Excel Coaching Classes

**Date: 21-Jun-2026**
**Time: 60min**

**Mathematical Logic**

**Marks: 20**

## SECTION A

**Q.1** **Select and write the correct answer for the following multiple choice type of questions:** **(4)**

i **Inverse of the statement ‘A family becomes literate if the woman in it is literate.’ is:**

(A) If a family becomes literate, then the woman in it is literate.

(B) If a family does not become literate, then the woman in the family is not literate.

(C) If the woman in the family is not literate, then the family does not become literate.

(D) None of these

**Ans:** ["C"]
**Explanation:**
Let p : The woman in a family is literate.

q : Family becomes literate.

∴ The given statement is $p \rightarrow q$.

Its inverse is $\sim p \rightarrow \sim q$.

If the woman in the family is not literate, then the family does not become literate.

ii **If $p \wedge q$ is F, $p \rightarrow q$ is F then the truth values of p and q are _______ respectively.**

(A) T, T

(B) T, F

(C) F, T

(D) F, F

**Ans:** ["B"]
**Explanation:**
$p \rightarrow q = F \Rightarrow p \equiv T$ and $q \equiv F$

**Q.2** **Answer the following questions:** **(2)**

i **Is the following sentence is statement in logic? Write down the truth value of the statement: The Sun is a star.**

It is a statement which is true. Hence, its truth value is T.

ii **Write the truth value of the statement:**

$2 \times 0 = 0$ **and** $2 + 0 = 2$**.**

Let p : $2 \times 0 = 0$.

q : $2 + 0 = 2$.

Truth values of p and q are T and T respectively.

The given statement in symbolic form is $(p \wedge q)$.

$\therefore \quad (p \wedge q) \equiv T \wedge T \equiv T$

$\therefore$ Truth value of the given statement is T.

## SECTION B

**Attempt any TWO of the following questions:** **(4)**

**Q.3** **If the statements p, q are true statements and r, s are false statements, then determine the truth value of the following.**

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

$[(\sim p \wedge q) \wedge \sim r] \vee [(q \rightarrow p) \rightarrow (\sim s \vee r)]$

$\equiv [(\sim T \wedge T) \wedge \sim F] \vee [(T \rightarrow T) \rightarrow (\sim F \vee F)]$

$\equiv [(F \wedge T) \wedge T] \vee [T \rightarrow (T \vee F)]$

$\equiv (F \wedge T) \vee (T \rightarrow T)$

$\equiv F \vee T$

$\equiv T$

Hence, truth value is T.

**Q.4** **Without using truth table prove that :**

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

$\sim (p \vee q) \vee (\sim p \wedge q) \equiv (\sim p \wedge \sim q) \vee (\sim p \wedge q)$ [Demorgan’s law]

$\equiv \sim p \wedge (\sim q \vee q)$ [Distributive law]

$\equiv \sim p \wedge t$ [Complement law]

$\equiv \sim p$ [Identity law]

**Q.5** **Construct the truth table for the following statement pattern.**

$$\mathbf{(q \rightarrow p) \vee (\sim p \leftrightarrow q)}$$

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

| p | q | ~p | $q \rightarrow p$ | $\sim p \leftrightarrow q$ | $(q \rightarrow p) \vee (\sim p \leftrightarrow q)$ |
|---|---|---|---|---|---|
| T | T | F | T | F | T |
| T | F | F | T | T | T |

| | | | | | |
|---|---|---|---|---|---|
| F | T | T | F | T | T |
| F | F | T | T | F | T |

## SECTION C

**Attempt any TWO of the following questions: (6)**

**Q.6** **Using truth tables prove the following logical equivalences**

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

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

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| p | q | r | $q \wedge r$ | $p \to (q \wedge r)$ | $p \to q$ | $p \to r$ | $(p \to q) \wedge (p \to r)$ |
| T | T | T | T | T | T | T | T |
| T | T | F | F | F | T | F | F |
| T | F | T | F | F | F | T | F |
| T | F | F | F | F | F | F | F |
| F | T | T | T | T | T | T | T |
| F | T | F | F | T | T | T | T |
| F | F | T | F | T | T | T | T |
| F | F | F | F | T | T | T | T |

In the above truth table, the entries in columns 5 and 8 are identical.

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

**Q.7** **Write converse, inverse and contrapositive of the following statement.**

**If surface area decreases then pressure increases.**

Let p : Surface area decreases.

q : Pressure increases.

$\therefore$ The given statement is $p \to q$.

Its converse is $q \to p$.

If pressure increases, then surface area decreases.

Its inverse is $\sim p \to \sim q$.

If surface area does not decrease, then pressure does not increase.

Its contrapositive is ~q → ~p.

If pressure does not increase, then surface area does not decrease.

**Q.8** **Construct the truth table for the following**

**[(~p ⋁ q) ⋀ (q → r)] → (p → r)**

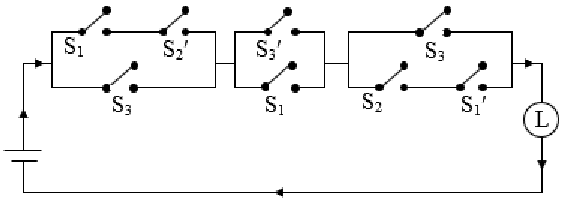
[(~p ⋁ q) ⋀ (q → r)] → (p → r)

| p | q | r | ~p | ~p ⋁ q | q → r | (~p ⋁ q) ⋀ (q → r) | p → r | [(~p ⋁ q) ⋀ (q → r)] →( p → r) |
|---|---|---|---|---|---|---|---|---|
| T | T | T | F | T | T | T | T | T |
| T | T | F | F | T | F | F | F | T |
| T | F | T | F | F | T | F | T | T |
| T | F | F | F | F | T | F | F | T |
| F | T | T | T | T | T | T | T | T |
| F | T | F | T | T | F | F | T | T |
| F | F | T | T | T | T | T | T | T |
| F | F | F | T | T | T | T | T | T |

## SECTION D

**Attempt any ONE of the following questions:** **(4)**

**Q.9** **Express the given circuit in the symbolic form of logic and write the input-output table.**




Let p : The switch $S_1$ is closed.

q : The switch $S_2$ is closed.

r : The switch $S_3$ is closed.

~ p : The switch $S_1'$ is closed

~ q : The switch $S_2'$ is closed.

~ r : The switch $S_3'$ is closed.

The symbolic form of the given circuit is [(p ⋀ ~ q) ⋁ r) ⋀ (~ r ⋁ p) ⋀ (r ⋁ (q ⋀ ~ p)] .

Let (p ⋀ ~ q) ⋁ r = A , (~ r ⋁ p) = B , (r ⋁ (q ⋀ ~ p) = C, A ⋀ B ⋀ C = D.

**Input – Output Table:**

| p | q | r | ~ p | ~ q | ~ r | p ∧ ~ q | A | B | A ∧ B | q ∧ ~ p | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

**Q.10** **Without using truth table prove that (p ∧ q) ∨ (~ p ∧ q) ∨ (p ∧ ~ q) ≡ p ∨ q**

L.H.S.

= (p ∧ q) ∨ (~ p ∧ q) ∨ (p ∧ ~ q)

≡ (p ∧ q) ∨ (p ∧ ~q) ∨ (~p ∧ q) [Commutative law]

≡ [p ∧ (q ∨ ~q)] ∨ (~p ∧ q) [Distributive law]

≡ (p ∧ T) ∨ (~p ∧ q) [Complement law]

≡ p ∨ (~p ∧ q) [Identity law]

≡ (p ∨ ~p) ∧ (p ∨ q) [Distributive law]

≡ T ∧ (p ∨ q) [Complement law]

≡ p ∨ q [Identity law]

= R.H.S.