

## Sheet 1 Chapter One

### Logical operations:

$\mathcal{A}$	$\neg \mathcal{A}$	$\mathcal{A}$	$\mathcal{B}$	$\mathcal{A} \& \mathcal{B}$	$\mathcal{A} \vee \mathcal{B}$	$\mathcal{A} \rightarrow \mathcal{B}$	$\mathcal{A} \leftrightarrow \mathcal{B}$
1	0	1	1	1	1	1	1
1	0	1	0	0	1	0	0
0	1	0	1	0	1	1	0
0	1	0	0	0	0	1	1

Which of these sentences are propositions? What are the truth values of those that are propositions?

a) Boston is the capital of Massachusetts. **proposition (idk)**

b) Miami is the capital of Florida. **proposition (false)**

c)  $2 + 3 = 5$ . **proposition True**

d)  $5 + 7 = 10$ . **proposition false**

e)  $x + 2 = 11$ . **not proposition**

f) Answer this question. **not prop**

Let p and q be the propositions

p : It is below freezing.

q : It is snowing.

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

a) It is below freezing and snowing.  **$p \wedge q$**

b) It is below freezing but not snowing.  **$p \wedge \neg q$**

c) It is not below freezing and it is not snowing.  **$\neg p \wedge \neg q$**

d) It is either snowing or below freezing (or both).  **$p \vee q$**

- e) If it is below freezing, it is also snowing.  $p \rightarrow q$   
 f) Either it is below freezing or it is snowing, but it is not snowing if it is below freezing.  $(p \vee \text{freezing}) \wedge (p \rightarrow q)$   
 g) That it is below freezing is necessary and sufficient for it to be snowing.  $P \leftrightarrow Q$

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 take discrete mathematics, you must have taken calculus or a course in computer science.  
 b) When you buy a new car from Acme Motor Company, you get \$2000 back in cash or a 2% car loan.  
 c) Dinner for two includes two items from column A or three items from column B.  
 d) School is closed if more than 2 feet of snow falls or if the wind chill is below  $-100$ .

Determine whether each of these conditional statements is true or false.

- a) If  $1 + 1 = 2$ , then  $2 + 2 = 5$ .  
 b) If  $1 + 1 = 3$ , then  $2 + 2 = 4$ .  
 c) If  $1 + 1 = 3$ , then  $2 + 2 = 5$ .  
 d) If monkeys can fly, then  $1 + 1 = 3$ .

Construct a truth table for each of these compound propositions.

- a)  $p \rightarrow (\neg q \vee r)$   
 b)  $(p \rightarrow q) \vee (\neg p \rightarrow r)$   
 c)  $(p \rightarrow q) \wedge (\neg p \rightarrow r)$   
 d)  $(p \leftrightarrow q) \vee (\neg q \leftrightarrow r)$   
 e)  $(\neg p \leftrightarrow \neg q) \leftrightarrow (q \leftrightarrow r)$

Show that  $(p \rightarrow q) \rightarrow r$  and  $p \rightarrow (q \rightarrow r)$  are not logically equivalent.

Show that  $(p \wedge q) \rightarrow r$  and  $(p \rightarrow r) \wedge (q \rightarrow r)$  are not logically equivalent.

*Best of luck!*



جامعة مصر للمعلوماتية  
EGYPT UNIVERSITY  
OF INFORMATICS

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EGYPT UNIVERSITY OF INFORMATICS  
FACULTY OF COMPUTING  
& INFORMATION SCIENCES