



Mathematics-11

Exercise - 2.4

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Q.1 Write the converse, inverse and contrapositive of the following conditionals:-

(i) $p \rightarrow q$
 (GRW 2021, 23, RWP 2021,
 LHR 2022, DGK 2023,
 SGD 2023)

Converse: $q \rightarrow p$

Inverse: $p \rightarrow q$

Contrapositive: $q \rightarrow p$

(ii) $q \rightarrow p$ (SGD 2022)

Converse: $p \rightarrow q$

Inverse: $q \rightarrow p$

Contrapositive: $p \rightarrow q$

(iii) $p \rightarrow q$ (FSD 2021, SHW 2021)

Converse: $q \rightarrow p$

Inverse: $p \rightarrow q$

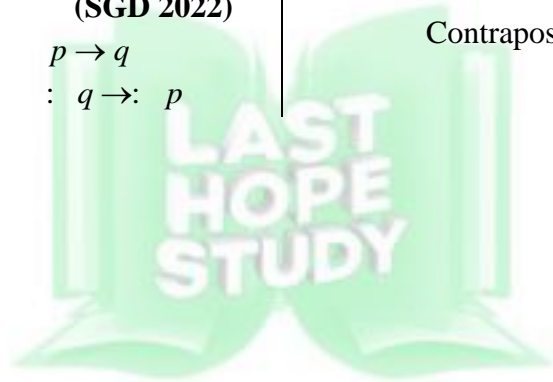
Contrapositive: $q \rightarrow p$

(iv) $q \rightarrow p$

Converse: $p \rightarrow q$

Inverse: $q \rightarrow p$

Contrapositive: $p \rightarrow q$



Q.2 Construct truth tables for the following statements:

(i) $(p \rightarrow p) \vee (p \rightarrow q)$ (LHR 2022, BWP 2023, GRW 2023)

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

(ii) $(p \wedge p) \rightarrow q$ (MTN 2021, 22, 23, RWP 2022, 23)

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

(iii) $\neg(p \rightarrow q) \leftrightarrow (p \wedge \neg q)$ (LHR 2021, FSD 2023)

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

Q.3 Show that each of the following statements is a tautology.

(i) $(p \wedge q) \rightarrow p$
(DGK 2021, 23, SGD 2021, LHR 2021, RWP 2022, GRW 2022)

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

Last column shows that given statement is a tautology.

(ii) $p \rightarrow (p \vee q)$
(SGD 2021, MTN 2021)

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

Last column shows that given statement is a tautology.

(iii) $\neg(p \rightarrow q) \rightarrow p$ (MTN 2023)

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

Last column shows that given statement is a tautology.

(iv) $\neg q \wedge (p \rightarrow q) \rightarrow \neg p$ (SHW 2022, 23)

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

Last column shows that given statement is a tautology.

Q.4 Determine whether each of the following is a tautology, a contingency or an absurdity.

(i) $p \wedge \neg p$

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

Have $p \wedge \neg p$ is an absurdity.

(ii) $p \rightarrow (q \rightarrow p)$

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

Hence $p \rightarrow (q \rightarrow p)$ is a tautology.

(iii) $q \vee (\neg q \vee p)$ (DGK 2022)

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

Hence $q \vee (\neg q \vee p)$ is a tautology.

Q.5 Prove that $p \vee (\neg p \wedge q) \vee (p \wedge q) = p \vee (\neg p \wedge q)$ (SGD 2023)

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

The last two columns show that

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

