MATHS

BOOKS - NAVBODH MATHS (HINGLISH)

MATHEMATICAL LOGIC

Solved Examples 2 Or 3 Marks Each

1. Translate the given statements in symbolic form and determine the truth value of each statement :

(1) 2 is a rational number and it is the only even prime number.

(2) $\sqrt{3}$ is a rational number or $3+i$ is a complex number.

(3) Neither 21 is a prime number nor it is divisible by 3.

(4) $3+5>7$ if and only if $4+6<10$.

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2. Prepare truth tables for the following statements :

(1) $(p \wedge q) \rightarrow (\sim P)$ (2) $\sim(\sim p \wedge \sim q) \vee q$ (3) $p \rightarrow [\sim(q \wedge r)]$

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3. If the statements p and q are true and the statement r is false, find the truth values of the following :

(1) $\sim p \overset{\Leftrightarrow}{} (\sim q \wedge r)$ (2) $\sim q \wedge (p \rightarrow q)$ (3) $p \vee (\sim q \Leftrightarrow r)$

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4. If the statements p and q are true and the statement r and s are false, find the truth values of :

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

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

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5. Writ the converse, inverse and contrapositive of each of the following statements :

(1) A family becomes literate if the women in it

are literate.

(2) If it rains, then the match will be cancelled.

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6. Using truth tables, prove the following equivalences :

(1) $\sim p \vee q \equiv \sim(p \wedge q) \rightarrow [\sim p \vee (\sim p \vee q)]$

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

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

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7. Without using truth table, show that

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

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

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8. If $A = \{2, 3, 4, 5, 6\}$, determine the truth value of each of the following:

(i) $\exists x \in A$, such that x+3=10

(ii) $\forall x \in A, x + 6 \geq 9$

(iii) $\exists x \in A$, such that $x + 2 < 5$.

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9. Use quantifiers to convert each of the following open sentences defined on N, into a true statement :

(i) $x^2 > 0$ (ii) $2x + 3 < 15$ (iii) $x^2 - 3x + 2 = 0$

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10. Write the negation of each of the following statements :

(1) All students of this college live in the hostel.

(2) Some real numbers are not complex numbers.

(iii) $\forall n \in N, n + 7 > 6$

(4) The kitchen is neat and tidy.

(5) $\exists x \in A$ such that $x + 5 > 8$

(6) 6 is an even number or 36 is a perfect square.

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11. Write the following statements in symbolic form and write their negatins :

(1) Mangoes are delicious, but expensive.

(2) A person is rich if and only if he is a software engineer.

(3) If diagonals of a parallelogram are perpendicular, then it is a rhombus. solution :

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12. Write the negation of each of the following statements (1) $p \wedge (q \rightarrow r)$ (2) $\sim p \vee (q \rightarrow \sim r)$ (3) $(\sim p \vee \sim q) \wedge (p \wedge \sim q)$.

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13. Write the dual of each of the following :

(1) $(p \vee q) \wedge T$ (2) $(p \wedge q) \vee (r \vee s)$ (3) $p \wedge [\sim q \vee (p \wedge q) \vee \sim r]$

(4) Madhuri has curly hair and brown eyes.

(5) $(p \wedge t) \wedge (c \wedge \sim q)$ where t is a tautology

and c is a contradiction.

Solution : The duals are given by :

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14. Determine whether each of the following statement patterns is a tautology or a contradiction or contingency :

(1) $[(p \to q) \wedge \sim q] \to (\sim p)$

(2) $(p \wedge \sim q) \Leftrightarrow (p \to q)$

(3) $(p \wedge q) \vee (p \wedge r)$

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15. Without using truth table, prove that $[(p \vee q) \wedge \sim p] \rightarrow q$ is a tautology.

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16. Construct the switching circuit for each of the following statements :

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

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

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

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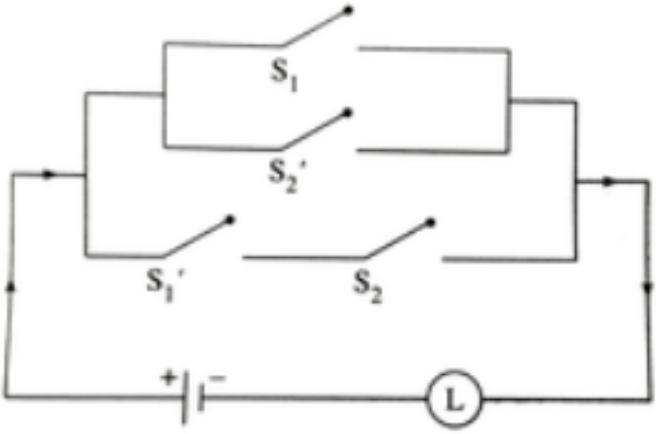
17. Express the following swicthing circuit in symblic form of logic.

Construct its switching table and write your conclusion from it :



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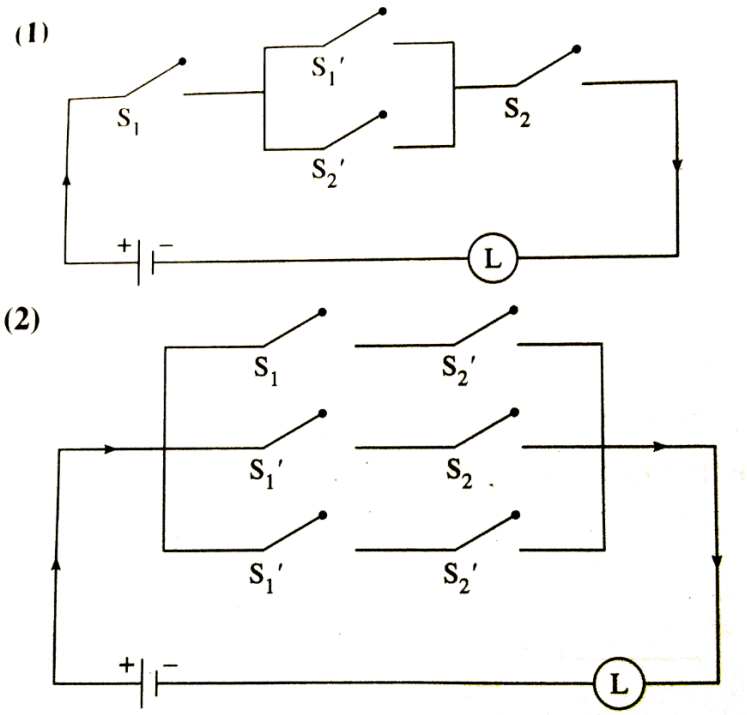
18. Obtain the equivalent simple circuits of the following switching circuits :



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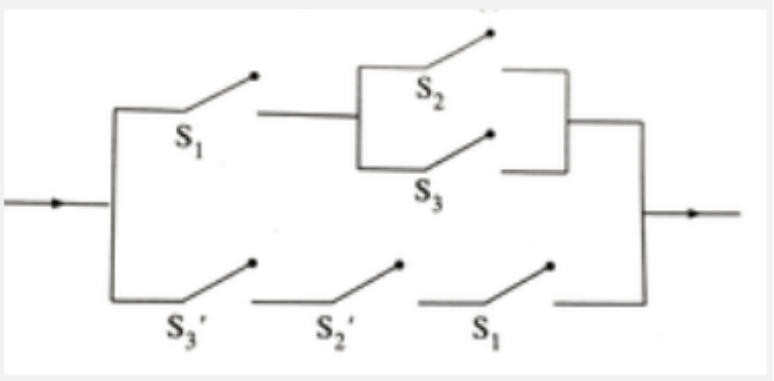
19. Construct the new switching circuit for the following circuit with only one switch by simplifying the given circuit :



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Examples For Practice 2 Or 3 Marks Each

1. State sentences are statements. In case of statement, write down the truth value :

(1) The sun is a star.

(2) Twenty-three is a perfect square.

(3) $x + 3 = 10$.

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2. State sentences are statements. In case of statement, write down the truth value :

(1) Every set is a finite set.

(2) May God bless you !

(3) Square of an odd number is odd.

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3. State sentences are statements. In case of statement, write down the truth value :

(1) The sun of cube roots of unity is one.

(2) $x^2 - 5x + 6 = 0$, when x =2

(3) Every parallelogram is a rhombus.

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4. State sentences are statements. In case of statement, write down the truth value :

(1) The sum of interior angles of a triangle is 180°.

(2) He is a good person.

(3) The sun rises in the East.

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5. State sentences are statements. In case of statement, write down the truth value :

(1) Congruent triangles are also similar.

(2) Zero is a complex number.

(3) $\sqrt{-9}$ is a rational number.

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6. Let p denote 'price' increases' and q denote 'demand falls'. Express the following in the symbolic form :

(1) Price increases, then demand falls.

(2) If price does not increase, then demand does not fall.

(3) Price increases if and only if the demand falls.

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7. Express the following statements in symbolic form :

(1) The drug is effective though it has side effects.

(2) Either we play football or go cycling.

(3) Two triangles have equal areas only if they are similar.

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8. Write the following compound statements symbolically, assuming the first part of each statement as p and the second part as q :

(1) Inspite of bad weather, India won the cricket match.

(2) A triangles is equilateral if and only if it is equiangular.

(3) Price increases and demand falls.

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9. Assuming p and q as given, write the verbal statement for the following symoblic statements :

p : It is a day time. " " q : It is warm.

(i) $p \wedge \sim q$ (ii) $\sim p \rightarrow q$ (iii) $q \rightarrow p$

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10. If p : girls are haapy, q : girls are playing, express the following sentences in symbolic form :

(i) Either the girls are happy or they are not

plyaing.

(ii) Girls are unhappy but they are playing.

(3) It is not true that the girls are not playing but they are happy.

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11. Translate the given statements in symbolic form and determine the truth value of each statement :

(1) 2 is a rational number and it is the only even prime number.

(2) $\sqrt{3}$ is a rational number or $3+i$ is a complex number.

(3) Neither 21 is a prime number nor it is divisible by 3.

(4) $3+5>7$ if and only if $4+6<10$.

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12. Prepare truth tables for the following statements :

(1) $p \rightarrow (q \rightarrow p)$

(2) $[(p \rightarrow q) \wedge q] \rightarrow p$

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

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

(5) $(p \Leftrightarrow r) \wedge (q \Leftrightarrow p)$.

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13. If the statement p and q have truth values T and F respectively, fing the truth values of :

(1) $p \rightarrow \sim q$ (2) $q \rightarrow \sim p$ (3) $(\sim p \rightarrow q) \wedge (\sim q)$.

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14. If p, q, r are the statements with truth values T, F, T respectively, determine the truth values of the following :

(1) $\sim(r \wedge \sim q) \vee (p \wedge \sim r)$ (2) $(r \wedge q) \Leftrightarrow (\sim q)$.

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15. If the statement p and q are true and the statements r and s are false, fing the truth values of :

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

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

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

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16. Write the converse cand contrapositive of the following statement :

'If two triangles are congruent, then their areas are equal.

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17. Write converse, inverse and contrapositive of the following conditional statement :

"If an angle is a right angle, then its measure is 90°".

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18. Wirte the contrapositive of the inverse of the following statement :

"If two numbers are not equal, then their squares are not equal."

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19. If $A = \{4, 5, 7, 9\}$ determine the truth value of each of the following statements :

(i) $\exists x \in A,$ such that $x + 2 = 7.$

(ii) $\forall x \in A, x + 3 < 10.$

(iii) $\exists x \in A,$ scuh that x is even.

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20. Use quantifiers to convert each of the following open sentences defined on N, into a

true statement :

(i) $x^2 = 25$ (ii) $3x + 1 \leq 5$ (iii) $x^2 + 1 \leq 5$

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21. Write the negations of the following statements :

(1) Some continuous functions are differentiable.

(2) All parents care of their children.

(3) $\exists x \in R$ such that $x^2 < x$

(4) $\forall n \in N$, $x^2 + x$ is even number.

(5) It is neither cold nor raining.

(6) If n is an even number, then 2n is not divisible by 4.

(7) A triangle is an equilateral if and only if it is an equiangular triangle.

(8) If I drive fast and do not follow traffic rules, then I will meet with an accident.

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22. Write the negation of each of the following statements and write equivalent statement

after simplification. Justify each step :

(1) $p \wedge (q \rightarrow r)$ (2) $\sim p \vee (q \rightarrow \sim r)$ (3) $(\sim p \vee \sim q) \wedge (p \wedge \sim q)$.

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23. Write the dual of each of the following :

(1) $p \vee (q \wedge r)$ (2) $(p \wedge q) \vee (\sim q)$ (3) $\sim p \wedge (q \vee c)$.

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24. Write the dual statement of each of the following compound statements : (1) Vijay and Vinay cannot speak Hindi. (2) Sweta is doctor or Sheela is a teacher. (3) Sunil and Anil play hockey.

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Examples For Practice 3 Marks Each

1. Using truth tables, determine wether the following statements are tautology or contradiction or contingency :

(1) $\sim(\sim p \wedge \sim q) \vee q$ (2) $[(p \vee q) \wedge \sim p] \wedge (\sim q)$

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2. Construct the truth table for the statement $p \to [q \to (p \wedge q)] p \to [q \to (p \wedge q)]$.

Interpret the result.

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3. Prepare the turth table for the statement pattern $(p \vee q) \wedge [\sim(p \vee q)]$. Interpret the result.

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4. Construct the truth table for the statement pattern $(p \vee q) \wedge (p \vee r)$. Interpret the result.

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Examples For Practice 3 Or 4 Marks Each

1. Construct the switching circuit for the following statement :

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

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Multiple Choice Questions 2 Marks Each

1. The converse of the contrapriate of ptoq is.

A. $\sim p \rightarrow \sim q$

B. $q \rightarrow p$

C. $p \rightarrow \sim q$

D. $\sim q \rightarrow \sim p$

Answer: $\sim p \rightarrow \sim q$

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2. The negation of the statement : "If a person is social, then he is happy." is

A. If a person is not social then he is not haapy.

B. A person is social but not happy.

C. If a person is not social then he is happy.

D. If a person is happy then he is social.

Answer: A person is social but not happy.

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3. The negation of $\sim p \wedge (q \rightarrow r)$ is

A. $p \wedge (\sim q \wedge \sim r)$

B. $\sim p \wedge (\sim q \wedge \sim r)$

C. $p \wedge (\sim q \wedge \sim r)$

D. $\sim p \wedge (q \to r)$

Answer: $\sim p \vee (q \wedge \sim r)$

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4. The negation of $\sim p \to (q \vee r)$ is

A. $p \wedge (\sim q \wedge \sim r)$

B. $\sim p \wedge (\sim q \wedge \sim r)$

C. $p \wedge (\sim q \vee \sim r)$

D. $\sim p \vee (\sim q \wedge \sim r)$.

Answer: $\sim p \wedge (\sim q \wedge \sim r)$

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5. If $p \wedge q = F, p \rightarrow q = F$ then the truth values of p and q are

A. T, T

B. T, F

C. F, T

D. F, F

Answer: $T.\ F$

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6. Negation of $''A \cup B = B$ is the sufficient condition for $A \subseteq B''$ is

A. $A \cup B = B$ and $A \not\subseteq B$

B. $A \cup B \neq B$ but $A \subseteq B$

C. If $A \not\subseteq B$, then $A \cup B \neq B$

D. $A \cap B = B$ and $A \subseteq B$

Answer: $A \cup B = B$ and $A \not\subseteq B$

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7. If $A = \{2, 3, 4, 5, 6\}$, Then which of the following is not true ?

A. $\exists x \in A$, such that $x + 3 = 8$

B. $\exists x \in A,$ such that $x + 2 < 5$

C. $\forall x \in A,$ such that $x + 2 < 9$

D. $\forall x \in A,$ such that $x + 6 \geq 9$

Answer: $\forall x \in A$ **such that** $x + 6 \geq 9$

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8. The negation of inverse of $\sim p \rightarrow q$ is

A. $\sim q \rightarrow p$

B. $p \wedge \sim q$

C. $\sim p \wedge q$

D. $p \wedge q$

Answer: $p \wedge q$

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9. Inverse of statement pattern $(p \vee q) \rightarrow (p \wedge q)$ is

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

B. $\sim(p \vee q) \rightarrow (p \wedge q)$

C. $(\sim p \vee \sim q) \rightarrow (\sim p \wedge \sim q)$

D. $(\sim p \wedge \sim q) \rightarrow (\sim p \vee \sim q)$

Answer: $(\sim p \wedge \sim q) \rightarrow (\sim p \vee \sim q)$

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10. $p \rightarrow (q \rightarrow r)$ is logically equivalent to

A. $(p \vee q) \rightarrow \sim r$

B. $(p \wedge q) \rightarrow \sim r$

C. $(p \vee q) \rightarrow r$

D. $(p \wedge q) \rightarrow r$

Answer: $(p \wedge q) \rightarrow r$

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