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HW4-EE307

collaborated w/ Regita & Tedman Iran

2.

t_R = rise time between 10% & 90% of swing

$V_{out} = V_{max}\left[1 - e^{(-\frac{t}{RC})}\right]$

$V_{out} = V_{max} \times \left[1 - e^{(-\frac{t}{RC})}\right] \quad \frac{V_{max}}{9}$

$\frac{1}{9} = e^{(-\frac{t}{RC})}$

$-\ln(9) = -\frac{t}{RC}$

$t_R = RC\ln(9)$

$= 2.2RC$

b) $V_{out} = V_{max}(e^{(-\frac{t}{RC})}) = \frac{V_{max}}{9}$

$e^{(-\frac{t}{RC})} = \frac{1}{9}$

$-\frac{t}{RC} = -\ln 9$

$t_F = \ln 9 RC$

$t_F = 2.2RC$

c) $\frac{V_{dd}}{2} = V_{dd}\, e^{-\frac{t}{RC}}$

$t_{PHL} = RC\ln 2 \qquad t_{PLH} = RC\ln 2$

$t_P = \frac{1}{2}(t_{PHL} + t_{PLH})$

$t_P = RC\ln(2)$

3. a) $R_{ave} = \frac{\left(\frac{V_{DD}}{I_{DS\,VDD}}\right) + \left(\frac{\frac{1}{2}V_{DD}}{I_{DS\,VDD}}\right)}{2} \approx \frac{\left(\frac{3}{0.015}\right) + \left(\frac{1.5}{0.0125}\right)}{2}$

$= 160\Omega$

b) $R_{ave} = \frac{\left(\frac{V_{DD}\cdot\frac{3}{4}}{I_{DS\,VDD\frac{3}{4}}}\right)}{2} = \frac{\frac{(0.75\cdot 3)}{14A\times 10^{-3}}}{2} = 81\Omega$

c) Active region for calculating Ron b/c that's when the circuit is on and transister can be seen as resistor.

d) Using center point approximation

$\frac{k'}{2}\frac{W}{L} = \frac{1}{1000}\frac{A}{V^2}$, $V_{TN} = 0.6$ $V_{DD} = 5V$

$I_{DS} = \frac{1}{1000}\frac{A}{V^2}(5-0.6)^2 = 0.01936$

$\frac{5}{0.01936} = 193.678\Omega$

e) $\left(\frac{W}{L}\right) \Rightarrow \left(\frac{40\mu m}{2\mu m}\right)(6.2) = 124\,\Omega$

f) $(2607)\left(\frac{2\mu m}{L}\right) = 10k$

$L = 76.71\,\mu m$

4. $V_m = \frac{6V}{2} = 3V$ ($V_{max} - V_{min}$)

a)

b) $G = 2 \cdot r'(V_m - V_E)\frac{1}{2\lambda V_{DS}}$

$= 2 \cdot 200\frac{\mu A}{V^2}(3 - 0.5)\frac{1}{2(0.07)(0.00452)} = -9.445$

$I_D = \frac{k}{2}(V_{GS} - V_m)^2(1 + \lambda V_{DS})$

$100\mu(3 - V_m)^2(1 + 0.07(3)) = 0.756m$

c) $V_{IL} \Rightarrow y = mx + b$

$V_{out}(V_m) = 9(1 + 9.445) = 31.33 = b$

$V_{max} = 6 = -9.945 V_m + 3(31.33) = V_{max} = 2.68$

$V_{min} = 0 = -9.945 V_m + 3(31.33) = 3.3176$

d) $V_{IL} = 2.68$

$V_{IH} = 3.3176$

e) $N_{ML} = 2.68 - 0 = 2.68V$

f) $N_{MH} = 6 - 3.3176 = 2.68$

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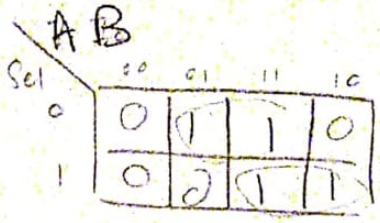
5.

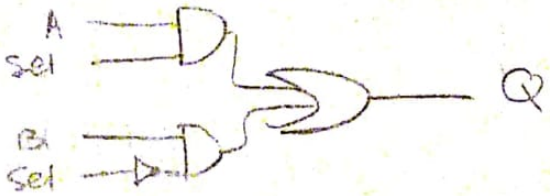
a) Truth Table 2:1 MUX

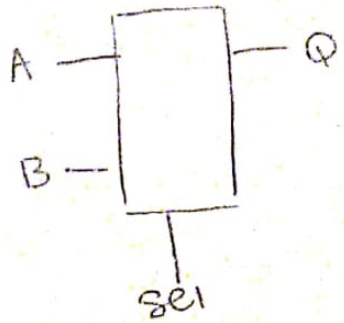
Sel	A	B	Q
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1



b) $Q = \overline{Sel}\,B + Sel\,A$

c) 2:1 MUX





Mult_Adder_Mux

A when Sel = 1
B when Sel = 0

⇒ When Sel = 1 ⇒ mult = 3×14 = 42 101010
Sel = 0 ⇒ adder = 3+14 = 17 10001

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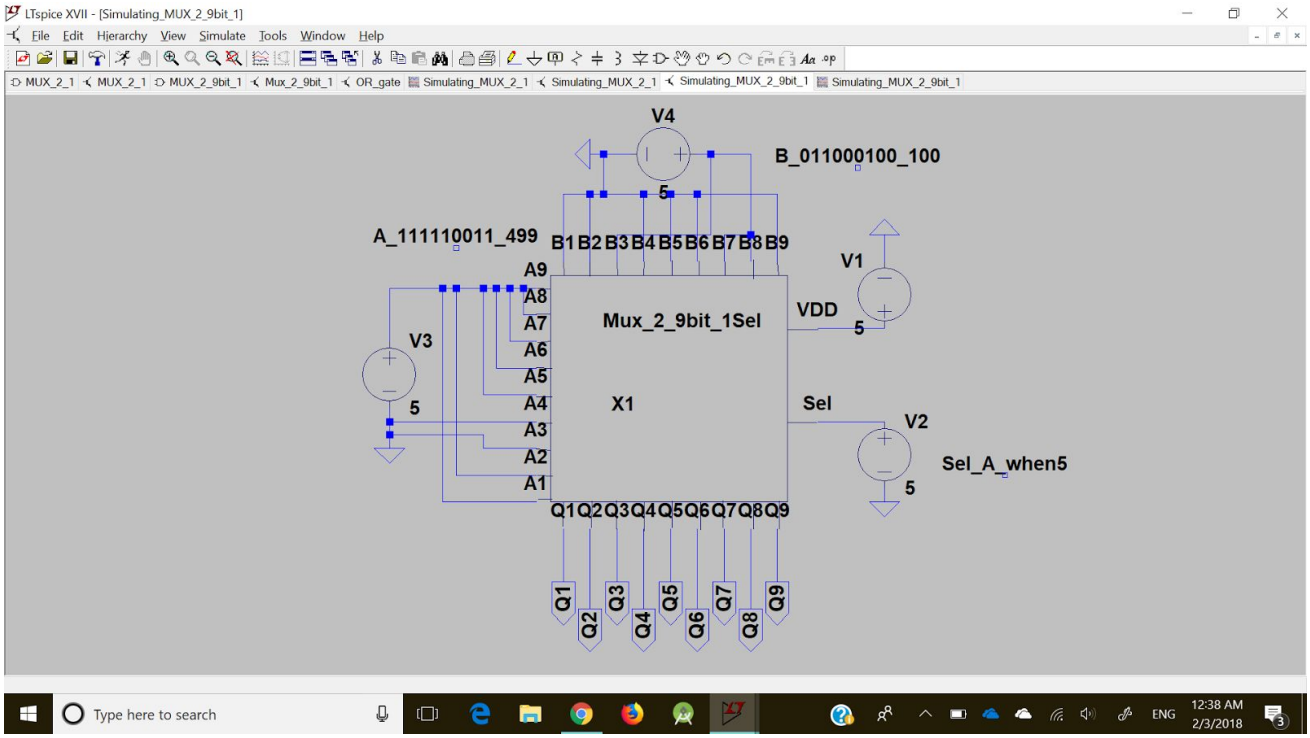
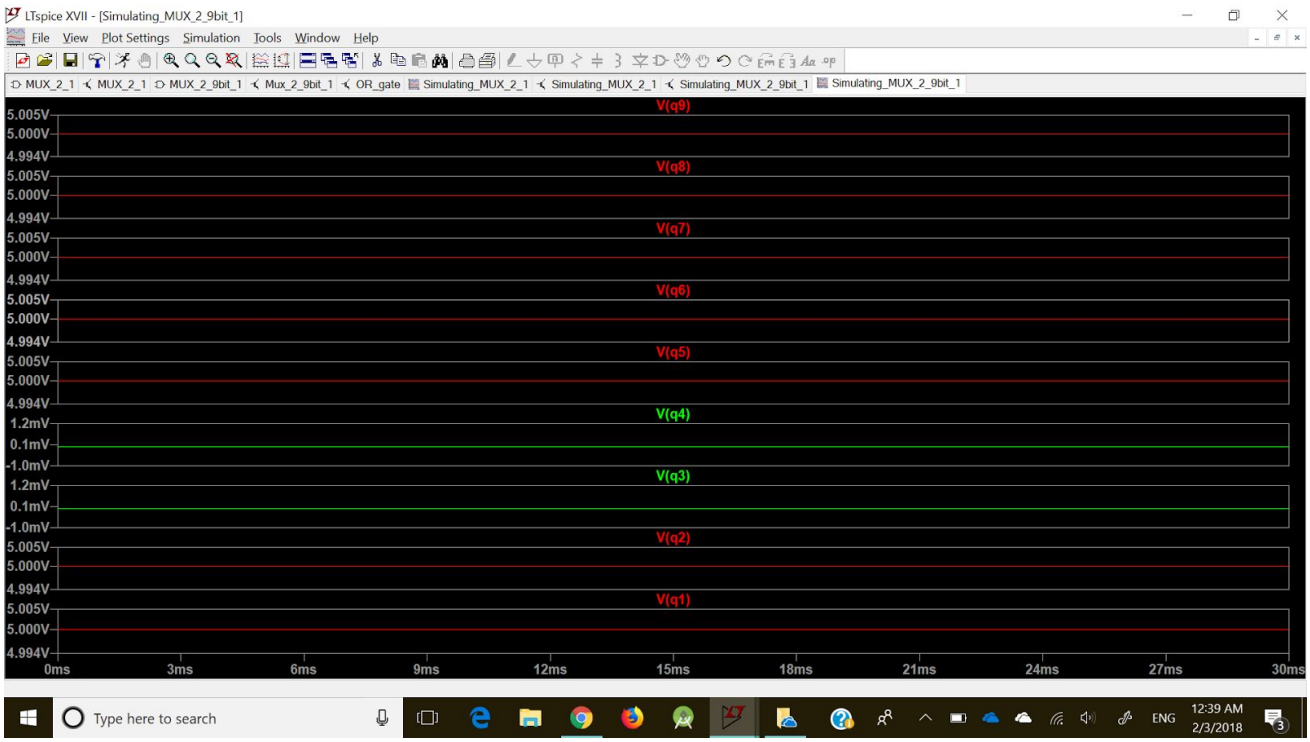
9 bit Mux and Mux with Multiplier & Adder





5D) Pictured above is my 9bit 2input 1select MUX. I set the value of A to be 499 (111110011), B to be 100 (011000100) and Sel to be on. The Select then choose to make the output Q the A value 111110011 as shown.

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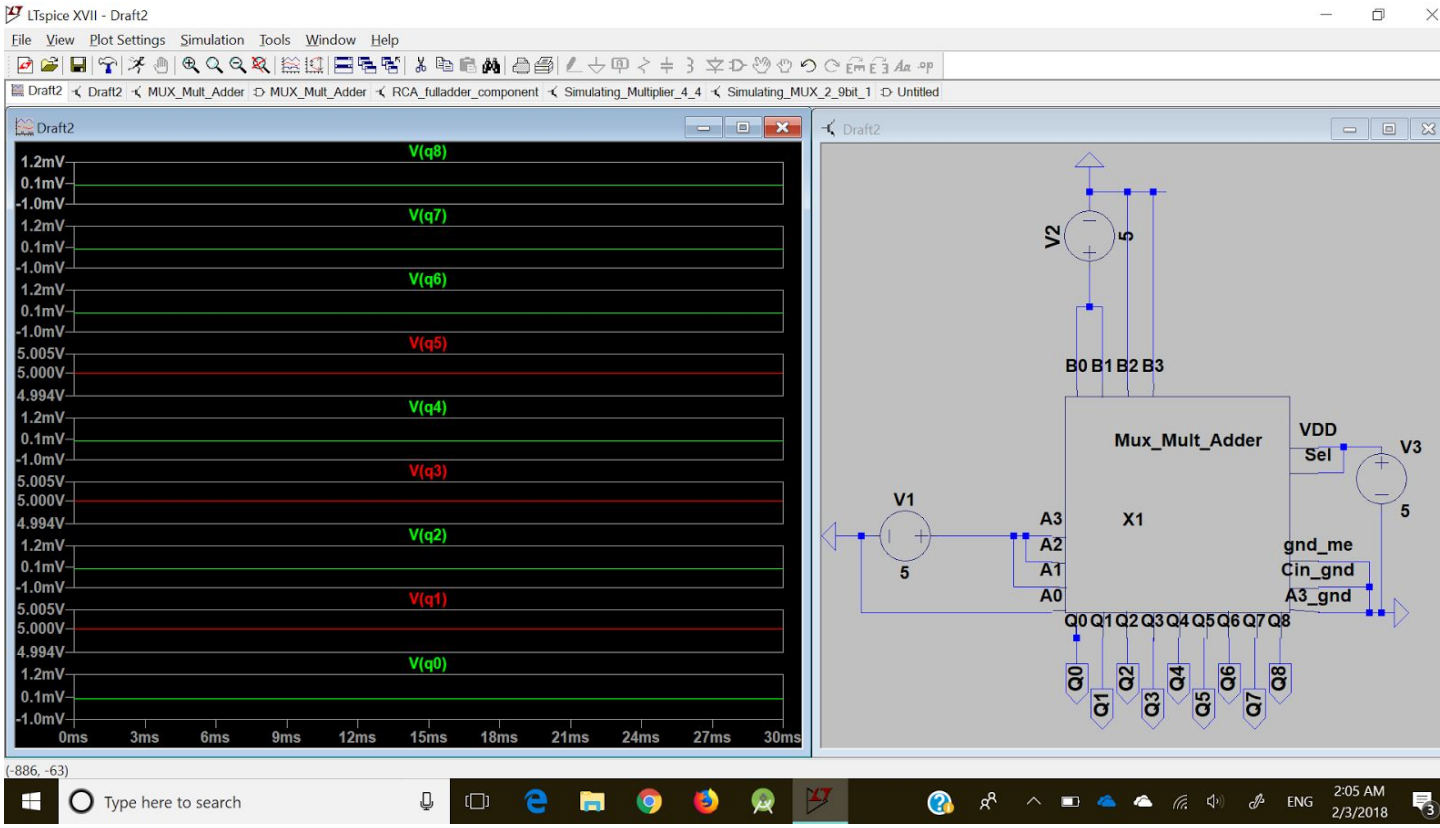

5F)
Set A=1110 and B=0011 and Sel to “1” so the 9bit MUX chose the multiplier which results in 3*14 = 42 (000101010)

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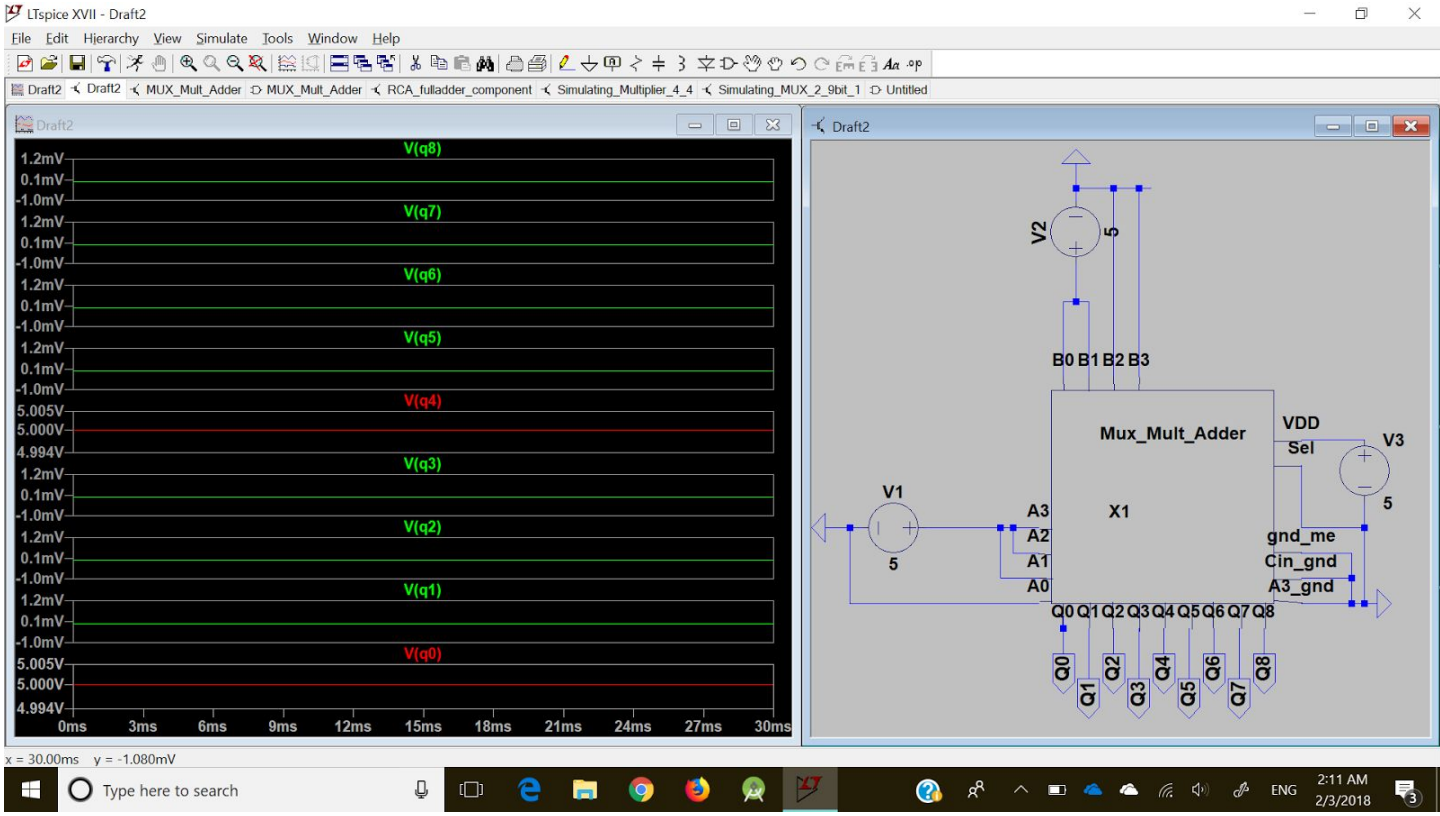

5F)

Set A=1110 and B=0011 and Sel to “0” so the 9bit MUX chose the adder which results in 3+14 = 17 (000010001)