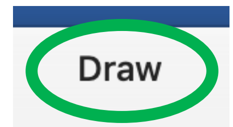
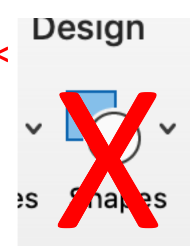
Haegang Yang

Directions

- Carefully read the overhead projection for any additional directions specific to this quiz/exam.
- In the header, replace the highlighted text with your name and remove the highlight.
- Make your final answers clear, ideally with circles or in green. Correct answers made clear "after the fact" will not be graded.
- Any questions with an answer but no justifying work will be graded as **incorrect**.
- All work and answers must be done using a MS-Word "drawing".



  (Exceptions are made for those with accommodations requests.)
  >>>>>> ALL TEXT OR OTHER FORMS OF ANSWERS WILL BE IGNORED!!!!!!!! <<<<<<<
  >>>>>> THIS INCLUDES POWERPOINT AND OTHER VECTORIZED DRAWINGS !!!!! <<<<



- Violating any of these rules or other malicious behavior will result in a 0 grade and disciplinary action report to the provost's office.
- Partial credit is awarded for flawed work or answering the question outside of given constraints: **do not leave an answer blank if you can answer a similar question**.
- Any indication of copied work, especially identical incorrect answers or identically formatted answers will **1)** be marked as incorrect and **2)** be referred to the Provost's Office for academic misconduct.
- Submit your final answers as a PDF document by the deadline.

	Expression	Dual
P2	$a+0=a$	$a\cdot 1=a$
P3	$a+b=b+a$	$ab=ba$
P4	$a+(b+c)=(a+b)+c$	$a(bc)=(ab)c$
P5	$a+bc=(a+b)(a+c)$	$a(b+c)=ab+ac$
P6	$a+\bar{a}=1$	$a\cdot\bar{a}=0$
T1	$a+a=a$	$a\cdot a=a$
T2	$a+1=1$	$a\cdot 0=0$
T3	$\bar{\bar{a}}=a$	
T4	$a+ab=a$	$a(a+b)=a$
T5	$a+\bar{a}b=a+b$	$a(\bar{a}+b)=ab$
T6	$ab+a\bar{b}=a$	$(a+b)(a+\bar{b})=a$
T7	$ab+a\bar{b}c=ab+ac$	$(a+b)(a+\bar{b}+c)=(a+b)(a+c)$
T8	$\overline{a+b}=\bar{a}\bar{b}$	$\overline{ab}=\bar{a}+\bar{b}$
T9	$ab+\bar{a}c+bc=ab+\bar{a}c$	$(a+b)(\bar{a}+c)(b+c)=(a+b)(\bar{a}+c)$
T10(a)	$f(x_1,x_2,\dots,x_n)=x_1\cdot(f(1,x_2,\dots,x_n)+\overline{x_1}\cdot f(0,x_2,\dots,x_n)$	
T10(b)	$f(x_1,x_2,\dots,x_n)=[x_1+f(0,x_2,\dots,x_n)][\overline{x_1}+f(1,x_2,\dots,x_n)]$	

Haegang Yang

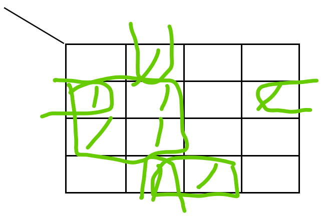
<u>This page is intentionally left blank: you may use it as scratch "paper".</u>

Haegang Yang

Problem 1 (2.5 points)

Minimize the following function using K-maps into its **minimal sum-of-products** form.

$$f(a,b,c,d) = a\bar{b}cd + \bar{b}\bar{c}d + ab\bar{c} + \bar{a}b\bar{d} + \bar{a}b\bar{c}d$$

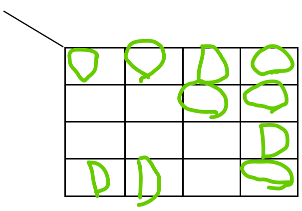


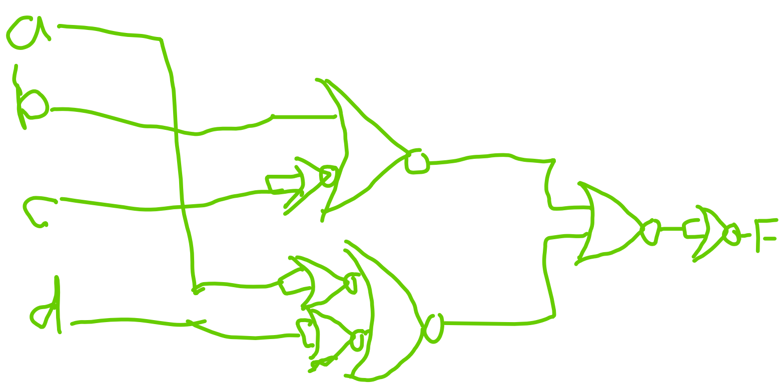
$b\bar{c} + \bar{a}b\bar{d} + \bar{b}\bar{c}d + a\bar{b}d$

Problem 2 (2.5 points)

Make the following function using the minimum number of NOR gates.

$$f(A,B,C,D) = \prod(0,1,2,6,7,10) \cdot D(3,8,9,14)$$

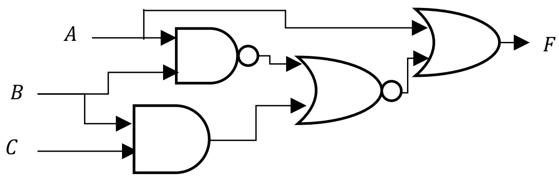


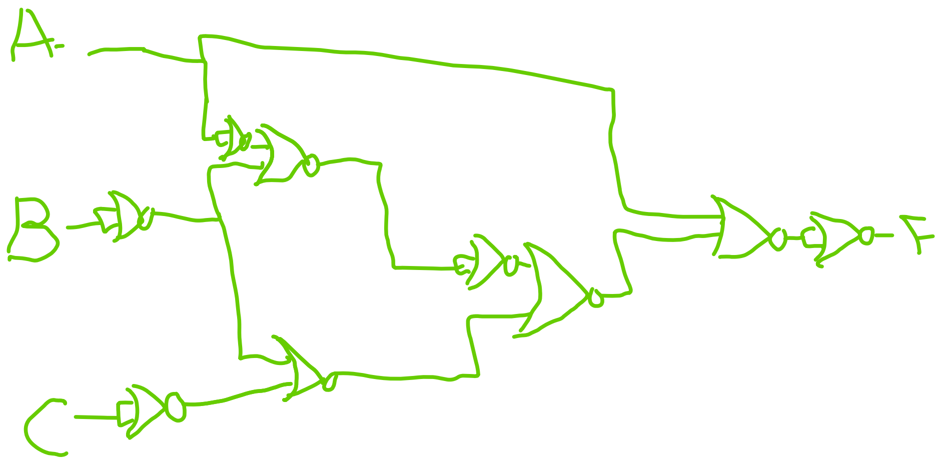


Haegang Yang

Problem 3 (2.5 points)

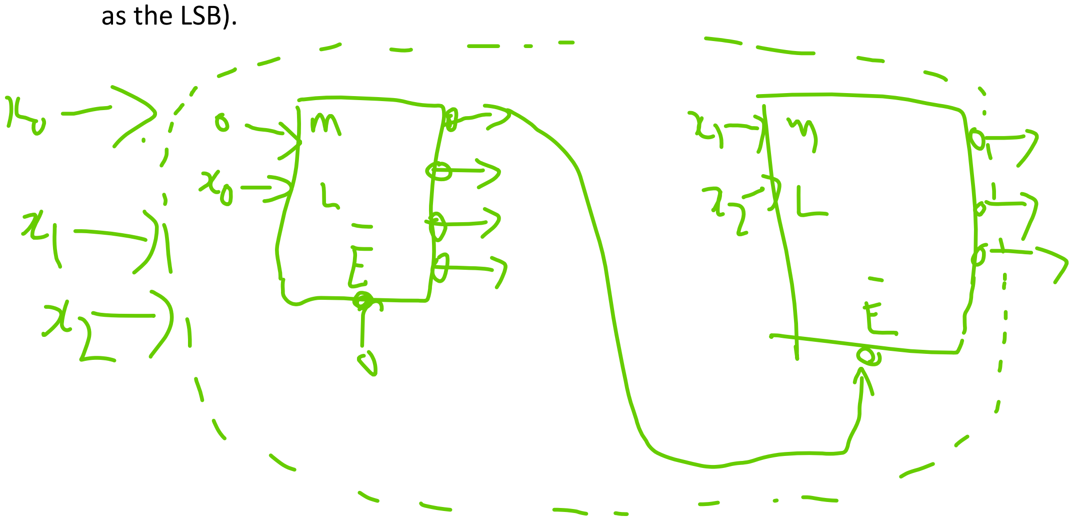
Convert the following circuit into one using only NOR gates (and no inverters). Do not optimize the circuit except for the number of “inverters”.





Problem 4 (2.5 points)

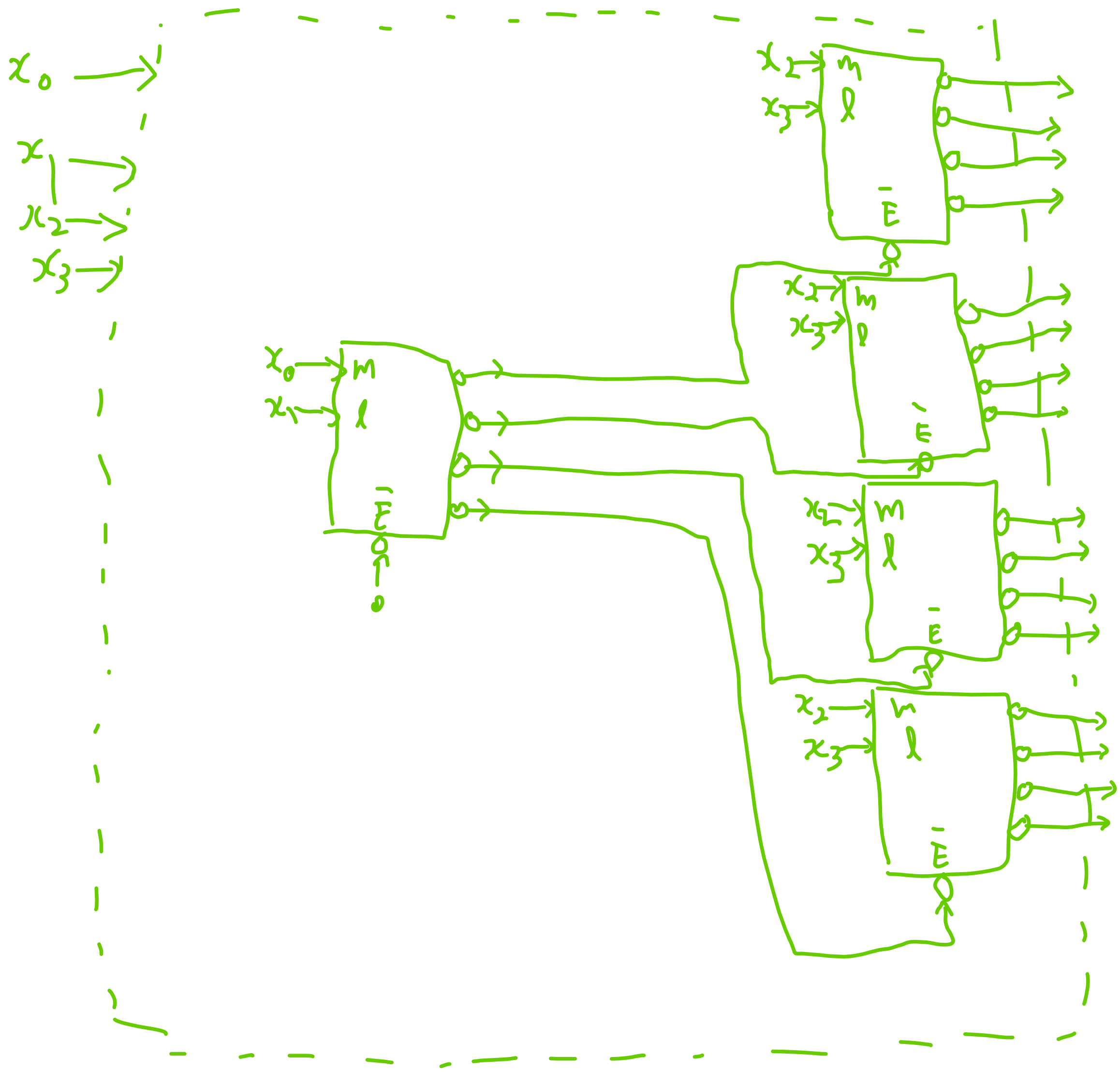
Create a 2-to-3 active-low decoder with an active-low enable. Name your inputs $\{x_2, x_1, x_0, \bar{E}\}$ (with x_0 as the LSB).



Haegang Yang

Problem 5 (4 points)

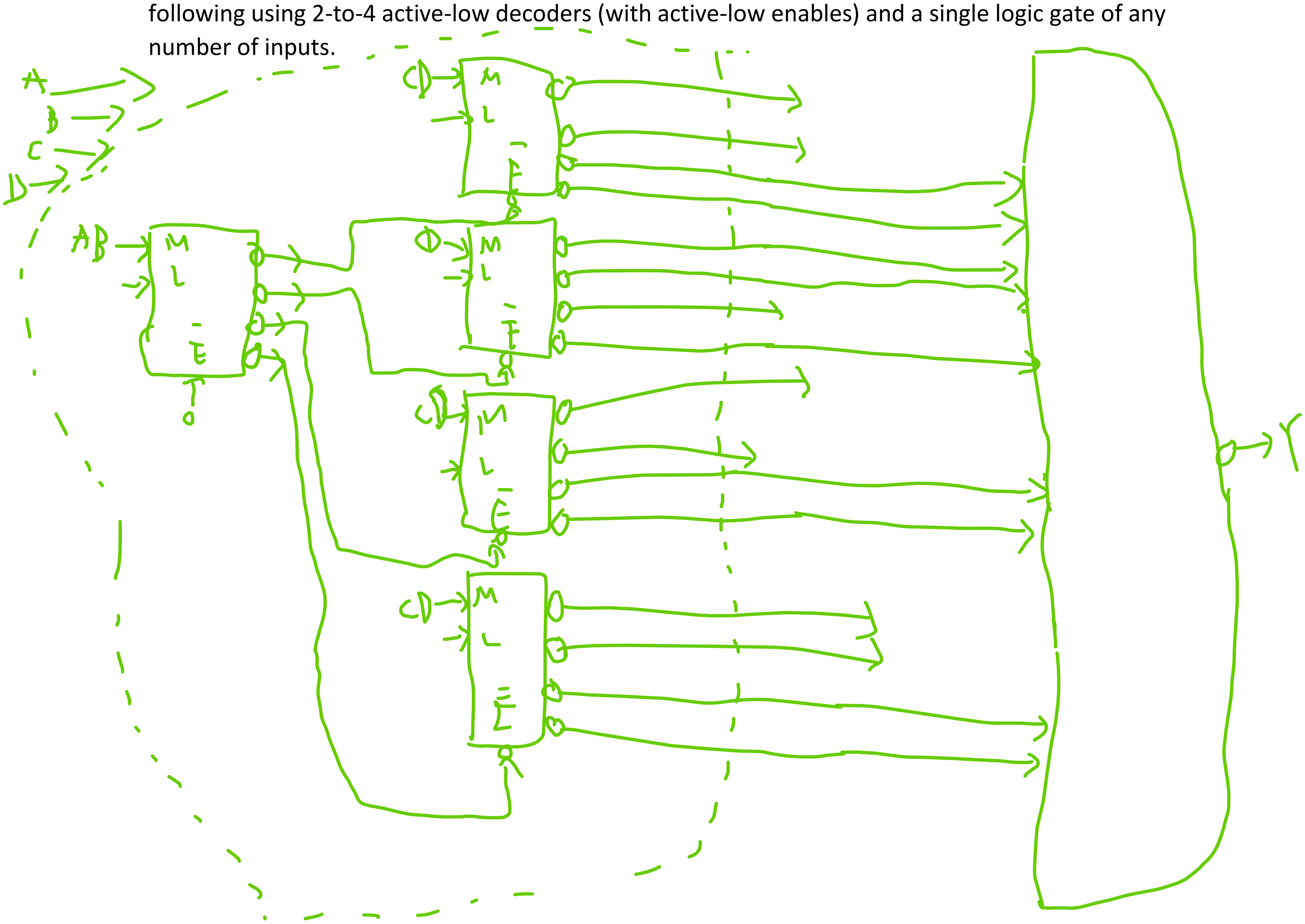
Design a 4-to-16 active-low decoder using only 2-to-4 active-low decoder modules. No other gate types or modules may be used (you may use constant values). Assume that each 2-to-4 decoder has one active-low enable input, $\bar{E}$. Name your 4-to16 decoder inputs $\{x_3, x_2, x_1, x_0\}$ with x_3 being the MSB.



Haegang Yang

Problem 6 (3 points)

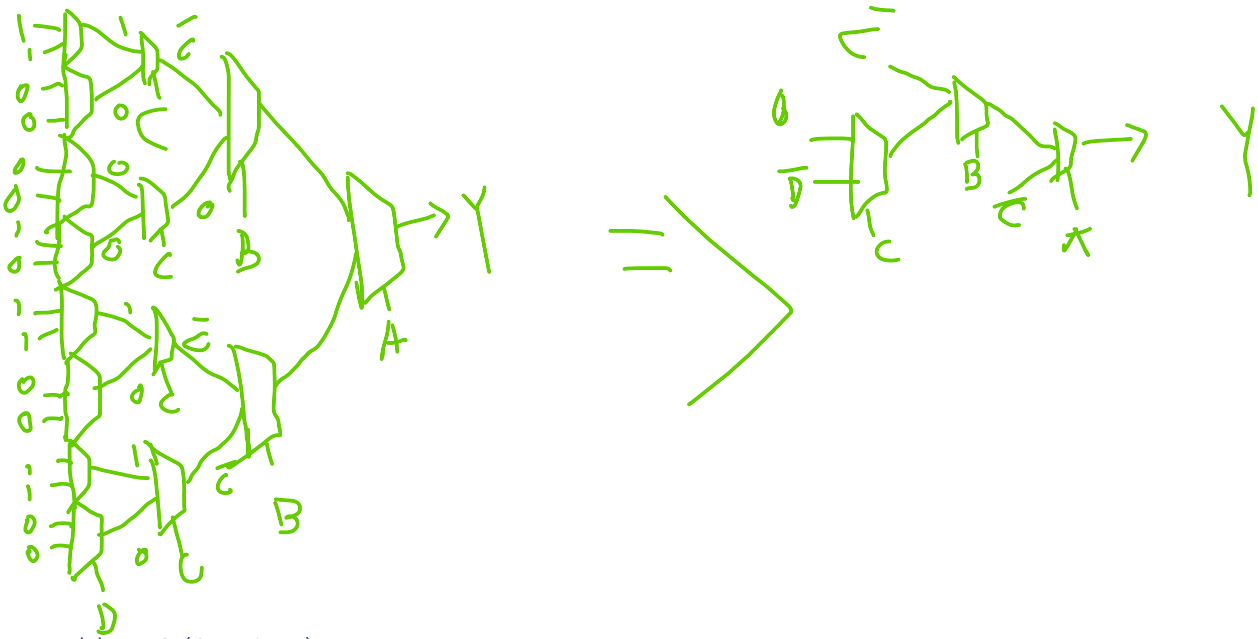
Realize the expression $Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}BC\bar{D} + \bar{A}\bar{B}\bar{C}D + A\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D$ using the following using 2-to-4 active-low decoders (with active-low enables) and a single logic gate of any number of inputs.



Haegang Yang

Problem 7 (2.5 points)

Realize the expression $Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}BC\bar{D} + \bar{A}\bar{B}\bar{C}D + A\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D$ using a minimal number of 2-to-1 multiplexers.



Problem 8 (3 points)

Create a 5-bit subtractor using using NAND and XOR gates.

Haegang Yang

Problem 9 (5 points)

For the following circuit, complete the given timing diagram. "D2" is given for your convenience and will not be graded, but all other rows will be graded.