

King Fahd University of Petroleum and Minerals

Information and Computer Science Department

ICS 253: Discrete Structures I

Homework Assignment #1 (Due Friday July 14, 2017 at midnight)

- 1) (5 points) Which of these are propositions? What are the truth values of those that are propositions?

a) (1 point) One can live without water.

False. $\langle 1, 0 \rangle$ each

b) (1 point) All kangaroos fly.

False.

c) (1 point) Call me tomorrow.

Not a proposition.

d) (1 point) How are you doing?

Not a proposition.

e) (1 point) What is the best way to study for the exam?

Not a proposition.

- 2) (10 points) Let p, q and r be the propositions "Bats are blind", "Camels store fat in their humps" and "Lions eat grass" respectively. Express each of these compound propositions as an English sentence.

a) (3 points) $p \wedge \neg r$

Bats are blind but lions do not eat grass.

$\langle 3, 2, 0 \rangle$ (0 if not answered)

b) (3 points) $r \rightarrow \neg q$

If lions eat grass, then camels do not store fat in their humps.

$\langle 3, 2, 0 \rangle$

c) (4 points) $(\neg p \wedge \neg q) \leftrightarrow r$

Bats being not blind and camels not storing fat in their humps are equivalent to saying that lions eat grass.

$\langle 4, 3, 0 \rangle$

- 3) (6 points) For each of these sentences, state what the sentence means if the logical connective *or* is an inclusive *or* (that is, a disjunction) versus an exclusive *or*. Which of these meanings of *or* do you think is intended?

a) To register your son in this school, you need to bring a house deed or an apartment rental agreement.

Inclusive or: you may bring a house deed, a rental agreement or both to register your son.

Exclusive or: you can only bring a house deed or a rental agreement but not both to register your son.

$\langle 1, 0 \rangle$

Inclusive or is intended. $\langle 1, 0 \rangle$

b) The combo meal comes with French fries or rice.

Inclusive or: The combo meal comes with French fries or rice or both.

Exclusive or: You can either get French fries or rice with your combo meal but not both.

$\langle 1, 0 \rangle$

Exclusive or is intended. $\langle 1, 0 \rangle$

- c) The ministry will announce a vacation if there is too much rain or too much dust in the air.

Inclusive or: The ministry will announce a vacation if there is too much rain or too much dust in the air or both, rain and dust in the air.

Exclusive or: The ministry will announce a vacation if there is either too much rain or too much dust in the air but not both. $\langle 1, 0 \rangle$

The inclusive or is intended. $\langle 1, 0 \rangle$

- 4) (15 points) Let p , q , and r be the propositions

p : You can speak English very well.

q : You are a Manchester United fan.

r : You can go to the UK.

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

- a) (3 points) Although you can't speak English very well, you can still go to the UK.

$$\neg p \wedge r \quad \langle 3, 1, 0 \rangle$$

- b) (3 points) You can't go to the UK unless you speak English very well.

$$\neg p \rightarrow \neg r \quad \langle 3, 1, 0 \rangle$$

(0 if not answered)

- c) (3 points) For you to go to the UK, it is sufficient that you are a Manchester United fan.

$$q \rightarrow r \quad \langle 3, 1, 0 \rangle$$

- d) (3 points) You can speak English very well only if you are a Manchester United fan.

$$p \rightarrow q \quad \langle 3, 1, 0 \rangle$$

- e) (3 points) If you can go to the UK, you can speak English very well, and conversely.

$$r \leftrightarrow p \quad \langle 3, 1, 0 \rangle$$

- 5) (6 points) State the converse, contrapositive, and inverse of the following statement: "I go home whenever there is a long weekend"

The statement is: if there is a long weekend, then I go home.

Converse: If I go home, then there is a long weekend. $\langle 2, 0 \rangle$

Contrapositive: If I don't go home, then it is not a long weekend. $\langle 2, 0 \rangle$

Inverse: If it is not a long weekend, then I do not go home. $\langle 2, 0 \rangle$

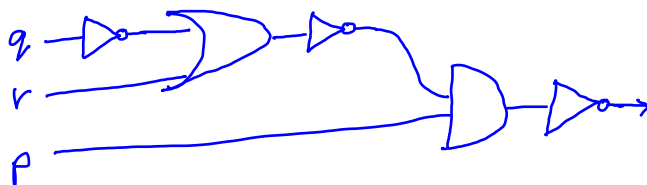
- 6) (3 points) What is the value of x after the statement

if $(x + 1 = 3)$ **OR** $(2x + 2 = 3)$ **then** $x := x + 1$

is encountered in a computer program, if $x = 1$ before the statement is reached?

$$x = 1 \quad \langle 3, 0 \rangle$$

- 7) (5 points) Construct a combinatorial circuit using inverters, OR gates, and AND gates that produces the output $\neg(p \wedge \neg(\neg q \vee r))$



<5,4,3,0>
(0 if not answered)

- 8) (5 points) When planning a party you want to know whom to invite. Among the people you would like to invite are three touchy friends. You know that if Salim attends, he will become unhappy if Samir is there, Samir will attend only if Khalid will be there, and Khalid will not attend unless Salim also does. Which combinations of these three friends can you invite so as not to make someone unhappy? Clearly justify your answer.

The propositions to consider are the following:

If Salim attends, he will become unhappy if Samir is there. $\text{Samir} \rightarrow \neg \text{Salim}$

If Samir attends, Khalid will be there $\text{Samir} \rightarrow \text{Khalid}$

If Salim does not attend, Khalid will not attend. $\neg \text{Salim} \rightarrow \neg \text{Khalid}$

(Note: Consider Salim → Samir as a correct answer.)

<3,1,0>

| Salim | Samir | Khalid | $\neg \text{Salim}$ | $\neg \text{Khalid}$ | $\text{Samir} \rightarrow \neg \text{Salim}$ | $\text{Samir} \rightarrow \text{Khalid}$ | $\neg \text{Salim} \rightarrow \neg \text{Khalid}$ |
|-------|-------|--------|---------------------|----------------------|--|--|--|
| T | T | T | F | F | F | T | T |
| T | T | F | F | T | F | F | T |
| T | F | T | F | F | T | T | T |
| T | F | F | F | T | T | T | T |
| F | T | T | T | F | T | T | F |
| F | T | F | T | T | T | F | T |
| F | F | T | T | F | T | T | F |
| F | F | F | T | T | T | T | T |

Hence, the only combination to attend is Salim and Khalid (or Salim alone although Salim by himself is not a combination). <2,1,0>

(0 if not present)

- 9) (5 points) Construct a truth table for $((p \wedge q) \vee \neg r) \leftrightarrow r$. Specify whether it is a tautology, contingency or contradiction.

| p | q | r | $\neg r$ | $p \wedge q$ | $(p \wedge q) \vee \neg r$ | $((p \wedge q) \vee \neg r) \leftrightarrow r$ |
|---|---|---|----------|--------------|----------------------------|--|
| T | T | T | F | T | T | T |
| T | T | F | T | T | T | F |
| T | F | T | F | F | F | F |
| T | F | F | T | F | T | F |
| F | T | T | F | F | F | F |
| F | T | F | T | F | T | F |

<4,3.5,3,2,0>

| | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|
| <i>F</i> | <i>F</i> | <i>T</i> | <i>F</i> | <i>F</i> | <i>F</i> | <i>F</i> |
| <i>F</i> | <i>F</i> | <i>F</i> | <i>T</i> | <i>F</i> | <i>T</i> | <i>F</i> |

It is a contingency. $\langle 1, 0 \rangle$

IMPORTANT NOTE REGARDING YOUR SUBMISSION.

- 1- Your homework submission must be a pdf file. If you do not type your homework and just solve by hand, make sure you clearly scan the pages of your homework and convert it to **A SINGLE pdf file.**
- 2- Please submit a pdf file with the following filename:

Name_ID_Assignment1.pdf

For example: If your name is *Wasfi Ghassan Al-Khatib* and your ID is *201043210*, your filename should be

WasfiAlKhatib_201043210_Assignment1.pdf