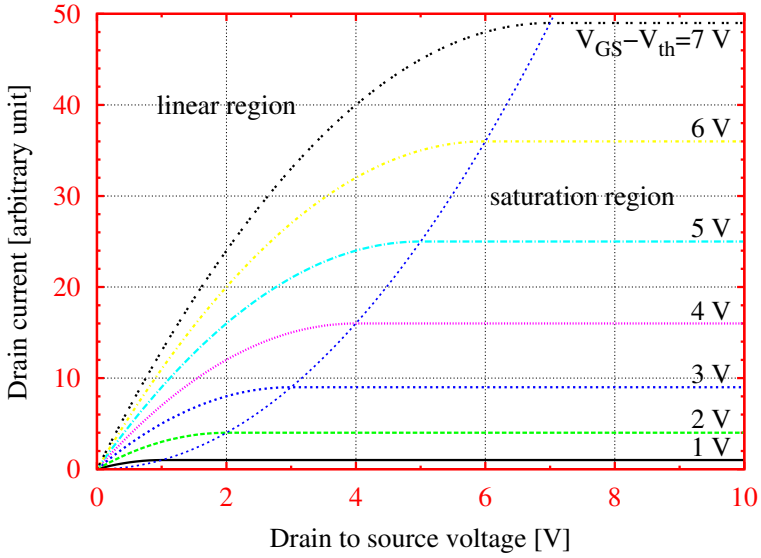


5. For a transistor in subthreshold, If V_{th} =300mV, $S = n\left(\frac{kT}{q}\right)\ln(10) = 100\text{mV}$,

   (a) what is $I_{ds}(V_{gs} = 300\text{mV})/I_{ds}(V_{gs} = 0\text{V})$?

   (b) now if $S = 60mV$, what is $I_{ds}(V_{gs} = 300\text{mV})/I_{ds}(V_{gs} = 0\text{V})$?





V_{GS}	V_{DS}	Mode	I_{DS}
$> V_{th}$	$< V_{GS} - V_{th}$	Resistive	$\mu_n C_{OX} \left(\frac{W}{L}\right) \left((V_{GS} - V_{th}) V_{DS} - \frac{(V_{DS})^2}{2} \right)$
	$> V_{GS} - V_{th}$	Saturation	$\frac{\mu_n C_{OX}}{2} \left(\frac{W}{L}\right) (V_{GS} - V_{th})^2$
$< V_{th}$		Subthreshold	$I_S \left(\frac{W}{L}\right) e^{\frac{V_{GS} - V_{th}}{nkT/q}} \left(1 - e^{-\frac{V_{DS}}{kT/q}}\right)$