CprE 281 HW7
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Multiplexers, Decoders, and Encoders
Assigned Date: Eighth Week
Finish by Oct. 16, 2023

P1 (10 points). Given the following truth table

w1	w2	w3	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

a. Implement the Boolean function f with a 4-to-1 multiplexer.
b. Implement the Boolean function f with using a 2-to-1 multiplexer.

P2 (20 points). Use Shannon's expansion theorem to factorize and implement the function $F(\text{w1}, \text{w2}, \text{w3}) = \sum m(0,1,6,7)$ using **<u>only</u>** 2-to-1 multiplexers for these conditions:

a. Use w1 as the select line for the top-level MUX (the one that outputs F).
b. Use w3 as the select line for the top-level MUX (the one that outputs F).

P3 (10 points). Use Shannon's expansion theorem to factorize and implement the function $F(\text{w1}, \text{w2}, \text{w3}, \text{w4}) = \sum m(0,1,3,5,6,9,12,13)$ with a 4-to-1 multiplexer given that:

a. The select lines are w1 and w2.
b. The select lines are w3 and w4.

P4 (10 points). Implement a 2-to-4 decoder with enable using 1-to-2 decoders with enable.

P5 (10 points). Draw the circuit diagram for a 3-to-8 decoder with enable (using only basic logic gates with any number of inputs).

P6 (10 points). Draw the truth table for a 1-to-4 demultiplexer.

P7 (10 points). Draw the circuit diagram for a 1-to-4 demultiplexer.

P8 (20points). Answer the following questions about decoders (with enable in all cases) and MUXes and draw a circuit diagram (label all inputs and outputs) for each subproblem:

a. How many 2-to-4 decoders are necessary to create a 4-to-16 decoder?
b. How many 3-to-8 decoders are necessary to create a 6-to-64 decoder?
c. How many 2-to-1 MUXes are necessary to create an 8-to-1 MUX?
d. How many 4-to-1 MUXes are necessary to create a 16-to-1 MUX?