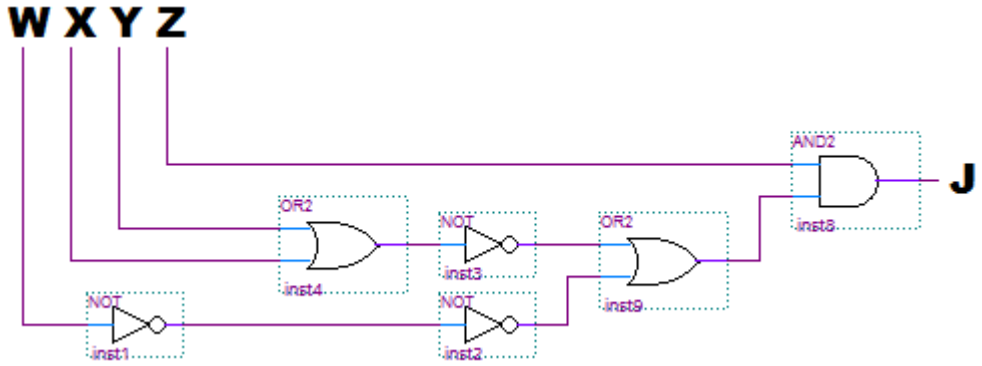
Cpr E 281 HW02
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Boolean Algebra/Circuit Synthesis
Assigned: Week 2
Due Date: Sep. 5, 2018

P1 (5 points): A given circuit takes V, a 7-bit binary number, divides V by 5, and stores the quotient and remainder into Q and R, respectively. (e.g. if V=13, then Q=2 and R=3).
A: How many bits are needed to represent all possible values of Q.
B: How many bits are needed to represent R.

P2 (5 points): For the circuit below, show the combinations of inputs that will yield the output J=1.



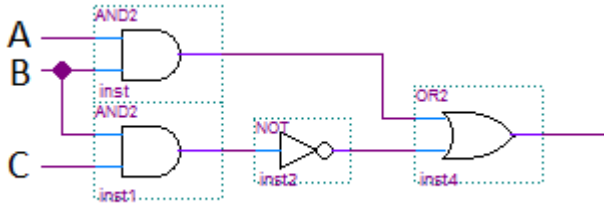
P3 (10 points): Using a Venn diagram, show that $\bar{x}\bar{y} \neq \overline{(xy)}$

P4 (10 points): Draw the circuit for the following expressions:
$X = \bar{a}\bar{b} + \overline{(cd)}$ $Y = a + b + \overline{(a + bc)} + abc$

P5 (20 points): Given the following expression $G = (A\bar{B} + C\bar{D})(\bar{A}C + B\bar{D})$:
A. Let the circuit cost be defined as the number of gates plus the number of gate inputs. Draw the circuit for G, then show that the cost of this circuit is 27. You may have to reuse a gate to reduce the cost; the circuit should be drawn appropriately to reflect the cost.
B. Use Boolean algebra to simplify the expression for G.
C. Draw the circuit for G and state the new cost of the circuit.

P6 (10 points): Use Boolean Algebra to simplify the following expressions:
A: $wx\bar{y}z + wx\bar{y}\bar{z} + wxy\bar{z} + wxyz + w\bar{x}y\bar{y}$
B: $(\bar{p} + \bar{q} + r)(\bar{q} + r + \bar{s})(\bar{p} + q + r)(\bar{q} + \bar{r} + \bar{s})$
C: $w + wx\bar{y} + wx\bar{z} + w\bar{x}y + w\bar{x}z$

P7 (10 points): For the circuit below,
A: show the truth table for the circuit and
B: prove that the output of the circuit matches the expression that follows:



$= a + b' + c'$

P8 (10 points): Given the following truth table for F, write the expression for F in canonical sum-of-products notation and in canonical product-of-sums notation.

L	M	N	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

P9 (10 points): Use DeMorgan's Theorem to determine the complement of each expression:
$A = wx + w\bar{y} + \bar{w}z + \bar{x}\bar{y} + \overline{xz} + \overline{\bar{y}z}$ $B = p + \bar{q}(\bar{r} + s\bar{v})$

P10 (10 points): Use Boolean Algebra to prove the following expressions as equivalent:
I: $(a+b)\overline{(a+c)} + \overline{(a+b+c)} = \overline{a+c}$
II: $w\bar{x} + wxy + \bar{w} + \bar{w}\overline{(xy)} = \bar{w} + \bar{x} + y$
III: $\overline{(pr + \bar{p}r)} + \bar{q}(\bar{p}r + pr) + qr = 1$