

Discrete Mathematics

Mathematical logic

DPP-01

[MCQ]

1. Which of the following is tautology?

- (a) $(\sim p \wedge (p \rightarrow q)) \rightarrow \sim q$
- (b) $\sim (p \rightarrow q) \rightarrow \sim q$
- (c) $[(\sim p \wedge q) \wedge [q \rightarrow (p \rightarrow q)]] \rightarrow \sim r$
- (d) None of these

[MCQ]

2. The statement $[P \vee (p \leftrightarrow Q) \vee Q]$ is equivalent to

- (a) P
- (b) Q
- (c) A tautology
- (d) $(P \wedge Q)$

[MCQ]

3. Consider the following statement

$$S_1: [(p \Rightarrow q) \wedge (q \Rightarrow r)] \Rightarrow (r \Rightarrow p)$$

$$S_2: [((p \Rightarrow q) \wedge (q \Rightarrow r)) \Rightarrow (p \Rightarrow r)]$$

Which of the following is/are correct?

- (a) S_1 is contingency
- (b) S_2 is tautology
- (c) S_1 and S_2 both contingency
- (d) S_1 and S_2 both Tautology

[MCQ]

4. Which of the following is valid?

$$S_1: p \Rightarrow (q \vee r) \equiv (p \Rightarrow q) \vee (p \Rightarrow r)$$

$$S_2: p \Rightarrow (q \wedge r) \equiv (p \Rightarrow q) \wedge (p \Rightarrow r)$$

- (a) S_1 is valid and s_2 is not valid
- (b) S_1 is not valid and s_2 is valid
- (c) Both S_1 and S_2 are valid
- (d) Neither S_1 nor S_2 is valid

[MCQ]

5. Which of the following is not a tautology?

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

Answer Key

- | | |
|-----------|--------|
| 1. (b) | 4. (c) |
| 2. (c) | 5. (d) |
| 3. (a, b) | |



Hints and solutions

1. (b)

$$\sim (p \rightarrow q) \rightarrow \sim q$$

$$\sim [\sim (p \rightarrow q)] \vee \sim q$$

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

$$\sim p \vee q \vee \sim q$$

$$\sim p \vee 1 \equiv 1$$

Hence, option B is tautology.

2. (c)

The statement : $P \vee (P \leftrightarrow Q) \vee Q$

$$P \vee P'Q' \vee PQ \vee Q$$

$$P \vee P'Q' \vee (P \vee 1)Q$$

$$P \vee P'Q' \vee Q$$

Apply absorption LAW

$$\underline{P \vee \bar{P} \bar{Q}} \vee Q$$

$$P \vee \bar{Q} \vee Q$$

$$\therefore P \vee 1 \equiv 1$$

Hence, the given statement is tautology.

3. (a, b)

Statement S1 : Contingency

$$[(p \Rightarrow q) \wedge (q \Rightarrow r)] \Rightarrow (r \Rightarrow p)$$

$$[(\bar{p} + q) \wedge (\bar{q} + r)] \Rightarrow (\bar{r} + p)$$

$$(\bar{p} + q) + (\bar{q} + r) + (\bar{r} + p)$$

$$\therefore p\bar{q} + q\bar{r} + \bar{r} + p$$

$$\therefore p + \bar{r} \text{ [LAW of Absorption]}$$

Hence, S1 is contingency

Statement S2 : Tautology

$$[(p \Rightarrow q) \wedge (q \Rightarrow r)] \Rightarrow (p \Rightarrow r)$$

$$\therefore p\bar{q} + q\bar{r} + \bar{p} + r$$

$$\therefore \underline{p\bar{q} + \bar{p}} + q\bar{r} + r$$

$$\therefore \bar{p} + \underline{\bar{q} + q} + r$$

$$\therefore \bar{p} + 1 + r \equiv 1$$

Hence, S2 is tautology

4. (c)

Statement S₁ : valid

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

$$\bar{p} + q + r \equiv (\bar{p} + q) + (\bar{p} + r)$$

$$\bar{p} + q + r = \bar{p} + q + r$$

Hence, statement S₁ is valid

Statement S₂ : Valid

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

$$\bar{p} + qr \equiv (\bar{p} + q) \cdot (\bar{p} + r)$$

$$\bar{p} + qr \equiv \bar{p} + qr$$

Hence, statement S₂ is also valid.

5. (d)

Statement : $(p \rightarrow (q \rightarrow r)) \rightarrow ((p \rightarrow q) \rightarrow r)$

$$(p \rightarrow (\bar{q} + r)) \rightarrow ((\bar{p} + q) \rightarrow r)$$

$$(\bar{p} + \bar{q} + r) \rightarrow ((\bar{p} + q) + r)$$

$$(\bar{p} + \bar{q} + r) + p\bar{q} + r$$

$$p\bar{q}\bar{r} + p\bar{q} + r$$

$$p(q\bar{r} + \bar{q}) + r$$

$$p(\bar{r} + \bar{q}) + r$$

$$p \underline{\bar{r} + p\bar{q}} + r$$

$$\therefore \underline{p + r + p} \bar{q}$$

$$p(1 + \bar{q}) + r$$

$$\therefore p + r \neq 1$$

Hence, option D is not tautology.



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