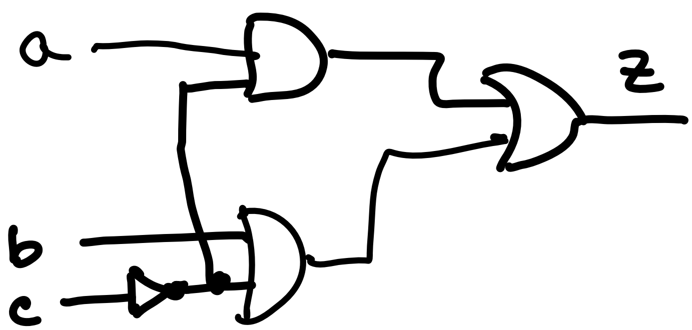
On my honor, I have not given, nor received, nor witnessed any unauthorized assistance on this work.

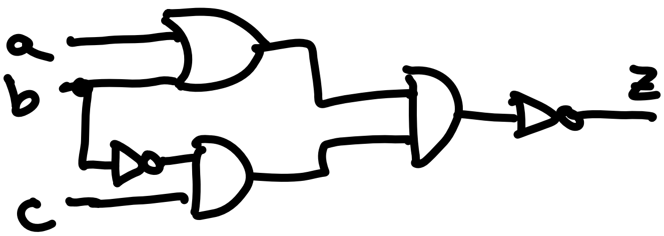
Print name and sign: ______________________________

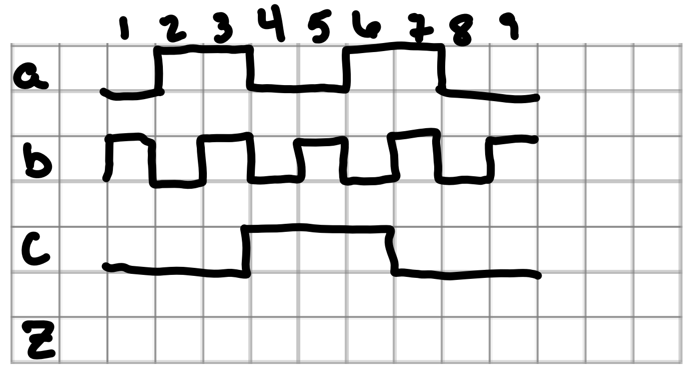
Question:	1	2	3	4	Total
Points:	5	5	12	8	30
Score:					

1. (5 points) Convert the following circuit to universal NAND gates. You do not need to reduce the circuit.



2. (5 points) Give the output timing diagram for the following circuit given the timing diagrams for the inputs





3. Draw the circuit for the following. You do not need to reduce the circuit.

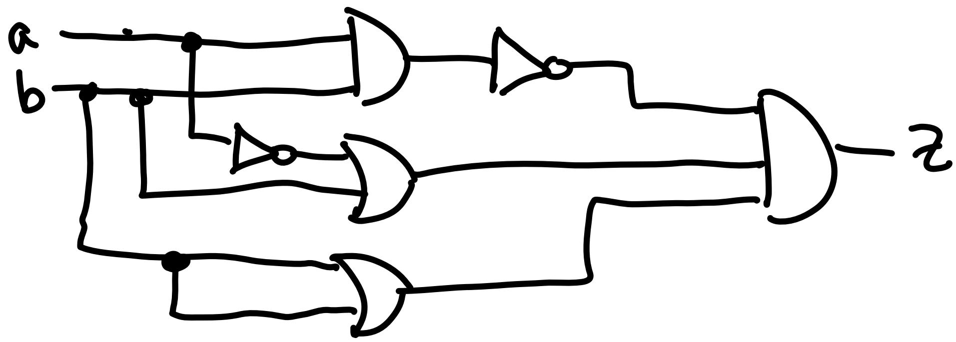
(a) (6 points) for the truth table

a	b	c	z
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

c

(b) (6 points) the propositional logic statement $\neg(a \vee b \vee c) \wedge ((\neg c \wedge b) \vee \neg(a \wedge b)$

4. (8 points) Reduce the following circuit. *Hint: my answer has 2 gates in it.*



Reference Page:

Identity Laws:	$p \wedge T \equiv p$ $p \vee F \equiv p$
Domination Laws:	$p \vee T \equiv T$ $p \wedge F \equiv F$
Idempotent Laws:	$p \vee p \equiv p$ $p \wedge p \equiv p$
Double negation Law:	$\neg(\neg p) \equiv p$
Commutative Laws:	$p \vee q \equiv q \vee p$ $p \wedge q \equiv q \wedge p$
Associative Laws:	$(p \vee q) \vee r \equiv p \vee (q \vee r)$ $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$
Distributive Laws:	$p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$ $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$
DeMorgan's Laws:	$\neg(p \wedge q) \equiv \neg p \vee \neg q$ $\neg(p \vee q) \equiv \neg p \wedge \neg q$
Absorption Laws:	$p \vee (p \wedge q) \equiv p$ $p \wedge (p \vee q) \equiv p$
Negation Laws:	$p \vee \neg p \equiv T$ $p \wedge \neg p \equiv F$