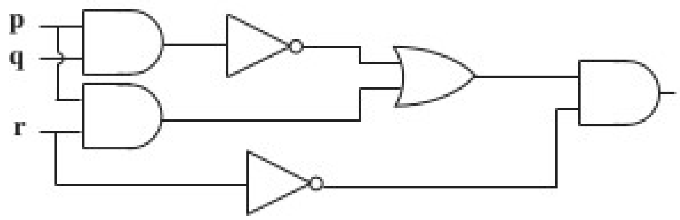
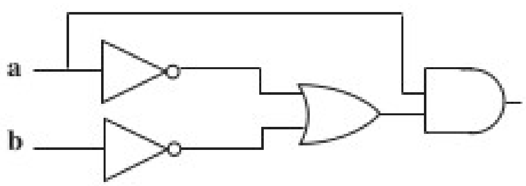
Review Questions for Test #2

For the following logic circuits, determine the final output, reduce the final output expression algebraically to a simpler form, draw the simplified logic diagram, verify the 2 algebraic expressions are equivalant to one another using the truth table.

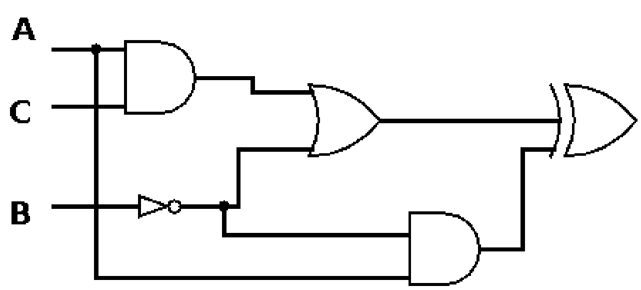
1.



2.



3.



Use De Morgan's theorem and the reference table to simplify the following Boolean expressions

4. $\overline{\overline{(AB)}\,\overline{(C+D)}}$

5. $\overline{A+B(C+\overline{A}\,B)}$

6. $\overline{(\overline{A}B)(\overline{C}\,B+A)}$

7. $\overline{\overline{A}+B(C+\overline{D})+FG}$

Simplify the following Boolean expressions using the algebraic properties and reference table

8. $AB+A(B+C)+B(B+C)$

9. $\overline{C}(D+AB)+\overline{A}B(CD+A)+A(BC+A)$

10. $(B+A)(AC+B)+BC(\overline{A}+BC)+AB(\overline{C}+B)$

11. $(PQ)\oplus(P+RQ)$

MAT8002

Answers to Test #2 Review Questions

1. $(\overline{P}+\overline{Q})\overline{R} \;=\; \overline{P}\,\overline{R}+\overline{Q}\,\overline{R}$

2. $A\overline{B}$

3. $(AC+\overline{B})\oplus(A\overline{B})$ reduces to $ABC+\overline{A}\,\overline{B}$

4. $AB+C+D$

5. $\overline{A}\,\overline{B}$

6. $A+\overline{A}C+\overline{B} \;=\; A+\overline{B}+C$

7. $A[\overline{B}+\overline{C}D][\overline{F}+\overline{G}] \;=\; A(\overline{B}+\overline{C})(D+\overline{B})(\overline{F}+\overline{G})$

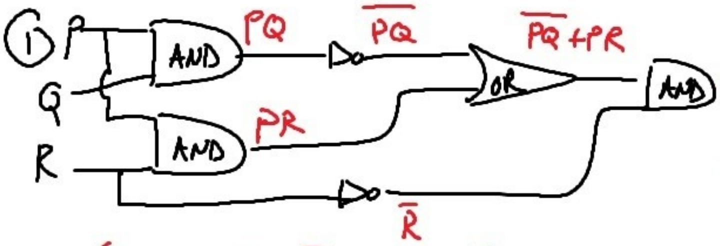
8. $B+AC$

9. $A+\overline{A}BCD+\overline{C}D \;=\; A+(B+\overline{C})D$

10. $AC+B$

11. $\overline{P}RQ+\overline{Q}P$

1



$(\overline{PQ}+PR)\bar R$

$\downarrow$ 13b

$(\bar P+\bar Q+PR)\bar R$ $\downarrow$ 12a

$\bar P\bar R + \bar Q\bar R + PR\bar R$ $\downarrow$ 8a

$\bar P\bar R + \bar Q\bar R$ $\quad \cancel{P\,0}$

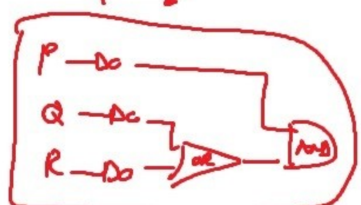
$\bar R(\bar P+\bar Q)$

Is $(\overline{PQ}+PR)\bar R = \bar R(\bar P+\bar Q)$?

correct

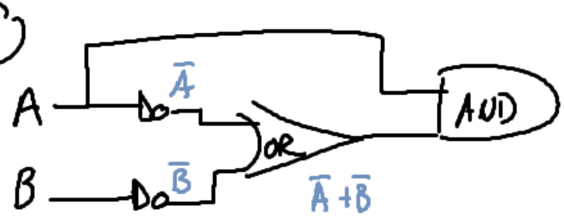
match

P	Q	R	$\bar P$	$\bar Q$	$\bar R$	PQ	$\overline{PQ}$	PR	$\overline{PQ}+PR$	$(\overline{PQ}+PR)\bar R$	$\bar P+\bar Q$	$(\bar P+\bar Q)\bar R$
0	0	0	1	1	1	0	1	0	1	1	1	1
0	0	1	1	1	0	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1	0	1	1	1	1
0	1	1	1	0	0	0	1	0	1	0	1	0
1	0	0	0	1	1	0	1	0	1	1	1	1
1	0	1	0	1	0	0	1	1	1	0	1	0
1	1	0	0	0	1	1	0	0	0	0	0	0
1	1	1	0	0	0	1	0	1	1	0	0	0



simplified circuit

2



$(\bar{A}+\bar{B})\,A$

$A(\bar{A}+\bar{B})$

$\downarrow$ 12b

$A\bar{A} + A\bar{B}$

$\downarrow$ 8a

$0 + A\bar{B}$

$\boxed{A\bar{B}}$

simplified circuit

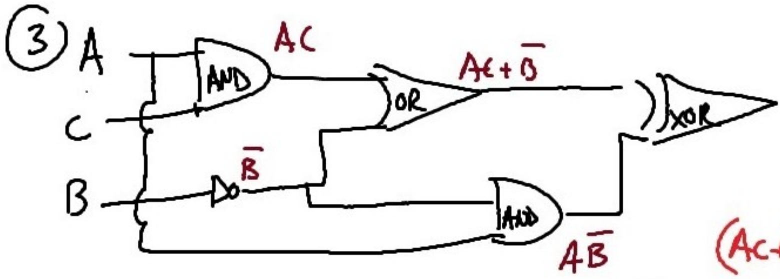
Is $A(\bar{A}+\bar{B}) = A\bar{B}$?

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$	$A(\bar{A}+\bar{B})$	$A\bar{B}$
0	0	1	1	1	0	0
0	1	1	0	1	0	0
1	0	0	1	1	1	1
1	1	0	0	0	0	0

match $\therefore$

correct

(3)



$(AC+\bar B)\oplus(A\bar B)$

A B

$\boxed{A\oplus B = A\bar B + \bar A B \quad 19b}$

19b

$(AC+\bar B)(\overline{A\bar B}) + (\overline{AC+\bar B})(A\bar B)$

13b 13a

$(AC+\bar B)(\bar A+\bar{\bar B}) + [(\overline{AC})\bar{\bar B}](A\bar B)$

13b

FOIL

12a

$(AC+\bar B)(\bar A+B) + [(\bar A+\bar C)B](A\bar B)$ 12a

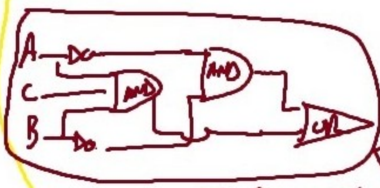
$\bar A AC + ABC + \bar A\bar B + B\bar B + [\bar A B + B\bar C][A\bar B]$

8a 8a 12a

$\cancel{0\cdot C} + ABC + \bar A\bar B + 0 + \bar A A B\bar B + A\bar B B\bar C$

8a 8a

Is $(AC+\bar B)\oplus(A\bar B) = ABC+\bar A\bar B$?



simplified circuit

$\boxed{ABC+\bar A\bar B}$ $0\cdot 0 + \cancel{A\cdot 0\cdot\bar C}$

correct

match

A	B	C	$\bar A$	$\bar B$	AC	AC+$\bar B$	A$\bar B$	AC+$\bar B$ $\oplus$ A$\bar B$	ABC	$\bar A\bar B$	ABC + $\bar A\bar B$
0	0	0	1	1	0	1	0	1	0	1	1
0	0	1	1	1	0	1	0	1	0	1	1
0	1	0	1	0	0	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0	0
1	0	0	0	1	0	1	1	0	0	0	0
1	0	1	0	1	1	1	1	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	1	1	0	1	1	0	1

④ $\overline{(\overline{AB})(\overline{C+D})}$

$\downarrow$ 13b

$(\overline{\overline{AB}}) + (\overline{\overline{C+D}})$

$\downarrow$ 9a $\downarrow$

$\boxed{AB + C + D}$

⑤ $\overline{A + B(C + \bar{A}B)}$

$\downarrow$ 12a

$\overline{A + BC + \bar{A}BB}$

$\downarrow$ 6a

$\overline{A + BC + \bar{A}B}$

13b $\downarrow$

$(\bar{A})(\overline{BC})(\overline{\bar{A}B})$

$\downarrow$ 13a $\downarrow$

$\bar{A}(\bar{B} + \bar{C})(\bar{\bar{A}} + \bar{B})$

$\downarrow$ 9a

$\bar{A}(\bar{B} + \bar{C})(A + \bar{B})$

$\to (\bar{A}\bar{B} + \bar{A}\bar{C})(A + \bar{B})$

$\downarrow$ FOIL

$(\bar{A}A\bar{B} + \bar{A}\bar{B}\bar{B} + \bar{A}A\bar{C} + \bar{A}\bar{B}\bar{C})$

$\downarrow$ 8a $\downarrow$ 8a

$\cancel{0 \cdot \bar{B}} + \bar{A}\bar{B} + \cancel{0 \cdot \bar{C}} + \bar{A}\bar{B}\bar{C}$

$\bar{A}\bar{B} + \bar{A}\bar{B}\bar{C}$

$\downarrow$ factoring

$\bar{A}\bar{B}(1 + \bar{C})$

$\downarrow$ 5b

$\bar{A}\bar{B}\,(1) \to \boxed{\bar{A}\bar{B}}$

(6) $\overline{(\bar{A}B)(\bar{C}B + A)}$

12a

$\overline{\bar{A}BB\bar{C} + \bar{A}AB}$

6a 8a

$\bar{A}B\bar{C} + \cancel{0 \cdot B}$

$\overline{\bar{A}B\bar{C}}$

13b

$\bar{\bar{A}} + \bar{B} + \bar{\bar{C}}$

9a

$\boxed{A + \bar{B} + C}$

(7) $\overline{\bar{A} + B(C+\bar{D}) + FG}$

12a

$\overline{\bar{A} + BC + B\bar{D} + FG}$

13a

$(\bar{\bar{A}})(\overline{BC})(\overline{B\bar{D}})(\overline{FG})$

9a 13b 13b

$(A)(\bar{B}+\bar{C})(\bar{B}+\bar{\bar{D}})(\bar{F}+\bar{G})$

9a

$A(\bar{B}+\bar{C})(\bar{B}+D)(\bar{F}+\bar{G})$

$(\bar{B}+\bar{C})(\bar{B}+D)(\bar{F}+\bar{G})A$

FOIL

$(\bar{B}\bar{B}+\bar{B}D+\bar{B}\bar{C}+\bar{C}D)(\bar{F}+\bar{G})A$

6a

$(\bar{B}+\bar{B}D+\bar{B}\bar{C}+\bar{C}D)(\bar{F}+\bar{G})A$

factoring 6

$\{\bar{B}[1+D+\bar{C}]+\bar{C}D\}(\bar{F}+\bar{G})A$

5b

$\{\bar{B}[1]+\bar{C}D\}(\bar{F}+\bar{G})A \rightarrow \boxed{(\bar{B}+\bar{C}D)(\bar{F}+\bar{G})A}$

(8) $AB + A(B+C) + B(B+C)$

12a

$$\underbrace{AB + AB}_{6b} + AC + \underbrace{BB}_{6a} + BC$$

$$AB + AC + B + BC$$

$$AC + AB + B + BC$$

factoring

$$AC + (A + 1 + C)B$$

5b

$$AC + (1)B$$

$$\boxed{AC + B}$$

9) $\bar{C}(D+AB)+\bar{A}B(CD+A)+A(BC+A)$

12a 12a

$(\bar{C}D+AB\bar{C})+(\bar{A}BCD+A\bar{A}B)+(ABC+AA)$

8a 6a

$\bar{C}D+AB\bar{C}+\bar{A}BCD+0\cdot B+ABC+A$

$\bar{C}D+\bar{A}BCD+AB\bar{C}+ABC+A$

factoring

$\bar{C}D+\bar{A}BCD+(B\bar{C}+BC+1)A$

5b

$\bar{C}D+\bar{A}BCD+(1)A$

$\bar{C}D+\bar{A}BCD+A$

$\boxed{A+BC=(A+B)(A+C) \quad 12b}$

absorption via 12b

$\bar{C}D+(\bar{A}+A)(A+BCD)$

8b

$\bar{C}D+(1)(A+BCD)$

$A+\bar{C}D+BCD$

factoring

$A+(\bar{C}+BC)D$

absorption via 12b

$A+[(\bar{C}+B)(\bar{C}+C)]D$

8b

$A+[(\bar{C}+B)(1)]D$

$\boxed{A+(\bar{C}+B)D}$

$$10)\ \underbrace{(B+A)(AC+B)}_{\text{FOIL}} + BC(\bar{A} + BC) + AB(\bar{C} + B)$$

12a 12a

$$(ABC + BB + AAC + AB) + (\bar{A}BC + BBCC) + (AB\bar{C} + ABB)$$

$$ABC + B + AC + AB + \bar{A}BC + BC + AB\bar{C} + AB$$

$$ABC + B + AB + \bar{A}BC + BC + AB\bar{C} + AB + AC$$

factoring

$$B(AC + 1 + A + \bar{A}C + C + A\bar{C} + A) + AC$$

5b

$$B(1) + AC \longrightarrow \boxed{B + AC}$$

(11) $\underbrace{PQ}_{A} \oplus \underbrace{(P + RQ)}_{B}$ 19b

$$\boxed{A \oplus B = A\overline{B} + \overline{A}B \quad 19b}$$

$$(PQ)(\overline{P+RQ}) + (\overline{PQ})(P+RQ)$$

13a 13b

$$(PQ)[\overline{P}(\overline{RQ})] + (\overline{P}+\overline{Q})[P+RQ]$$

13b

$$(PQ)[\overline{P}(\overline{R}+\overline{Q})] + (\overline{P}+\overline{Q})(P+RQ)$$ FOIL

12a

$$PQ(\overline{P}\,\overline{R} + \overline{P}\,\overline{Q}) + (\overline{P}P + \overline{P}RQ + P\overline{Q} + RQ\overline{Q})$$

12a 8a 8a

$$P\overline{P}\,\overline{R}Q + P\overline{P}Q\overline{Q} + 0 + \overline{P}RQ + P\overline{Q} + \cancel{R0}$$

8a 8a

$$\cancel{0\cdot\overline{R}Q} + \cancel{0\cdot 0} + \boxed{\overline{P}RQ + P\overline{Q}}$$