Unit 3 Part 1: Boolean Logic and Logic Circuits
STUDY GUIDE

1. Define, write the mathematical notation, and give an example of each of the following.

Logically Equivalent:

Two statements that produce the same truth table ⟷

Tautology:

All outputs are true regardless of inputs. A statement that always evaluates the true. $p \vee \sim p$ | Anti-taut. $p \wedge \sim p$

Inverse:

if $s \to t$, then $\sim s \to \sim t$ / negation of if then

Converse:

(O-together/ $t \to s$ / switch if, then

Contrapositive:

$\sim t \to \sim s$

2. Fill in the following truth table.

p	q	$p \wedge q$	$q \to p$	$\sim(q \to p)$	$(p \wedge q) \leftrightarrow \sim(q \to p)$
T	T	T	T	F	F
T	F	F	T	F	T
F	T	F	F	T	F
F	F	F	T	F	T

3. Construct a truth table for $(p \leftrightarrow q) \vee (p \to (\sim q))$

p	q	$\sim q$	$p \to \sim q$	$p \leftrightarrow q$	$(p \leftrightarrow q) \vee (p \to (\sim q))$
T	T	F	F	T	T
T	F	T	T	F	T
F	T	F	T	F	T
F	F	T	T	T	T

(tautology)

4. State the eight logical equivalences presented in class.

$p \to q \iff \sim p \vee q$

$p \leftrightarrow q \iff \sim(p \otimes q)$

$\sim(p \wedge p) \iff \sim p$

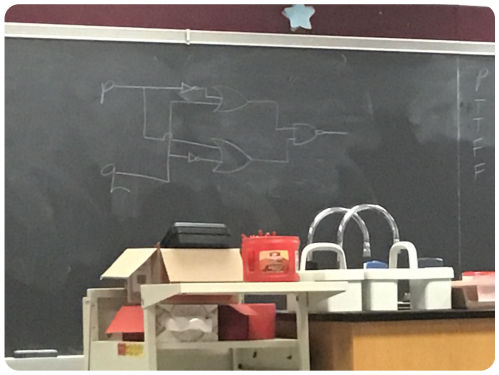
$\sim(p \vee q) \iff \sim p \wedge \sim q$

$p \to q \iff \sim q \to \sim p$ (Conditional / Contrapositive)

$\sim p \to \sim q \iff q \to p$ (Inverse / Converse)

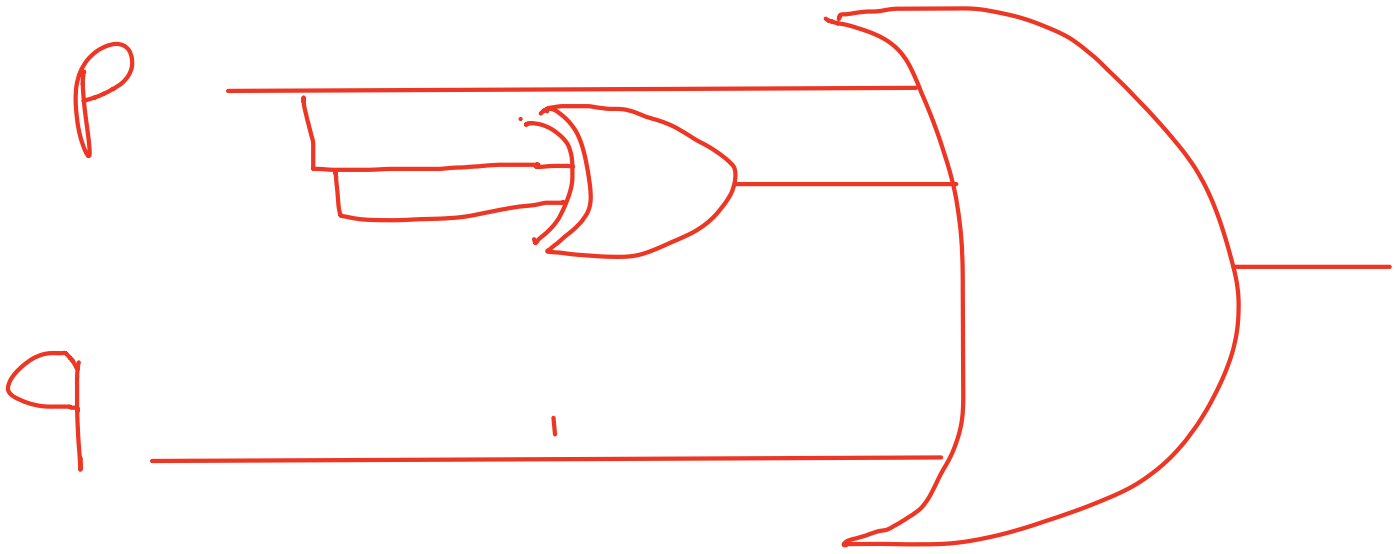
$\sim(\sim p) \iff p$

5. Draw a circuit diagram for $\sim\big((\sim p \vee q) \wedge (p \vee \sim q)\big)$. Start at end

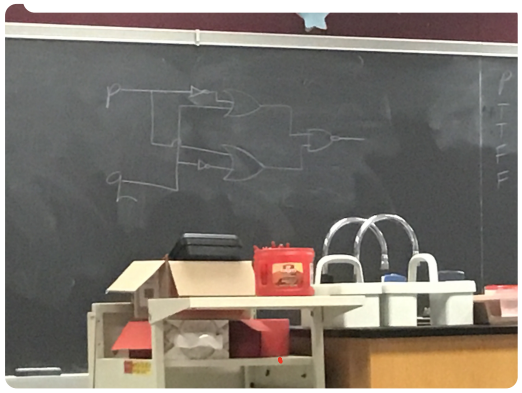


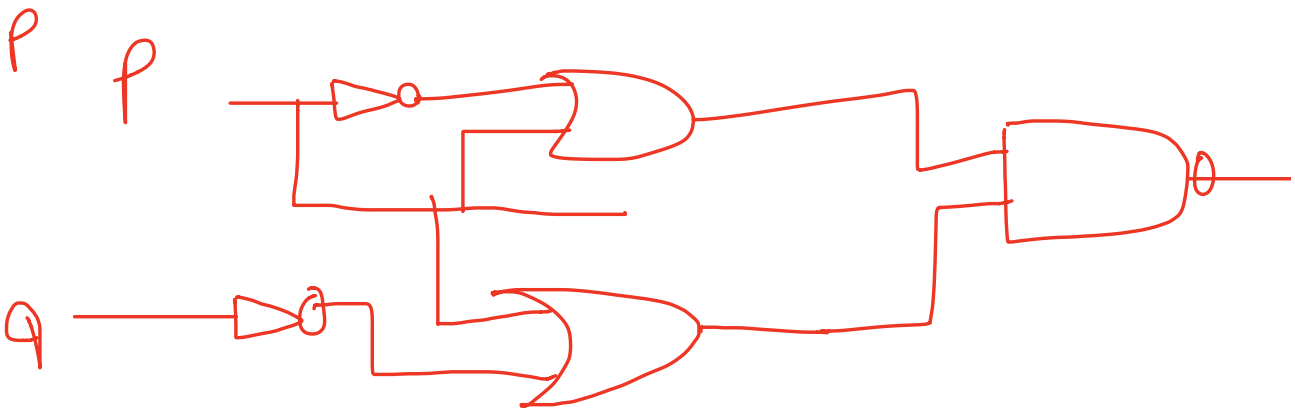
6. Rewrite the statement to eliminate the use of the biconditional and then draw a circuit diagram for $(p \vee q) \leftrightarrow \sim p$.

$\sim((p \vee q) \otimes \sim p)$

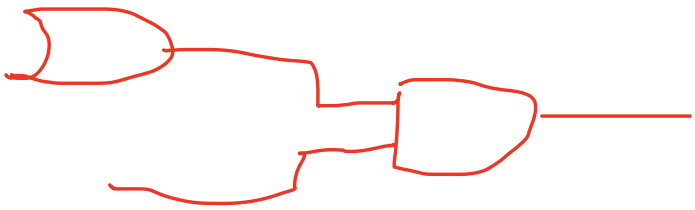


5. $\sim((\sim p \vee q) \wedge (p \vee \sim q))$.





$\sim((\sim p \vee q) \wedge (p \vee \sim q))$.



$S \to t \Leftrightarrow \sim S \vee t$

$\sim q \quad \sim p$

$\sim q \to \sim p$

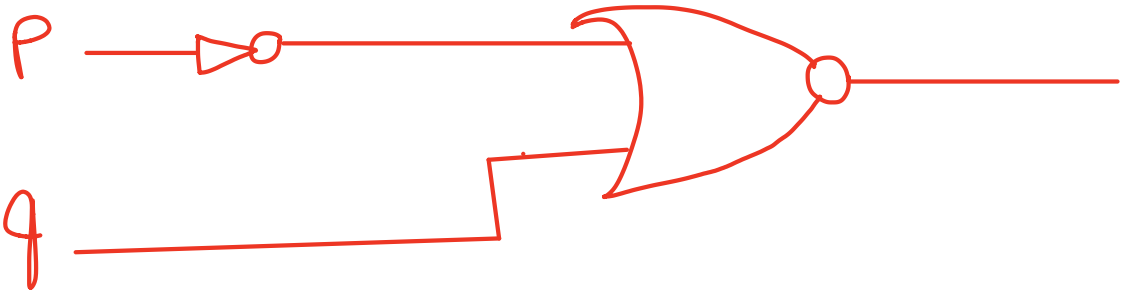
7. Simplify $\sim(\sim q \to (\sim p))$ using logical equivalences and then draw a circuit diagram of the simplified statement.

F	F	T	F
T	F	F	T
F	T	T	F
T	T	T	f

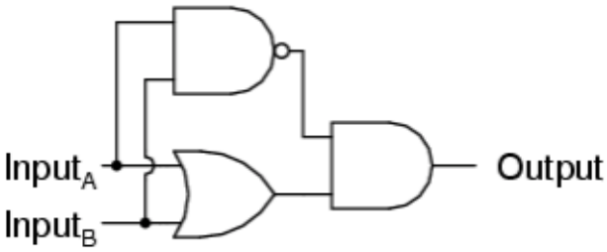
$p \to q \Leftrightarrow \sim p \vee q$

Simplified statement: $\sim(q \vee \sim p)$

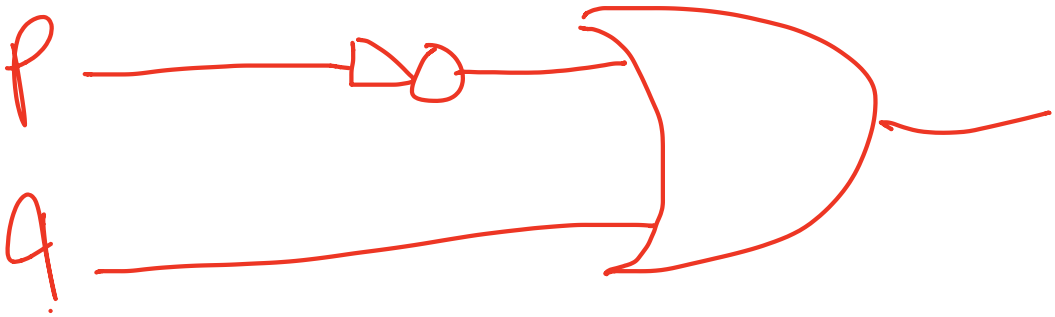
Circuit Diagram:



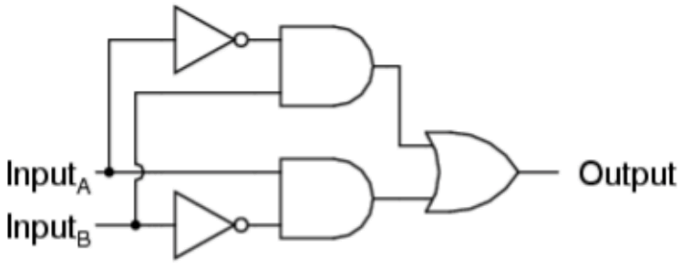
8. Write a logic statement for the following circuit diagram.



$(A \leftrightarrow B) \wedge (A \vee B)$



9. Use this circuit diagram to answer the following questions.



a. Write the logic statement the circuit represents.

$(\sim a \wedge b) \wedge (\sim b \wedge a)$

b. Create a truth table for the statement.

a	b	$\sim a$	$\sim b$	$\sim a \wedge b$	$\sim b \wedge a$	$(\sim a \wedge b) \wedge (\sim b \wedge a)$
t	t	f	f	f	f	f
t	f	f	t	f	t	f
f	t	t	f	t	f	f
f	f	t	t	f	f	t

c. Find a simpler statement that is logically equivalent to the statement in part a.

$\sim(p \vee q)$

d. Draw a circuit diagram of the statement in part c.