King Saud University

College of Sciences

Department of Mathematics

151 Math Exercises

(1)

Sentential (Propositional) Calculus

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$\frac{1440\text{هـ}}{2018}$

Algebraic Properties of Connectives

بفرض p , q , r تقارير (Statements) :

1) قاعدتا الإبدال (*Commutative Rules*) :

(أ) $p \wedge q \equiv q \wedge p$ (ب) $p \vee q \equiv q \vee p$

(2) قاعدتا التجميع (*Associative Rules*) :

(أ) $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$ (ب) $(p \vee q) \vee r \equiv p \vee (q \vee r)$

(3) قاعدتا التوزيع (*Distributive Rules*) :

(أ) $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$ (ب) $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$

(4) قاعدتا العنصر المحايد (*Identity Rules*) :

(أ) $p \wedge T \equiv P$ (ب) $p \vee F \equiv p$

(5) قاعدتا النفي (*Negation Rules*) :

(أ) $p \vee \neg p \equiv T$ (ب) $p \wedge \neg p \equiv F$

(6) قاعدة نفي النفي (*Double Negation Rule*) : $\neg(\neg p) \equiv p$

(7) قاعدتا الجمود (*Idempotent Rules*) :

(أ) $p \vee p \equiv p$ (ب) $p \wedge p \equiv p$

(8) قاعدتا ديمورجان (*DeMorgan's Rules*) :

(أ) $\neg(p \wedge q) \equiv \neg p \vee \neg q$ (ب) $\neg(p \vee q) \equiv \neg p \wedge \neg q$

(9) قاعدتا الشمول (*Universal Rules*) :

(أ) $p \vee T \equiv T$ (ب) $p \wedge F \equiv F$

(10) قاعدتا الإمتصاص (*Absorption Rules*) :

(أ) $p \vee (p \wedge q) \equiv p$ (ب) $p \wedge (p \vee q) \equiv p$

(11) قاعدتا البرهان البديل (*Alternative proof Rules*) :

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

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

(12) قاعدتا الشرط (*Conditional Rules*) :

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

(13) قواعد ثنائي الشرط (*Biconditional Rules*) :

(أ) $p \leftrightarrow q \equiv (p \to q) \wedge (q \to p)$

(ب) $p \leftrightarrow q \equiv (p \wedge q) \vee (\neg p \wedge \neg q)$

(ج) $p \leftrightarrow q \equiv (\neg p \vee q) \wedge (p \vee \neg q)$

(14) قاعدة المكافئ العكسي (*Rule of Contrapositive*) : $p \to q \equiv \neg q \to \neg p$

(15) قاعدة الإنطلاق والوصول (*Exportation – Importation Rule*) :

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

في التقرير الشرطي $p \to q$ ، يسمى التقرير p (المقدمة *Antecedent*)، بينما يسمى التقرير q (النتيجة *Consequent*).

يقترن بالتقرير الشرطي $p \to q$ تقارير شرطية أخرى هي :

العكس (*Converse*) : $q \to p$

المعكوس (*Inverse*) : $\neg p \to \neg q$

المكافئ العكسي (*Contrapositive*) : $\neg q \to \neg p$

p	q	$p \wedge q$	$p \vee q$	$p \to q$	$p \leftrightarrow q$
T	T	T	T	T	T
T	F	F	T	F	F
F	T	F	T	T	F
F	F	F	F	T	T

$p \wedge q$ يكون صواباً T إذا كان كل منهما صائباً T ، عدا ذلك يكون خاطئاً .

$p \vee q$ يكون خاطئاً F إذا كان كل منهما خاطئاً F ، عدا ذلك يكون صواباً .

$p \to q$ يكون خاطئاً F إذا كان p صائباً T و كان q خاطئاً F ، عدا ذلك يكون صواباً.

$p \leftrightarrow q$ يكون صواباً T إذا كان كل منهما صائباً T ، أو إذا كان كل منهما خاطئاً F ، عدا ذلك يكون خاطئاً .

DEFINITION 1 A compound proposition that is always true, no matter what the truth values of the propositional variables that occur in it, is called a *tautology*. A compound proposition that is always false is called a *contradiction*. A compound proposition that is neither a tautology nor a contradiction is called a *contingency*.

DEFINITION 2 The compound propositions p and q are called *logically equivalent* if $p \leftrightarrow q$ is a tautology. The notation $p \equiv q$ denotes that p and q are logically equivalent.

TABLE 1 Examples of a Tautology and a Contradiction.

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

TABLE 2 De Morgan's Laws.

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

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

EXAMPLE 2 Show that $\neg(p \vee q)$ and $\neg p \wedge \neg q$ are logically equivalent.

TABLE 3 Truth Tables for $\neg(p \vee q)$ and $\neg p \wedge \neg q$.

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

EXAMPLE 3 Show that $p \rightarrow q$ and $\neg p \vee q$ are logically equivalent.

TABLE 4 Truth Tables for $\neg p \vee q$ and $p \rightarrow q$.

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

EXAMPLE 4 Show that $p \vee (q \wedge r)$ and $(p \vee q) \wedge (p \vee r)$ are logically equivalent. This is the *distributive law* of disjunction over conjunction.

TABLE 5 A Demonstration That $p \vee (q \wedge r)$ and $(p \vee q) \wedge (p \vee r)$ Are Logically Equivalent.

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

TABLE 6 Logical Equivalences.

Equivalence	*Name*
$p \wedge \mathbf{T} \equiv p$ $p \vee \mathbf{F} \equiv p$	Identity laws
$p \vee \mathbf{T} \equiv \mathbf{T}$ $p \wedge \mathbf{F} \equiv \mathbf{F}$	Domination laws
$p \vee p \equiv p$ $p \wedge p \equiv p$	Idempotent laws
$\neg(\neg p) \equiv p$	Double negation law
$p \vee q \equiv q \vee p$ $p \wedge q \equiv q \wedge p$	Commutative laws
$(p \vee q) \vee r \equiv p \vee (q \vee r)$ $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$	Associative laws
$p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$ $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$	Distributive laws
$\neg(p \wedge q) \equiv \neg p \vee \neg q$ $\neg(p \vee q) \equiv \neg p \wedge \neg q$	De Morgan's laws
$p \vee (p \wedge q) \equiv p$ $p \wedge (p \vee q) \equiv p$	Absorption laws
$p \vee \neg p \equiv \mathbf{T}$ $p \wedge \neg p \equiv \mathbf{F}$	Negation laws

TABLE 7 Logical Equivalences Involving Conditional Statements.

$p \to q \equiv \neg p \vee q$

$p \to q \equiv \neg q \to \neg p$

$p \vee q \equiv \neg p \to q$

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

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

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

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

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

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

TABLE 8 Logical Equivalences Involving Biconditional Statements.

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

$p \leftrightarrow q \equiv \neg p \leftrightarrow \neg q$

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

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

Exercises

Q1− Show whether the following statement is a tautology or a contradiction or a contingency :

1) $(p \wedge q) \to (\neg p \to q)$

Solution:

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

(By rules " without using the truth tables")

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

Solution:

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

(By rules " without using the truth tables)

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

$$\equiv p \vee \neg(p \vee q) \vee q$$ (DeMorgan's Rule)

$$\equiv (p \vee q) \vee \neg(p \vee q)$$ (Commutative and Associative Rules)

$$\equiv x \vee \neg x \equiv t$$ (Negation Rule)

$$: x \equiv p \vee q$$ (Substitution Rule for Logical Equivalence)

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3) $\neg(p \to q) \to \neg q$

Solution:

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

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4) $[p \wedge (p \to q)] \to q$

Solution:

p	q	$p \to q$	$p \wedge (p \to q)$	$[p \wedge (p \to q)] \to q$
T	T			
T	F			
F	T			
F	F			

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

Solution:

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

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

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

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

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

(By rules " without using the truth tables)

8) $\neg u \to [(u \wedge v) \to w]$

u	v	w	$\neg u$	$u \wedge v$	$(u \wedge v) \to w$	$\neg u \to [(u \wedge v) \to w]$
T	T	T				
T	T	F				
T	F	T				
T	F	F				
F	T	T				
F	T	F				
F	F	T				
F	F	F				

(By rules " without using the truth tables)

9) Show whether the following statement is a tautology or a contradiction?

$$[(p \rightarrow q) \vee (q \rightarrow r)] \rightarrow (p \rightarrow \neg r)$$

10) Show that the following statement is a tautology $[(p \rightarrow q) \wedge (q \rightarrow r)] \rightarrow (p \rightarrow r)$?

11) Show that the following statement is a tautology : $(\boldsymbol{p} \wedge \boldsymbol{q}) \rightarrow (\boldsymbol{r} \rightarrow \boldsymbol{q})$?

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12) Prove the following statement is a tautology , without using the truth table :

$$(\boldsymbol{p} \wedge \boldsymbol{q}) \rightarrow [(\boldsymbol{q} \vee \boldsymbol{r}) \rightarrow \boldsymbol{p}]$$

Proof:

$$(\boldsymbol{p} \wedge \boldsymbol{q}) \rightarrow [(\boldsymbol{q} \vee \boldsymbol{r}) \rightarrow \boldsymbol{p}] \equiv \neg(p \wedge q) \vee [\neg(q \vee r) \vee p]$$

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

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

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

$$\equiv [\neg p \vee \neg q \vee \neg q \vee p] \wedge [\neg p \vee \neg q \vee \neg r \vee p]$$

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

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

$$\equiv T \wedge T \equiv T$$

13) Without using the truth table, show whether the following statement is a tautology or not :

$$(\mathbf{p} \wedge \mathbf{q}) \rightarrow [\mathbf{r} \rightarrow (\mathbf{p} \vee \mathbf{q})]$$

Solution:

14) Show that the following statement is a tautology : $[(p \vee q) \wedge (p \rightarrow r) \wedge (q \rightarrow r)] \rightarrow r$

Solution:

15) Show that the following statement is a tautology : $[(p \rightarrow q) \wedge (q \rightarrow r)] \rightarrow (p \rightarrow r)$

Solution:

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16) Show that the following statement is a tautology : $[\, p \leftrightarrow (q \vee r)\,] \rightarrow [\,(\neg q \wedge \neg r) \vee p\,]$

Solution:

Q2 : 1) Show that $\neg(p \to q)$ and $p \wedge \neg q$ *are logically equivalent ?*

Solution:

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

$$\begin{aligned}\neg(p \to q) &\equiv \neg(\neg p \vee q) && \text{by condition law}\\ &\equiv \neg(\neg p) \wedge \neg q && \text{by the second De Morgan law}\\ &\equiv p \wedge \neg q && \text{by the double negation law}\end{aligned}$$

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2) Show that $\neg(p \vee (\neg p \wedge q))$ and $\neg p \wedge \neg q$ are logically equivalent by developing a series of logical equivalences.

Solution:

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

$$\begin{aligned}\neg(p \vee (\neg p \wedge q)) &\equiv \neg p \wedge \neg(\neg p \wedge q) && \text{by the second De Morgan law}\\ &\equiv \neg p \wedge [\neg(\neg p) \vee \neg q] && \text{by the first De Morgan law}\\ &\equiv \neg p \wedge (p \vee \neg q) && \text{by the double negation law}\\ &\equiv (\neg p \wedge p) \vee (\neg p \wedge \neg q) && \text{by the second distributive law}\\ &\equiv \mathbf{F} \vee (\neg p \wedge \neg q) && \text{because } \neg p \wedge p \equiv \mathbf{F}\\ &\equiv (\neg p \wedge \neg q) \vee \mathbf{F} && \text{by the commutative law for disjunction}\\ &\equiv \neg p \wedge \neg q && \text{by the identity law for } \mathbf{F}\end{aligned}$$

3) Show that the following statements are logically equivalent :

$$(\boldsymbol{p} \rightarrow \boldsymbol{q}) \rightarrow \boldsymbol{q} \equiv (\boldsymbol{p} \vee \mathbf{q})$$

Solution:

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4) Show that the following statements are logically equivalent :

$$(\boldsymbol{p} \rightarrow \boldsymbol{q}) \rightarrow (\neg \boldsymbol{p} \rightarrow \boldsymbol{r}) \equiv \boldsymbol{p} \vee \boldsymbol{r}$$

Solution:

5) Show that the following statements are logically equivalent :

$$(\boldsymbol{p} \rightarrow \boldsymbol{q}) \wedge (\boldsymbol{p} \rightarrow \boldsymbol{r}) \equiv (\neg \boldsymbol{q} \vee \neg \boldsymbol{r}) \rightarrow \neg \boldsymbol{p}$$

Solution:

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6) Show that the following statements are logically equivalent :

Solution:

$(\boldsymbol{p} \rightarrow \boldsymbol{q}) \vee (\boldsymbol{p} \rightarrow \boldsymbol{r}) \equiv (\neg p \vee q) \vee (\neg p \vee r)$ (*Conditional Rule*)

$\equiv \neg p \vee q \vee \neg p \vee r$

$\equiv [(\neg p \vee \neg p) \vee q] \vee r$ (*Commutative and Associative Rules*)

$\equiv (\neg p \vee q) \vee r$ (*Idempotent Rule*)

$\equiv (\boldsymbol{p} \rightarrow \boldsymbol{q}) \vee \boldsymbol{r}$ (*Conditional Rule*)

7) Show that the following statements are logically equivalent :

$$(\neg \boldsymbol{p} \vee \neg \boldsymbol{r}) \rightarrow (\boldsymbol{p} \wedge \boldsymbol{q}) \equiv \boldsymbol{p} \wedge (\boldsymbol{q} \vee \boldsymbol{r})$$

Solution:

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8) Show that the following statements are logically equivalent :

Solution:

$$(\boldsymbol{p} \vee \boldsymbol{q}) \rightarrow \boldsymbol{r} \equiv \neg(p \vee q) \vee r \qquad \text{(Conditional Rule)}$$

$$\equiv (\neg p \wedge \neg q) \vee r \qquad \text{(DeMorgan's Rule)}$$

$$\equiv (\neg p \vee r) \wedge (\neg q \vee r) \qquad \text{(Distributive Rule)}$$

$$\equiv (\boldsymbol{p} \rightarrow \boldsymbol{r}) \wedge (\boldsymbol{q} \rightarrow \boldsymbol{r}) \qquad \text{(Conditional Rule)}$$

9) Show that the following statements are logically equivalent :

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

Solution:

$$
\begin{aligned}
(p \vee q) \to (\neg p \wedge r) &\equiv \neg(p \vee q) \vee (\neg p \wedge r) && \text{(Conditional Rule)}\\
&\equiv (\neg p \wedge \neg q) \vee (\neg p \wedge r) && \text{(DeMorgan's Rule)}\\
&\equiv \neg p \wedge (\neg q \vee r) && \text{(Distributive Rule)}\\
&\equiv \neg p \wedge (q \to r) && \text{(Conditional Rule)}
\end{aligned}
$$

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10) Show that the following statements are logically equivalent :

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

Solution:

11) Show that the following statements are logically equivalent

$$(p \to q) \land (q \lor \neg r) \equiv (p \lor r) \to q$$

Then use it to prove that

$$[(u \lor v) \to w] \land [w \lor \neg(x \land y)] \equiv [(u \lor v) \lor (x \land y)] \to w$$

Solution:

12) Show that $(p \rightarrow q) \wedge (p \rightarrow r)$ and $p \rightarrow (q \wedge r)$ are logically equivalent ?

Solution:

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13) Show that $(p \rightarrow r) \wedge (q \rightarrow r)$ and $(p \vee q) \rightarrow r$ are logically equivalent ?

Solution:

14) Show that $(p \to q) \vee (p \to r)$ and $p \to (q \vee r)$ are logically equivalent ?

Solution:

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15) Show that $(p \to r) \vee (q \to r)$ and $(p \wedge q) \to r$ are logically equivalent ?

Solution:

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16) Show that $\neg p \to (q \to r)$ and $q \to (p \lor r)$ are logically equivalent ?

Solution:

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17) Show that $p \leftrightarrow q$ and $(p \to q) \land (q \to p)$ are logically equivalent ?

Solution:

18) Show that $p \leftrightarrow q$ and $\neg p \leftrightarrow \neg q$ are logically equivalent ?

Solution:

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19) Show that the following statements are logically equivalent ?

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

Solution:

20) Show that the following statements are logically equivalent ?

Solution:

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

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21) Show that the following statements are logically equivalent ?

Solution:

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

22) Show that the following statements are logically equivalent ?

Solution: $\neg[p \wedge (q \vee r)] \equiv (p \rightarrow \neg q) \wedge (p \rightarrow \neg r)$

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23) Show that the following statements are logically equivalent

Solution: $(p \rightarrow q) \wedge [\neg q \wedge (\neg q \vee r)] \equiv \neg(q \vee p)$

24) Show that the following statements are logically equivalent

Solution: $(p \wedge q) \rightarrow r \equiv (p \wedge \neg r) \rightarrow \neg q$

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25) Show that the following statements are logically equivalent

Solution: $[p \rightarrow (q \rightarrow p)] \wedge (p \rightarrow r) \wedge (p \rightarrow \neg r) \equiv \neg p$

26) Show that $(p \wedge q) \rightarrow (p \rightarrow \neg q)$ and $\neg(p \wedge q)$ are logically equivalent ?

Solution:

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27) Show that the following statements are logically equivalent, or not?

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

Solution:

28) Show that the following statements are logically equivalent, or not?

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

Solution:

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29) Show that the following statements are logically equivalent ?

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

Solution:

30) Show that the following statements are logically equivalent , without using the truth table.

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

Solution:

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31) Show that $(p \wedge r) \leftrightarrow (q \wedge r)$ and $(p \leftrightarrow q) \wedge r$ are logically equivalent ?

Solution:

32) Show that the contrapositive of $(p \wedge q) \rightarrow r$ is logically equivalent to $p \rightarrow (q \rightarrow r)$

Solution:

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33) Show that the contrapositive of $(p \vee q) \rightarrow r$ is logically equivalent to $\neg r \rightarrow (\neg p \vee \neg q)$

Solution:

Q3 - Write the c ontrapositive of the following statements :

1) If mn is an odd number, then m is an odd number and also n is an odd number .

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2) If the number 3 divided the numbers $m \ and \ n$, then 3 divided $m+n$

3) If $m \,.\, n = l$, then $m \geq 0 \quad or \quad n \geq 0 \ \ or \ \ l \geq 0$: $m, n, l \in \mathbb{Z}$

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4) If the number $a+b-c$ is an even number , then $a \ is \ an \ even$ or $b \ is \ an \ even$ or $c \ is \ an \ even$,where $a, b, c \in \mathbb{Z}$

5) If n is a prime number where $n \neq 2$, then n is an odd number .

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6) If x is an integer number, then x is an odd number or x is an even number .

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7) If a is an odd number and b is to an odd number , then $a + b$ is an even number .

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8) *Find the inverse , converse and also the contrapositive of the following statement :*

"If you study the course 151 Math , and didn't absence from tutorial classes , you will pass the course with high grade "