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Subj- Discrete Structures

Assigment No. 01

Que # 01:-

Q1) Which of these sentences are propositions? What are the truth values of those that are propositions?

a) Boston is the capital of Massachusetts
b) Miami is the capital of Florida
c) $2+3=5$
d) $5+7=10$
e) $x+2=11$
f) Answer the following

	Proposition	Truth Value
a)	T (yes)	T
b)	T (yes)	F
c)	T (yes)	T
d)	T (yes)	F
e)	F (NO)	—
f)	F (NO)	—

X————X

Q3) What is the negation of each of these propostions?

a) Mei has an MP3 player.
Mei has not an MP3 player

b) There is no pollution in New Jersey.
There is pollution in New Jersey.

c) $2+1=3$

$2+1\neq 3$

d) The summer in Maine is hot and sunny.

The summer in Maine is not hot nor sunny.

Q9) 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) $\neg q$

Sharks have not been spotted near the shore.

b) $p \wedge q$

Swimming at the New Jersey is allowed and sharks have been spotted near the shore.

c) $\neg p \vee q$

Swimming at the New Jersey is not allowed, or sharks have been spotted near the shore.

d) $p \rightarrow \neg q$

If swiming at the New Jersey is allowed, then sharks have not been spotted near the shore

e) $\neg q \rightarrow p$

If sharks have not been spotted near the shore, than swimming at the New Jersey is allowed.

f) $\neg p \rightarrow \neg q$

If swimming at the New Jersey is not allowed, then sharks have not been spotted near the shore.

g) $p \leftrightarrow \neg q$

Swimming at the New Jersey is allowed, if and only if sharks have not been spotted near the shore.

h) $\neg p \wedge (p \vee \neg q)$

Swiming at the New Jersey is not allowed, and either swimming at the New Jersey is allowed or Sharks have not been spotted near the shore.

Q11) Let p and q be the propositions

p :- It is below freezing

q :- It is snowing

Write the propostions 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

$(p \vee q) \wedge (p \rightarrow q)$

g) That it is below freezing is necessary and sufficient for it to be snowing.

$p \leftrightarrow q$

Q13) Let p and q be the propositions

p :- You dive over 65 miles per hour

q :- You get a speeding ticket

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

a) You do not drive over 65 miles per hour.

$\neg p$

b) You dive over 65 miles per hour, but you do not get a speeding ticket.

$p \wedge \neg q$

c) You will get a speeding ticket if you dive over 65 miles per hour.

$p \rightarrow q$

d) If you do not drive over 65 miles per hour, then you will not get a speeding ticket.

$\neg p \rightarrow \neg q$

e) Diving over 65 miles per hour is sufficient for getting a speeding ticket.

$p \rightarrow q$

f) You get a speeding ticket, but you do not dive over 65 miles per hour.

$q \wedge \neg p$.

g) Whenever you get a speeding ticket, you are driving over 65 miles per hour.

$q \to p$

Q15) Let p, q and r be the propositions

p:- Grizzly bears have been seen in the area

q:- Hiking is safe on the trail

r:- Berries are ripe along the trail.

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

a) Berries are ripe along the trail, but grizzly bears have not been seen in the area.

$r \wedge \neg p$

b) Grizzly bears have not been seen in the area and hiking on the trail is safe, but berries are ripe along the trail.

$\neg p \wedge q \wedge r$

c) If berries are ripe along the trail, hiking is safe if and only if grizzly bears have not been seen in the area.

$r \to (q \leftrightarrow \neg p)$

d) It is not safe to hike on the trail, but grizzly bears have not been seen in the area and the berries along the trail are ripe.

$\neg q \wedge (\neg p \wedge r)$

e) For hiking on the trail to be safe, it is necessary but not sufficient that berries not be ripe along the trail and for grizzly bears not to have been seen in the area.

$$(q \rightarrow (\neg r \wedge \neg p)) \wedge \neg((\neg r \wedge \neg p) \rightarrow q)$$

f) Hiking is not safe on the trail whenever grizzly bears have been seen in the area and berries are ripe along the trail.

$$(p \wedge r) \rightarrow \neg q$$

Q17) Determine whether each of these conditional statements is true or false

a) If $1+1=2$, then $2+2=5$ (False)
b) If $1+1=3$, then $2+2=4$ (True)
c) If $1+1=3$, then $2+2=5$ (True)
d) If monkeys can fly, then $1+1=3$ (True)

Q19) For each of these sentences, determine whether an inclusive or, or an exclusive or, is intended. Explain your answer.

a) Coffee or tea comes with dinner.

Ans:- Exclusive OR:- Because only one option is required to be true i.e. only one beverage is required.

b) A password must have at least three digits or be at least eight characters long.

Ans:- Inclusive OR:- Because both the situations can be true at same time.

c) The prerequisite for the course is a course in number theory or a course in cryptography.

Ans: Inclusive OR:- Because the student with both course can be eligible.

d) You can pay using US dollars or euros.

Ans: Inclusive OR:- Because we can pay either in US dollars or euros or by both.

Q25) 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.

Ans: You buy an ice cream if and only if it is hot

b) For you to win the contest it is necessary and sufficient that you have the only winning ticket.

Ans: You can win the contest if and only if you have the winning ticket.

c) You get promoted only if you have connections, and you have connections only if you get promoted.

An.

You get promoted if and only if you have connections

d) If you watch television your mind will decay, and conversely.

A. Your mind will decay if and only if you watch television.

e) The trains run late on exactly those days when I take it.

A. The trains run late if and only if I take it.

Q27) State the converse, contrapositive and inverse of each of these conditional statements.

a) If it snows today, I will ski tomorrow.

=) Converse - I will ski tomorrow only if it snows today.

=) Contrapositive - If I do not ski tomorrow, then it will not have snowed today.

=) inverse :- If it does not snow today, then I will not ski tomorrow.

b) I come to class whenever there is going to be a quiz.

=) Converse :- If I come to class, then there will be quiz.

=) Contrapositive :- If I do not come to class, then there will not be a quiz.

=) Inverse :- If there is not going to be a quiz, then I don't come to class.

c) A positive integer is a prime only if it has no divisors other than 1 and itself.

⇒ Converse- A positive integer is a prime if it has no divisors other than 1 and itself.

⇒ Contrapositive- If a positive integer has a divisor other than 1 and itself, then it is not prime.

⇒ Inverse:- If positive integer is not prime, then it has a divisor other than 1 and itself.

Q29) How many rows appear in a truth table for each of these compound propositions?

Formula = 2^n

= where n is number of variables

a) $p \to \neg p$

p	¬p	p→¬p
T	F	F
F	T	T

⇒ 2^1

⇒ 2 Rows

Ans.

b) $(p \vee \neg r) \wedge (q \vee \neg s)$

Sol:

⇒ 2^4

⇒ 16 Rows

Ans.

c) $q \vee p \vee \neg s \vee \neg r \vee \neg t \vee u$

Sol: ⇒ 2^6

⇒ 64 Rows

Ans.

d) $(p \wedge r \wedge t) \leftrightarrow (q \wedge t)$

$\Rightarrow 2^4$

$\Rightarrow$ 16 Rows

A.

Q31) Construct a truth table for each of these compound propositions

a) $p \wedge \neg p$

p	$\neg p$	$p \wedge \neg p$
T	F	F
F	T	F

b) $p \vee \neg p$

p	$\neg p$	$p \vee \neg p$
T	F	T
F	T	T

c) $(p \vee \neg q) \rightarrow q$

p	q	$\neg q$	$p \vee \neg q$	$p \vee \neg q \rightarrow q$
T	T	F	T	T
T	F	T	T	F
F	T	F	F	T
F	F	T	T	F

d) $(p \vee q) \rightarrow (p \wedge q)$

p	q	$p \vee q$	$p \wedge q$	$(p \vee q) \rightarrow (p \wedge q)$
T	T	T	T	T
T	F	T	F	F
F	T	T	F	F
F	F	F	F	T

e) $(p \rightarrow q) \leftrightarrow (\neg q \rightarrow \neg p)$

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

f) $(p \rightarrow q) \rightarrow (q \rightarrow p)$

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

Q33) Construct a truth table for each of these compound propositions

a) $(p \vee q) \rightarrow (p \oplus q)$

p	q	$p \vee q$	$p \oplus q$	$p \vee q \rightarrow p \oplus q$
T	T	T	F	F
T	F	T	T	T
F	T	T	T	T
F	F	F	F	T

b) $(p \oplus q) \to (p \wedge q)$

p	q	$p \oplus q$	$p \wedge q$	$p \oplus q \to (p \wedge q)$
T	T	F	T	T
T	F	T	F	F
F	T	T	F	F
F	F	F	F	T

c) $(p \vee q) \oplus (p \wedge q)$

p	q	$p \vee q$	$p \wedge q$	$(p \vee q) \oplus (p \wedge q)$
T	T	T	T	F
T	F	T	F	T
F	T	T	F	T
F	F	F	F	F

d) $(p \leftrightarrow q) \oplus (\neg p \leftrightarrow q)$

p	q	$\neg p$	$p \leftrightarrow q$	$\neg p \leftrightarrow q$	$(p \leftrightarrow q) \oplus (\neg p \leftrightarrow q)$
T	T	F	T	F	T
T	F	F	F	T	T
F	T	T	F	T	T
F	F	T	T	F	T

e) $(p \leftrightarrow q) \oplus (\neg p \leftrightarrow \neg r)$

p	q	r	$\neg r$	$p \leftrightarrow q$	$\neg p$	$\neg p \leftrightarrow \neg r$	$(p \leftrightarrow q) \oplus (\neg p \leftrightarrow \neg r)$
T	T	T	F	T	F	T	F
T	T	F	T	T	F	F	T
T	F	T	F	F	F	T	T
T	F	F	T	F	F	F	F
F	T	T	F	F	T	F	F
F	T	F	T	F	T	T	T
F	F	T	F	T	T	F	T
F	F	F	T	T	T	T	F

f) $(p \oplus q) \rightarrow (p \oplus \neg q)$

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

Q37) Construct a truth table for each of these compound propositions

a) $p \rightarrow (\neg q \vee r)$

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

b) $\neg p \rightarrow (q \rightarrow r)$

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) $(p \to q) \vee (\neg p \to r)$

p	q	$p \to q$	$\neg p$	r	$\neg p \to r$	$(p \to q) \vee (\neg p \to r)$
T	T	T	F	T	T	T
T	T	T	F	F	T	T
T	F	F	F	T	T	T
T	F	F	F	F	T	T
F	T	T	T	T	T	T
F	T	T	T	F	F	T
F	F	T	T	T	T	T
F	F	T	T	F	F	T

d) $(p \to q) \wedge (\neg p \to r)$

$p \to q$	$\neg p \to r$	$(p \to q) \wedge (\neg p \to r)$
T	T	T
T	T	T
F	T	F
F	T	F
T	T	T
T	F	F
T	T	T
T	F	F

e) $(p \leftrightarrow q) \vee (\neg q \leftrightarrow r)$

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

f) $(\neg p \leftrightarrow \neg q) \leftrightarrow (q \leftrightarrow r)$

p	q	r	$\neg p$	$\neg q$	$\neg p \leftrightarrow \neg q$	$q \leftrightarrow r$	$(\neg p \leftrightarrow \neg q) \leftrightarrow (q \leftrightarrow r)$
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

Que # 02:-

Q1) Translate the given propositional logic using the propositions provided
⇒ You cannot edit a protected Wikipedia entry unless you are an administrator. Express your answer in terms of e: "You can edit a protected Wikipedia entry" and a: "You are an administrator".

Ans:

$e \rightarrow a, \quad \neg a \rightarrow \neg e$

Q7) Express these system 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".

Ans: $q \rightarrow p$

b) "The message was sent from an unknown system but it was not scanned for viruses.

Ans.

$q \wedge \neg p$.

c) "It is necessary to scan the message from viruses whenever it was sent from an unknown system."

Ans.

$q \rightarrow p$

d) "When message is not sent from an unknown system it is not scanned for viruses.

Ans.

$\neg q \rightarrow \neg p$

Q9) Are these system 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 is not in multiuser state, then it is in interrupt mode. The system is not in interrupt mode".

Ans.

The system is "Inconsistent".

Q11) Are these system specifications consistent? "Whenever the system software is being updated, users cannot access the file system. If users can access the file system, then they can save new files. If user cannot save new files, then the system software is not being updated

Ans.

The system is "Consistent".

Que no. 03:-

Show that the following propositions are logically equivalent to each other (using laws).

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

$\Rightarrow$ $p \leftrightarrow q \equiv \underbrace{(p \wedge q)} \vee (\neg p \wedge \neg q)$

$(p \to q) \wedge (q \to p) \equiv p \vee (\neg p \wedge \neg q)$

$(p \to q) \wedge (q \to p) \equiv (p \vee \neg p) \wedge (p \vee \neg q)$

$(p \to q) \wedge (q \to p) \equiv [(p \wedge q) \vee \neg p] \wedge [(p \wedge q) \vee \neg q]$

$(p \to q) \wedge (q \to p) \equiv [(p \vee \neg p) \wedge (q \vee \neg p)] \wedge [(p \vee \neg q) \wedge (q \vee \neg q)]$

$(p \to q) \wedge (q \to p) \equiv [T \wedge (q \vee \neg p)] \wedge [(p \vee \neg q) \wedge T]$

$(p \to q) \wedge (q \to p) \equiv (q \vee \neg p) \wedge (p \vee \neg q)$

$(p \to q) \wedge (q \to p) \equiv (\neg p \vee q) \wedge (\neg q \vee p)$

$\boxed{(p \to q) \wedge (q \to p) \equiv (p \to q) \wedge (q \to p)}$

Proved

b) $(p \to q) \wedge (p \to r) \equiv p \to \underline{(q \wedge r)}$.

$(p \to q) \wedge (p \to r) \equiv p \to q$

$(p \to q) \wedge (p \to r) \equiv \neg p \vee q$

$(p \to q) \wedge (p \to r) \equiv \neg p \vee (q \wedge r)$

$(p \to q) \wedge (p \to r) \equiv (\neg p \vee q) \wedge (\neg p \vee r)$

$\boxed{(p \to q) \wedge (p \to r) \equiv (p \to q) \wedge (p \to r)}$

Proved