

## RELATIONS AND FUNCTIONS

- $A \times B = \{a \in A, b \in B\}$
- If  $a = b$  then  $(a, b) = (b, a)$
- $A \times B \neq B \times A$  but  $n(A \times B) = n(B \times A)$
- $A \times B = \emptyset$  if and only if  $A = \emptyset$  or  $B = \emptyset$
- If  $n(A) = p$  and  $n(B) = q$  then  $n(A \times B) = p q$
- For any three sets  $A, B, C$ 
  - $A \times (B \cup C) = (A \times B) \cup (A \times C)$
  - $A \times (B \cap C) = (A \times B) \cap (A \times C)$
- A relation  $\mathbb{R}$  from  $A$  to  $B$  is always a subset of  $A \times B$   
i.e.  $\mathbb{R} \subseteq A \times B$
- If  $x \in A$  is related to  $y \in B$  through  $\mathbb{R}$  then we write it as  $x \mathbb{R} y$ .  
 $x \mathbb{R} y$  if and only if  $(x, y) \in \mathbb{R}$
- A relation which contains no element is called "Null relation"
- A function  $f$  from  $X$  to  $Y$  is written as  $f: x \rightarrow y$
- A relation  $f$  between two non-empty sets  $X$  and  $Y$  is called a function from  $X$  to  $Y$  if, for each  $x \in X$  there exists only one  $y \in Y$  such that  $(x, y) \in f$   
i.e.  $f = \{(x, y) \mid \text{for all } x \in X, y \in Y\}$
- If  $f: x \rightarrow y$  is a function then
  - The set  $X$  is called the domain of the function  $f$
  - The set  $Y$  is called its co-domain
  - If  $f(a) = b$  then  $b$  is called 'image' of  $a$  under  $f$ .  
 $a$  is called a 'pre image' of  $b$
  - The set of all images of elements of  $X$  under  $f$  is called the 'range' of  $f$
  - Every element in the domain of  $f$  has an image
  - The image is unique
- The range of a function is a subset of its co-domain

14. A function may be represented by

- (i) a set of ordered pairs
- (ii) a table form
- (iii) an arrow diagram
- (iv) a graphical form

15. Vertical Line Test

A curve drawn in a graph represents a function, if every vertical line intersects the curve in at most one point.

16. Types of Functions:

- (i) One-one function (or) injection
- (ii) Many-one function
- (iii) Onto function (or) Surjection
- (iv) Into function

17. One-one function (or) injection

A function  $f: A \rightarrow B$  is called One-one function if distinct elements of  $A$  have distinct images in  $B$

If  $\forall a_1, a_2 \in A, f(a_1) = f(a_2) \Rightarrow a_1 = a_2$ , then  $f$  is called one-one

18. Many-one function

A function  $f: A \rightarrow B$  is called Many-one function if two or more elements of  $A$  have same image in  $B$

19. Onto function (or) Surjection

A function  $f: A \rightarrow B$  is called Onto one function if the range of  $f$  is equal to the co-domain of  $f$  (OR) every element in the co-domain  $B$  has a pre image in the domain  $A$

20. Into function

A function  $f: A \rightarrow B$  is called an Into function if there exists at least one element in  $B$  which is not the image of any element of  $A$

## 21. Bijection

A function  $f: A \rightarrow B$  is both one-one and onto, then  $f$  is called a bijection from  $A$  to  $B$

## 22. Horizontal Line Test

A function represented in a graph is one-one, if every horizontal line intersects the curve in at most one point

## 23. Constant function

A function  $f: A \rightarrow B$  is called a constant function if the range of  $f$  contains only one element

## 24. Identity function

$A$  be a non-empty set. Then the function  $f: A \rightarrow A$  defined by  $f(x) = x, \forall x \in A$  is called an identity function on  $A$

## 25. Real Valued function

A function  $f: A \rightarrow B$  is called a real valued function if the range of  $f$  is a subset of the set of all real numbers  $\mathbb{R}$   
i.e.  $f(A) \subseteq \mathbb{R}$

26. For three non-empty sets  $A, B,$  and  $C$  if  $f: A \rightarrow B$  and  $g: B \rightarrow C$  are two functions then the composition of  $f$  and  $g$

is a function  $g \circ f: A \rightarrow C$  will be defined as  $g \circ f(x) = g(f(x)) \forall x \in A$

27. Composition of function is not commutative

i.e.  $f \circ g \neq g \circ f$

28. Composition of three functions is always associative

i.e.  $f \circ (g \circ h) = (f \circ g) \circ h$

## 29. Linear function

A function  $f: R \rightarrow R$  defined by  $f(x) = mx + c, m \neq 0$  is called a linear function.

## 30. Modulus function (OR) Absolute Valued Function

$f: R \rightarrow [0, \infty)$  defined by  $f(x) = |x|$

$$f(x) = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$$

31. Modulus function is not a linear function but it is composed of two linear functions  $x$  and  $-x$

32. Linear functions are always one-one function

33. Linear functions are applicable in Cryptography as well as in several branches of Science and Technology

34. Quadratic function

A function  $f: R \rightarrow R$  defined by  $f(x) = ax^2 + bx + c$  ( $a \neq 0$ ) is called a quadratic function

35. Cubic Function

A function  $f: R \rightarrow R$  defined by  $f(x) = ax^3 + bx^2 + cx + d$  ( $a \neq 0$ ) is called a cubic function

36. Reciprocal Function

A function  $f: R - \{0\} \rightarrow R$  defined by  $f(x) = \frac{1}{x}$  is called a reciprocal function.

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