CECS 228: HOMEWORK 1

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5 (c , d)

What is the negation of each of these propositions.

a. Mei has an MP3 player.
b. There is no pollution in New Jersey.
c. 2 + 1 = 3.
d. The summer in Maine is hot and sunny.

Solution:

a.
b.
c. $2 + 1 \neq 3$
d. The summer in Maine is not hot and sunny.

11

Let p and q be the propositions "Swimming at the New Jersey shore is allowed" and "Sharks have been spotted near the shore." respectively. Express each of these compound propositions as an English sentence.

a. $\neg q$
b. $p \wedge q$
c. $\neg p \wedge q$
d. $p \rightarrow \neg q$
e. $\neg q \rightarrow p$
f. $\neg p \rightarrow \neg q$
g. $p \leftrightarrow \neg q$
h. $\neg p \wedge (p \vee \neg q)$

Solution:

a. Sharks have not been spotted near the shore.
b. Swimming at the New Jersey shore is allowed and sharks have been spotted near the shore.
c. Swimming at the New Jersey shore is not allowed and sharks have been spotted near the shore.
d. If swimming at the New Jersey shore is allowed, then sharks have not been spotted near the shore.

e. If sharks have not been spotted near the shore, the swimming at the New Jersey shore is allowed.
f. If swimming at the New Jersey shore is not allowed, then sharks have not been spotted by the shore.
g. Swimming at the New Jersey shore is allowed if and only sharks have not been spotted by the shore.
h. Swimming at the New Jersey shore is not allowed, and either swimming at the New Jersey shore is allowed or sharks have not been spotted near the shore.

13

Let p and q be the proportions

p: It is below freezing and snowing.

q: It is snowing.

Write these propositions using p and q and logical connectives (including negations).

a. It is below freezing and snowing.
b. It is below freezing but not snowing.
c. It is not below freezing and it is not snowing.
d. It is either snowing or below freezing. (or both)
e. If it is below freezing, it is also snowing.
f. Either it is below freezing or it is snowing, but it is not snowing if it is below freezing.
g. That it is below freezing is necessary and sufficient for it to be snowing.

Solution:

a. $p \land q$
b. $p \land \neg q$
c. $\neg p \land \neg q$
d. $p \lor q$
e. $p \to q$
f. $(p \lor q) \land (p \to \neg q)$
g. $p \leftrightarrow q$

27

Write each of these propositions in the form “p if and only if q” in English.

a. If it is hot outside you buy an ice cream cone, and if you buy an ice cream cone it is hot outside.
b. For you to win the contest it is necessary and sufficient that you have the only winning ticket.

c. You get promoted only if you have connections, and you have connections only if you get promoted.
d. If you watch television your mind will decay, and conversely.
e. The trains run late on exactly those days when I take it.

Solution:

a. You buy an ice cream cone if and only if it is hot outside.
b. You win the contest if and only id you hold the only winning ticket.
c. You get promoted if and only if you have connections..
d. Your mind will decay if and only if you watch television.
e. The train runs late if and only if it is a day I take the train.

39 (b , d , f)

Construct a truth table for each of these compound propositions.

a.
b. $\neg p \rightarrow (q \rightarrow r)$
c.
d. $(p \rightarrow q) \wedge (\neg p \rightarrow r)$
e.
f. $(\neg p \leftrightarrow \neg q) \leftrightarrow (q \leftrightarrow r)$
g.

Solution:

a.
b.

p	q	r	$\neg p$	$q \rightarrow r$	$\neg p \rightarrow (q \rightarrow r)$
T	T	T	F	T	T
T	T	F	F	F	T
T	F	T	F	T	T
T	F	F	F	T	T
F	T	T	T	T	T
F	T	F	T	F	F
F	F	T	T	T	T
F	F	F	T	T	T

c.

d.

p	q	r	¬p	p→q	(¬p→ r)	(p→ q) ∧ (¬p→ r)
T	T	T	F	T	T	T
T	T	F	F	T	T	T
T	F	T	F	F	T	F
T	F	F	F	F	T	F
F	T	T	T	T	T	T
F	T	F	T	T	F	F
F	F	T	T	T	T	T
F	F	F	T	T	F	F

e.

f.

p	q	r	¬p	¬q	¬p↔¬q	q↔ r	(¬p ↔ ¬q) ↔ (q ↔ r)
T	T	T	F	F	T	T	T
T	T	F	F	F	T	F	F
T	F	T	F	T	F	F	T
T	F	F	F	T	F	T	F
F	T	T	T	F	F	T	F
F	T	F	T	F	F	F	T

F	F	T	T	T	T	F	F
F	F	F	T	T	T	T	T

g.

46

What is the value of x after each of these statements is encountered in a computer program, if x = 1 before the statement is reached?

a. **If** x+2 =3 **then** x:= x+1

b. **If** (x+1 = 3) OR (2x +2 = 3) **then** x:= x+1

c. **If** (2x + 3 =5) AND (3x +4 = 7) **then** x:= x+1

d. **If** (x+1 =2)XOR (x+2 =3) **then** x:=x+1

e. **If** x<2 **then** x=:x+1

Solution:

a. x= 2

b. x= 1

c. x=2

d. x=1

e. x=2

47 (b , d)

Find the bitwise OR, bitwise AND, and bitwise XOR of each of these pairs of bit strings.

a. 101 1110, 010 0001
b. 1111 0000, 1010 1010
c. 00 0111 0001, 10 0100 1000
d. 11 1111 1111, 00 0000 0000

Solution:

a. Bitwise OR: 111 1111; Bitwise AND: 000 0000; bitwise XOR: 111 1111;

b. Bitwise OR: 1111 1010; Bitwise AND: 1010 0000; bitwise XOR: 0101 1010;

c. Bitwise OR: 10 0111 1001; Bitwise AND: 00 0100 0000; bitwise XOR:10 0011 1001

d. Bitwise OR:11 1111 1111; Bitwise AND: 00 0000 0000; bitwise XOR: 11 1111 1111

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7

Express these systems specifications using the propositions p: “The message is scanned for viruses” and q: “The message was sent from an unknown system” together with logical connectives (including negations).

a. “The message is scanned for viruses whenever the message was sent from an unknown system.”
b. “The message was sent from an unknown system but it was not scanned for viruses.”
c. “It is necessary to scan the message for viruses whenever it was sent from an unknown system.”
d. “When a message is not sent from an unknown system it is not scanned for viruses.”

Solution:

a. $q \rightarrow p$
b. $q \wedge \neg p$
c. $q \rightarrow p$
d. $\neg q \rightarrow \neg p$

9

Are these systems specifications consistent? “The system is in multiuser state if and only if it is operating normally.If the system is operating normally, the kernel is functioning. The kernel is not functioning or the system is in interrupt mode.If the system in not in multiuser state, then it is in interrupt mode. The system is not in interrupt mode.”

Solution:

a: “The system is in multiuser state”

b: “The system is operating normally”

c: “The kernel is functioning

d: “They system is in interrupt mode

We want to make these expressions true:

$a \leftrightarrow b$, $b \rightarrow c$, $\neg c \vee d$, $\neg a \rightarrow d$, $\neg d$

To make to make these statements true, *d* must be false, and in order for $\neg a \rightarrow d$ to be true when *d* is false, the hypothesis $\neg a$ must be false, so *a* must be true. Because we want $a \leftrightarrow b$ to be true, then *b* must also be true. We also want $b \rightarrow c$ to be true, so we must have *c* true. But if *c* is true and *d* is false, then $\neg c \vee d$ is false. This means the system is inconsistent.

11

Are these system specifications consistent? "The router can send packets to the edge system only if it supports the new address space. For the router to support the new address space it is necessary that the latest software release be installed. The router can send packets to the edge system if the latest software release is installed. The router does not support the new address space."

Solution:

s : "The router can send packets to the edge system"

a:"The router supports the new address space"

r: "The latest software release is installed."

Our propositions:

$s \to a, \; a \to r, \; r \to s, \; \neg a$

a is false therefore, the second proposition indicates that *s* must be false as well. Moving on to the third proposition, since *s* is false, then *r* must also be false. Since *a* is false then the fourth proposition is true, making all four propositions true, so yes the system specifications are consistent.

19

Each inhabitant of a remote village always tells the truth or always lies. A villager will give only a "Yes" or a "No" response to a question a tourist asks. Suppose you are a tourist visiting this area and come to a fork in the road. One branch leads to the ruins you want to visit; the other branch leads deep into the jungle. A villager is standing at the fork in the road.What one question can you ask the villager to determine which branch to take?

Solution:

If I ask the question "If I were to ask you if the right branch leads to the ruins, would you say yes?" If the villager is a truth teller, then he will reply "yes" if and only if the right branch leads to the ruins. If the villager is a liar and the right branch leads to the ruins, then he would say "no" indicating that he actually means "Yes". Now if we ask "if the right path leads into the jungle", then the villager that is a truth teller would say "No" and the lying villager would say "yes" meaning that the answer is no.

23

A says "At least one of us is a knave" and B says nothing.

Solution:

If A is a knight then, B is a knave. But if A is a knave then his statement that “at least on of them is a knave” is false, indicating that both would be a knights.But this doesn’t make sense so it is most likely that A is a knight and B is a knave.

37

Steve would like to determine the relative salaries of three coworkers using two facts. First, he knows that if Fred is not the highest paid of the three,then Janice is. Second, he knows that if Janice is not the lowest paid, then Maggie is paid the most. Is it possible to determine the relative salaries of Fred, Maggie, and Janice from what steve knows? If so, who is paid the most and who the least? Explain your reasoning?

Solution:

If we assume that Fred is not the highest paid, then Janice becomes the highest paid. And if Jaince is the highest paid person then she is not the lowest paid person. By the information that steve gave then Maggie becomes the highest paid, but that is a contradiction.So then we know that Fred is the highest paid person. If we assume that Janice is not the lowest paid, then according to our facts Maggie becomes the highest paid, but that contradicts the fact that Fred is the highest paid, and because of this we know that Janice is the lowest paid. The only way to have a consistent set of facts without them contradicting is when Fred is paid the highest, followed by Maggie, and then Janice being paid the least.

39

A detective has interviewed four witness to a crime.From the stories of the witness the detective has concluded that if the butler is telling the truth then so is the cook; the cook and the gardener cannot both be telling the truth; the gardner and the handyman are not both lying; and if the handyman is telling the truth then the cook is lying.For each four witness, can the detective determine whether that person is telling the truth or lying? Explain your reasoning.

Solution:

B: Butler

C: Cook

G: Gardner

H: Handyman

Our propositions:

$B \to C$, $\neg C \vee \neg G$, $G \vee H$, $H \to \neg C$

If B is true, then according to our first proposition, then C must also be true. Using the second proposition, G must be false. The third proposition makes H true, but then the fourth proposition is false which violates the proposition. So therefore B cannot be true, which makes C not true as well. Because of this we now know that the butler and the cook are lying and the either the gardner or the handyman could be lying or telling the truth.

41

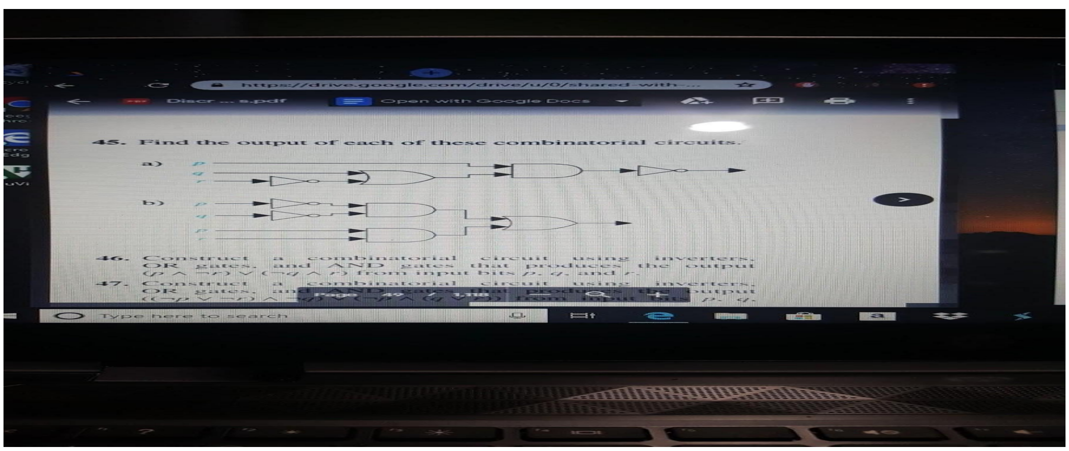
Suppose there are signs on the doors to two rooms. The sign on the first door reads “In this room there is a lady, and in the other one there is a tiger”; and the sign on the second door reads “In one of the these rooms, there is a lady, and in one of there is a tiger.” Suppose that you know that one of these signs is true and the other is false. Behind which door is the lady?

Solution:

The second sign is true and the first is false, because if the first sign were true, then the second sign would also be true, we can’t have one false sign and one true sign. So the second sign is true and there is a tiger in the first room and a lady in the second room.

45

Find the output of each of these combinatorial circuits.



Solution:

a. $\neg(p \land (q \lor \neg r))$
b. $((\neg p) \land (\neg q)) \lor (p \land r)$

PAGE 38: 11(e , f), 13(e , f), 65

11 (e,f)

Show that each of these conditional statements is a tautology by using truth tables.

a. 1
b. 2
c. 3
d. 4
e. ¬(p□ q)□ p
f. ¬ (p □q)□ ¬q

Solution:

a.
b.
c.
d.
e.

p	q	(p□ q)	¬(p□ q)	¬(p□ q)□ p
T	T	T	F	T
T	F	F	T	T
F	T	T	F	T
F	F	T	F	T

f.

p	q	¬q	(p □q)	¬ (p □q)	¬ (p □q)□ ¬q
T	T	F	T	F	T
T	F	T	F	T	T
F	T	F	T	F	T
F	F	T	T	F	T

13 (e,f)

Show that each conditional statement is exercise 11 is a tautology using the fact that a conditional statement is false exactly when the hypothesis is true and the conclusion is false. (Don't use truth tables)

a.
b.
c.
d.
e. $\neg(p \rightarrow q) \rightarrow p$
f. $\neg(p \rightarrow q) \rightarrow \neg q$

Solution:

a.
b.
c.
d.
e. If this statement were false $\neg(p \rightarrow q)$ would have to be true and p would have to be false. However, if p = F, then $\neg(p \rightarrow q)$ has to be false, making the entire statement FF, which is true.
f. This statement would be false if $\neg q$ =F, making q = T, and $\neg(p \rightarrow q)$ =T. However, for $\neg(p \rightarrow q)$ to be true, q must be false.Therefore, this entire statement has to always be true.

65

Determine whether each of these compound propositions is satisfiable.

a. $(p \vee \neg q) \wedge (\neg p \vee q) \wedge (\neg p \vee \neg q)$
b. (p □ q)∧ (p□ ¬q)∧ (¬p□ q) ∧ (¬p□ ¬q)
c. $(p \leftrightarrow q) \wedge (\neg p \leftrightarrow q)$

Solution:

a. $(p \vee \neg q) \wedge (\neg p \vee q) \wedge (\neg p \vee \neg q)$

   assuming p = T and q =F:

   $(p \vee \neg q)$= T

   $(\neg p \vee q)$ = T

   $(\neg p \vee \neg q)$ = T

   T ^T^T = T

$(p\ q) = T$ if $q = T$

These compositions are satisfiable.

b. $(p \rightarrow q) \wedge (p \rightarrow \neg q) \wedge (\neg p \rightarrow q) \wedge (\neg p \rightarrow \neg q)$

Assuming $p=T$;

$(p \rightarrow q) = T$ if $q = T$

$(p \rightarrow \neg q) = F$

$(\neg p \rightarrow q) = T$

$(\neg p \rightarrow \neg q) = T$

T^F^T^T=F

These compound propositions are not satisfiable.

c. $(p \leftrightarrow q) \wedge (\neg p \leftrightarrow q)$

Assuming $p = T$

$(p \leftrightarrow q) = T$

$(\neg p \leftrightarrow q) = F$

T^F =F

These compound propositions are not satisfiable.