FUNCTIONS

§§ **Cartesian product :**

The cartesian product of two sets A and B is $A \times B = \{(x,y): x \in A, y \in B\}$

§§ **Relation :**

Any subset of $A \times B$ is called a relation from A to B.

The number of relations from A to B is $2^{n(A).n(B)}$

§§ **Function :**

Let f : A $\rightarrow$ B be a relation then it is called a function or mapping from A to B, if every element in A has unique image in B.

§§ **Domain, codomain, Range :**

Let f: A $\rightarrow$ B be a function then A is called the domain and B is called the co-domain of the function.

The set of images of the domain A is called the range of f. The range of a function denoted by f(A) ($\subseteq$B)

The number of functions from A to B is $\{n(B)\}^{n(A)}$

The number of relations from A to B which are not functions is $2^{\{n(A).n(B)\}} - \{n(B)\}^{n(A)}$

§§ **One-one function (Injection), Many-one function**

A function f : A $\rightarrow$ B is one-one (or injective) if distinct elements of A have distinct images in B. A function which is not one-one is called many-one.

Let $n(A) = r$ and $n(B) = n$. Then the condition to define an injection from *A* to *B* is $r \leq n$ and the number of such injections is ^nP_r.

If $r > n$ then the number of injections is 0.

§§ **On to function (Surjection), In to function :**

f : A $\rightarrow$ B is called an onto or a surjection if every element of B has at least one pre-imag in A.

If f :A $\rightarrow$ B is onto (a surjection) then the range of f is B. i.e., f(A) = B.

If f : A $\rightarrow$ B is not onto then it is called an into function.

The condition for a function f : A $\rightarrow$ B to be a surjection from A to B is $n(A) \geq n(B)$.

If n(A) = $n(\geq 2)$, n(B) = 2 then the number of on-to functions from A to B = 2^n - 2.

The number of surjections from A to B is

$$n^r - {}^nC_1(n-1)^r + {}^nC_2(n-2)^r - {}^nC_3(n-3)^r + \ldots\ldots\ldots + (-1)^{n-1}.{}^nC_{n-1}.$$

Where $n(A) = r$ and $n(B) = n$

§§ **Bijection :**

A function which is one-one and onto is called a one-one onto or a bijection.

If f: A $\rightarrow$ B is a bijective function then n(A) = n(B)

If n(A) = n(B) = n, then the number of injection (or surjection or bijections) from A to B is n!.

If $n(A) \neq n(B)$ then the number of bijections is 0.

§§ **Types of functions :**

i) **Constant function :**

A function f: A $\rightarrow$ B is a constant function if the range of f contains only one element.The number of constant functions from A to B is n(B).

ii) **Equality of Funtions :**

Two functions f (x) and g(x) are equal iff

(a) the domain of f is the domain of g and

(b) f(x) = g(x) for all the elements of domain

iii) **Identity function :**

Let A be a non - empty set then f : A $\rightarrow$ A defined by $f(x) = x \ \forall \ x \in A$ is called the identity function on A and it is denoted by I_A.

iv) **Inverse function :**

If f: A $\rightarrow$ B is a bijection then f^{-1} :B $\rightarrow$ A defined by $f^{-1}(x) = y \Leftrightarrow f(y) = x, \forall x \in B, y \in A$ is called the inverse of f.

If the inverse of a function exists, then it is said to be invertible. The inverse of a function, if it exists, is unique.

v) **Composite function :**

If $f : A \rightarrow B$ and $g : B \rightarrow C$ are functions then $gof : A \rightarrow C$ is defined by $(gof)(x) = g\{f(x)\} \ \forall x \in A$ is called the composite function of f & g.

¶¶ **Properties of composite function :**

a) If $f: A \rightarrow B, g: B \rightarrow C$ are one-one then $gof : A \rightarrow C$ is also one-one.

b) If $f : A \rightarrow B, g:B \rightarrow C$ are onto then $gof:A \rightarrow C$ is also onto.

c) If $f : A \rightarrow B$ and $g : B \rightarrow C$ are bijections then $gof : A \rightarrow C$ is a bijection & $(gof)^{-1} = f^{-1}og^{-1}$.

d) If $gof: A \rightarrow C$ is one-one then f is one-one

e) If $gof:A \rightarrow C$ is onto then g is onto.

f) If $f : A \rightarrow B$ is a function then $foI_A = I_Bof = f$

g) If $f : A \rightarrow B$ is a bijection then $fof^{-1} = I_B, f^{-1}of = I_A$

h) If $f : A \rightarrow B$ and $g : B \rightarrow A$ are functions such that $gof = I_A$ and $fog = I_B$ then $f : A \rightarrow B$ is a bijection and $g = f^{-1}$.

i) If $f : A \rightarrow A$ is a bijection then $fof^{-1} = f^{-1}of = I_A$

$fog \neq gof$ in general.

j) If $f: A \rightarrow B, \ g: B \rightarrow C$ and $h:C \rightarrow D$ are functions then $ho(gof)=(hog)of$.

vi) **Real valued function :**

If the range of $f \subseteq R$ then f is a real - valued function.

$$(a.f + b.g)(x) = a.f(x) + b.g(x), x \in A \cap B; a, b \in R$$

vii) <u>Algebra of real valued function :</u>

Let $f: A \to R$ & $g: B \to R$ then

(i) $(f \pm g)(x) = f(x) \pm g(x) \forall x \in A \cap B$

(ii) $(fg)(x) = f(x).g(x) \forall x \in A \cap B$

(iii) $\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)}, \forall x \in A \cap B \;\&\; g(x) \neq 0$

(iv) $(f + k)(x) = f(x) + k, k \in R$

(v) $(kf)(x) = kf(x), k \in R$

(vi) $f^n(x) = \{f(x)\}^n, n > 0$

(vii) $|f|(x) = |f(x)|, x \in A$

viii) <u>Even & odd function :</u>

f:A $\to$ R,A $\subseteq$ R and $f(-x) = f(x) \forall x \in A$ then f is an even function.

f:A $\to$ R,A $\subseteq$ R and

$f(-x) = -f(x)\ \forall x \in A$ then f is an odd function.

¶ Important points of odd and even functions :

a) The graph of an odd function is symmetric about origin.

b) The graph of an even function is symmetric about Y-axis.

c) A function which is even or odd, when squared becomes even function.

d) The derivative of an odd function is an even function and derivative of an even function is an odd function.

e) Every function can be expressed as the sum of an even and an odd function.i.e.,

$f(x) = \frac{1}{2}\{f(x) + f(-x)\} + \frac{1}{2}\{f(x) - f(-x)\}$ = {even function} + {odd function}

f) A function may neither be even nor odd.

g) f(x) = 0 is the only function which is defined on the entire number line is even and odd at the same time.

h) Every even function y = f(x) is not one-one $\forall x \in D_f$.

i) If f and g both are even or both are odd then the function f.g will be even but if any one of them is odd then f.g will be odd.

a) Even or odd extension: if f(x) is defined for x > 0, f(x) can be made even by re-defining it as f(|x|) and odd by redefining it as -f(|x|) for x< 0

ix) <u>Polynomial function :</u>

If *f: A* $\to$ *R*, A $\subseteq$ R is defined by f(x)= $a_0x^n + a_1x^{n-1} + a_2x^{n-2} + .. + a_{n-1}x + a_n$,

$a_0 \neq 0, a_1,\ a_2\ .....\ a_n \in R$, n is a non-negative integer is a polynomial function of degree n.

x) Rational function :

A function of the form $\frac{f(x)}{g(x)}$ where f(x) and g(x) are polynomial functions and $g(x) \neq 0$ is called a rational function.

xi) Algebraic function :

A function obtained by a finite number of algebraic operations (addition, subtraction, multiplication, division, root extraction) on polynomial function is called an algebraic function.

xii) Explicit & Implicit functions :

A function f(x, y) =0 is said to the an explicit function if it expressed as y = f(x) otherwise it is called an implicit function.

xiii) Exponential function :

If a $\in$ R, a>0 then f(x)=a^x is called an exponential function.

xiv) Logarithmic function :

If $a \in R, a > 0$, a ¹ 1 then f(x) = $\log_a x$ is called a logarithmic function

xv) Step function(Greatest integer function) :

If x is any real number then there exist integers n and n+1 such that $n \leq x < n+1$. Then the integral part of x is defined as n. It is denoted by $[x]$.

Properties of greatest integer function :

(i) If f(x) = [x + n], where $n \in I$ and [.] denotes the greatest integer function, then f(x) = n +[x]

(ii) x = [x] + {x}, [.] denote the integral and {.} fractional part of x respectively

(iii) x – 1 < [x] $\leq$ x

(iv) [–x] = –[x], if $x \in I$

(v) [–x] = –[x] – 1, if $x \notin I$

(vi) [x] – [–x] = 2n - 1, if n - 1 < x < n, $n \in I$

(vii) [x] – [–x] = 2n + 1, if x = n + {x}, $n \in I$

(viii) [x + y] $\geq$ [x] + [y].

XVI) Modulus function(Absolute value function) :

The absolute value or numerical value or the modulus of real number x, denoted by | x |, is defined as

$$|x| = \begin{cases} -x & if \quad x < 0 \\ 0 & if \quad x = 0 \\ x & if \quad x > 0 \end{cases}$$

Thus we have $|x| \geq 0$ and | –x | = | x |

¶¶ Properties of modulus function

(i) $|x| \leq a \Rightarrow -a \leq x \leq a; (a \geq 0)$

(ii) $|x| \geq a \Rightarrow x \leq -a \ and \ x \geq a; (a \geq 0)$

(iii) $|x+y| = |x|+|y| \Leftrightarrow x \geq 0 \; and \; y \geq 0 \; or \; x \leq 0 \; and \; y \leq 0$

(iv) $|x-y| = |x|-|y| \Rightarrow x \geq 0 \; and \; |x| \geq |y| \; or \; x \leq 0 \; and \; y \leq 0 \; and \; |x| \leq |y|$

(v) $|x \pm y| \leq |x|+|y|$

(vi) $|x \pm y| \geq |x|-|y|$

§§ **Signum Function :**

The signum function f is defined as

$$sgn(x) = \begin{cases} \frac{|x|}{x} \; or \; \frac{x}{|x|}; & x \neq 0 \\ 0; & x = 0 \end{cases}$$

§§ **Periodic function :**

A function f(x) is said to be periodic function if, there exists a positive real number T, such that,

f(x + T) = f(x), $\forall x \in R$.

Then, f(x) is periodic with period T, where T is least positive value.

Function	***Domain***	***Range***
$\sqrt{a^2-x^2}$	[-a,a]	**[0,a]**
$\frac{1}{\sqrt{a^2-x^2}}$	(-a,a)	$\left[\frac{1}{a},\infty\right)$
$\sqrt{x^2-a^2}$	$(-\infty,-a] \cup [a,\infty)$	$[0,\infty)$
$\frac{1}{\sqrt{x^2-a^2}}$	$(-\infty,-a) \cup (a,\infty)$	$(0,\infty)$
a^x,(a>0, a $\neq$ A)	$(-\infty,\infty)$	$(0,\infty)$
e^x	$(-\infty,\infty)$	$(0,\infty)$
$\log_a x$ $(a>0, a\neq 1)$	$(0,\infty)$	$(-\infty,\infty)$
I *x* I	$(-\infty,\infty)$	$[0,\infty)$
[*x*]	$(-\infty,\infty)$	Z
{ *x*} = *x*-[*x*]	$(-\infty,\infty)$	[0,A)
$\sqrt{x}$	$[0,\infty)$	$[0,\infty)$
$\sin x$	$(-\infty,\infty)$	[-1,1]
$\cos x$	$(-\infty,\infty)$	[-1,1]
$\tan x$	$R-\left\{(2n+1)\frac{\pi}{2} : n \in Z\right\}$	$(-\infty,\infty)$
cosec x	$R-\{n\pi : n \in Z\}$	$(-\infty,-1] \cup [1,\infty)$

Function	*Domain*	*Range*
sec x	$R-\left\{(2n+1)\frac{\pi}{2}:n\in Z\right\}$	$(-\infty,-1]\cup[1,\infty)$
cot x	$R-\{n\pi:n\in Z\}$	$(-\infty,\infty)$
$Sin^{-1}x$	[-1,1]	$\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$
$Cos^{-1}x$	[-1,1]	$[0,\pi]$
$Tan^{-1}x$	$(-\infty,\infty)$	$\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$
$Cosec^{-1}x$	$(-\infty,-1]\cup[1,\infty)$	$\left[-\frac{\pi}{2},0\right)\cup\left(0,\frac{\pi}{2}\right]$
$Sec^{-1}x$	$(-\infty,-1]\cup[1,\infty)$	$\left[0,\frac{\pi}{2}\right)\cup\left(\frac{\pi}{2},\pi\right]$
$Cot^{-1}x$	$(-\infty,\infty)$	$(0,\pi)$
a cosx + b sinx	$(-\infty,\infty)$	$\left[-\sqrt{a^2+b^2},\sqrt{a^2+b^2}\right]$
a cosx + b sinx + c	$(-\infty,\infty)$	$\left[c-\sqrt{a^2+b^2},c+\sqrt{a^2+b^2}\right]$

If f(x) is a function such that $f(x+y)=f(x)f(y)$, then $f(x)=k^x$.

If f(x) is function such that $f(x+y)=f(x)+f(y)$, then $f(x)=kx$

If f(x) is function such that $f(xy)=f(x)+f(y)$,then $f(x)=k\log_a x\,(a\neq 1,a>0)$

If f(x) is a polynomial function such that $f(x)+f\left(\frac{1}{x}\right)=f(x)f\left(\frac{1}{x}\right)$,then $f(x)=1\pm x^n$.

If f(x) is a function such that $f(x+y)+f(x-y)=2f(x)f(y)$, then $f(x)=\frac{k^x+k^{-x}}{2}$.

TEACHING TASK

1. If f : A $\rightarrow$B is a function then

A) f(A) = B B) f(A) $\subset$ B C) f(A) $\subseteq$B D) B$\subseteq$f(A)

2. If f and g are functions such that fog is onto then

A) f is onto B) g is onto C) gof is onto D) Neither f nor g is onto

3. If f : A $\rightarrow$ B is surjective then

A) no two elements of A have the same image in B

B) Every element in A has an image in B
C) every element of B has at least one pre-image in A
D) A and B are finite non empty sets

4. If $f : A \to B$ is a bijection then $f^{-1}of$ =

A) fof^{-1} B) f C) f^{-1} D) I_A

5. If $f : A \to B$ is a constant function which is onto then B is

A) a singleton set   B) a null set   C) an infinite set   D) a finite set

6. The function y = f(x) such that $f\left(x+\frac{1}{x}\right)=x^2+\frac{1}{x^2}$

A) $2 - x^2$ B) $x^2 - 2$ C) $x^2 + 4$ D) $4x^2 - 2$

7. f , h are relations from A to B where $A=\{a,b,c,d\}, B=\{s,t,u\}$ defined as

$f(a)=t,\ f(b)=s,\ f(c)=s,\ f(d)=u, h(a)=s, h(b)=t, h(c)=s\ h(a)=u, h(d)=u$

the which of the following is true

A) f , h are functions   B) f is a function, but h is not a function
C) h is a function, but f is not a function   D) neither f nor h is a function

8. The number of relations from A={1,2,3} to B = {4,6,8,10} is

A) 4^3 B) 2^7 C) 2^{12} D) 3^4

9. The number of functions that can be defined from A={-1,0,1} to B = {2,7,8,9} is

A) 24   B) 12   C) 81   D) 64

10. The number of relations from A={2,6} to B={1,3,5,7} that are not functions from A to B is

A) 240   B) 16   C) 128   D) 200

11. The number of one-one functions that can be defined from A = $\{1,2,3\}$ to B = $\{a,e,i,o,u\}$ is

A) 3^5 B) 5^3 C) $^5p_3$ D) 5!

12. The number of possible many to one functions from A = {6, 36} to B = {1, 2, 3, 4, 5} is

A) 32   B) 25   C) 5   D) 20

13. If A = $\{1,8,11,14,25\}$ then the condition to define a surjection from A to B is

A) n(A) + n(B) = 20   B) n(A) <n(B)   C) n(B) $\leq$ 5   D) n (B) = 10

14. If B = $\{1,2,3\}$ and A = $\{4,5,6,7,8\}$ then the number of surjections from A to B is

A) 81   B) 64   C) 48   D) 150

15. The number of surjections that can be defined from A = $\{1,2,8,9\}$ to B = $\{3,4,5,10\}$ is

A) 4^4 B) 4^2 C) 24   D) 18

16. The number of non-surjective mappings that can be defined from A = $\{1,4,9,16\}$ to B = $\{2,8,16,32,64\}$ is

A) 1024   B) 20   C) 505   D) 625

17. If A = {11, 12, 13, 14} and B = $\{6,8,9,10\}$ then the number of bijections defined from A to B is

A) 256   B) 24   C) 16   D) 64

18. The number of non-bijective mappings possible from A = $\{1,2,3\}$ to B = {4, 5} is

A) 9   B) 8   C) 12   D) 6

19. The number of constant functions possible from R to B = $\{2,4,6,8,....24\}$ is

A) 24 B) 12 C) 8 D) 6

20. A constant function f : A $\rightarrow$ B will be onto if

A) n(A) = n(B) B) n (A) =1 C) n (B) = 1 D) n(A) > n(B)

21. Let A= {1,2,3,}, B = {a, b, c} and If f={(1,a),(2,b),(3,c)}, g={1,b),(2,a),(3,b)} , h={(1,b)(2,c),(3,a)} then

A) g and h are injections B) f and h are injections

C) f and g injections D) f,g and h are injections

22. $f:\left(-\frac{\pi}{2},\frac{\pi}{2}\right)\rightarrow(-\infty,\infty)$ defined by $f(x)=1+3x$ is

A) one-one but not onto B) onto but not one-one

C) neither one - one nor onto D) bijective

23. $f:R\rightarrow R$ defined by f(x) = cos (2x + 3) is

A) injective only B) surjective only C) bijective D) neither injective nor surjective

24. $f:N\rightarrow A$ Where A = {0,1} defined by $f(x)=\begin{cases}0\ if\ x\ is\ odd\\1\ if\ x\ is\ even\end{cases}$. Then f is

A) one - one, onto B) one-one, into

C) many-one, onto D) many-one, into

25. On the set of all integers defined as f : Z$\rightarrow$Z such that f(x) =[x] then it is

A) not a function B) many-to-one function C) into function D) identity function

26. If f(x) = 2x + 1 and g (x) = x^2 + 1 then go(fof)(B) =

A) 112 B) 122 C) 12 D) 124

27. If $f(x)=\frac{1}{x},g(x)=\sqrt{x}$ and $(go\sqrt{f})(16)=$

A) 2 B) 1 C) $\frac{1}{2}$ D) 4

28. If f(x) = 1, x is rational

= 0, x is irrational then (fof) $(\sqrt{5})=$

A) 0 B) 1 C) $\sqrt{5}$ D) $\frac{1}{\sqrt{5}}$

29. Let $f(x)=\frac{Kx}{x+1}(x\neq-1)$ then the value of K for which $(fof)(x)=x$ is

A) 1 B) -1 C) 2 D) $\sqrt{2}$

30. If: $R\rightarrow R, g:R\rightarrow R$ are defined by $f(x)=4x-1, g(x)=x^3+2,$ then $(gof)\left(\frac{a+1}{4}\right)=$

A) 43 B) 345 C) a^3+2 D) a^2-1

31. If $f:R\rightarrow R$ is defined by $f(x)=\frac{2x+1}{3}$ then $f^{-1}(x)=$

A) $\frac{3x-1}{2}$ B) $\frac{x-3}{2}$ C) $\frac{2x-1}{3}$ D) $\frac{x-4}{3}$

32. The function f : $(0,\infty)\rightarrow(-\infty,\infty)$ is defined by f(x) = $\log_3 x$ then f^{-1} (x) =

A) 3^x B) 3^{-x} C) -3^x D) $-3x^{-x}$

33. If f(x) = e^{5x+13} then $f^{-1}(x)$ =

A) $\frac{13-\log x}{5}$ B) $\frac{-13+\log x}{5}$ C) $\frac{5+\log x}{13}$ D) $\frac{5-\log x}{13}$

34. If f(x) = 3x -1 and g(x) = 5x + 6 then $(g^{-1}of^{-1})$ (2)=

A) 10 B) -1 C) 11 D) 12

35. If f(x) = $\frac{5x+6}{7x+9}$ then f^{-1} (x) =

A) $\frac{x+6}{7x+9}$ B) $\frac{7x+9}{5x+6}$ C) $\frac{9x-6}{-7x+9}$ D) $\frac{9x-6}{-7x+5}$

36. If f from R into R defined by $f(x) = x^3 - 1$, then $f^{-1}\{-2,0,7\}$ =

A) {-1, 1, 2} B) {0, 1, 2} C) $\{\pm 1, \pm 2\}$ D) $\{0, \pm 2\}$

37. f : R$\to$R is defined by f(x) = x^2 + 4 then f^{-1}(13)=

A) $\{-3,3\}$ B) $\{-2,2\}$ C) $\{-1,1\}$ D) $\{0,4\}$

38. If $f:[1,\infty)\to[2,\infty)$ is given by $f(x) = x + \frac{1}{x}$ $then\ f^{-1}(x) =$

A) $\frac{x+\sqrt{x^2-4}}{2}$ B) $\frac{x}{1+x^2}$ C) $\frac{x-\sqrt{x^2-4}}{2}$ D) $x+\sqrt{x^2-4}$

39. If $f:\{1,2,3,.....\}\to\{0,\pm1,\pm2,....\}$ is defined by $f(n) = \begin{cases} n/2 & if\ n\ is\, even \\ -\left(\frac{n-1}{2}\right) & if\ n\ is\ odd \end{cases}$ then

$f^{-1}(-100) is$

A) 100 B) 199 C) 201 D) 200

40. If f(x) = 2^x then $\frac{f(x+3)}{f(x-1)} =$

A) f(x) B) $\frac{1}{f(x)}$ C) f(4) D) f(2)

41. If $f:R\to R$ is defined by $f(x) = x^2 - 3x + 2$, then $f(x^2 - 3x - 2) =$

A) $x^4 + 1$ B) $x^4 - 3x + 2$

C) $x^4 - 6x^3 + 2x^2 + 21x + 12$ D) $x^4 + 2x + 2$

42. If $f(x) = \cos[\pi^2]\,x + \cos[-\pi^2]x$ where $[x]$ is the step function, then

A) $f(0) = 1$ B) $f(\pi/4)$=2 C) $f(\pi/2) = -1$ D) $f(\pi) = 1$

43. If $f(x+y) = f(x)f(y)$ and $f(5) = 32$ then $f(7) =$

A) 35 B) 36 C) 7/5 D) 128

44. If f(x) is a polynomial in x (>0) satisfying the equation f(x) + f$\left(\frac{1}{x}\right)$ = f(x)f$\left(\frac{1}{x}\right)$ and f(2) = 9, then f(3) =

A) 26 B) 27 C) 28 D) 29

45. If $f : R \to R$ is continuous such that $f(x+y) = f(x) + f(y), \forall x \varepsilon R, y \varepsilon R$ and f(1) = 2 then f(100) =

A) 100 B) 50 C) 200 D) 0

46. If f(n+1) = f(n) for all $n \in N$, $f(7) = 5$ then f(35)=

A) 25 B) 49 C) 35 D) 5

47. If $f(x)$ is a function such that $f(xy) = f(x) + f(y)$ and $f(2)$=1 then $f(x) =$

A) x^2 B) 2^x C) $\log_2 x$ D) $\log_x 2$

48. If f = $\{(a,0),(b,-2),(c,3)\}$, $g = \{(a,-2),(b,0),(c,1)\}$ then $\frac{f}{g}$ =

A) $\{(a,-1),(b,-2),(c,4)\}$ B) $\{(a,3),(b,-2),(c,2)\}$ C) $\{(a,0),(c,3)\}$ D) does not exist

49. If f(x) = x +1 and g(x) = x² + 1 then $\frac{f+g}{fg}(o) =$

A) 1 B) 2 C) 4 D) 1/4

50. If $f(x) = 2x-1, g(x) = x^2$, then $(3f - 2g)(x) =$

A) $5x - x^2 + 9$ B) $6x - 5x^2 - 4$ C) $2x - x^2 - 3$ D) $6x - 2x^2 - 3$

51. If f(x) = $\frac{7^{1+1nx}}{x^{1n7}}$ then f (2008) =

A) 20 B) 7 C) 2008 D) 100

52. If f(x) = x^2+1, $x \le 0$
= 2x-1, 0<x<5
= 4x+3, $x \ge 5$ then

$\frac{f(-3)+f(2)+f(5)}{f(1)} =$

A) 28 B) 36 C) 26 D) 34

53. If f(x) = sin (log x) then f(xy) + f$\left(\frac{x}{y}\right)$-2f(x) cos (logy) =

A) cos (logx) B) sin (logy) C) cos (log (xy)) D) 0

54. The domain of f(x) = $\frac{1}{\sqrt{x^2-4}}$ is

A) $(-\infty,4)$ B) $(-2,3)$ C) $(4,\infty)$ D) $(-\infty,-2)\cup(2,\infty)$

55. The domain of f (x) = $\sqrt{25-x^2}$ is

A) $(-\infty,-5)$ B) $(5,\infty)$ C) $[-5,5]$ D) $[-\infty,\infty]$

56. The domain of f(x) = $\sqrt{x-2} + \frac{1}{\log(4-x)}$ is

A) $[2,\infty)$ B) $(-\infty,4)$ C) $[2,3)\cup(3,4)$ D) $[3,\infty)$

57. The domain of f(x) = cot $\frac{x}{3}$ is

A) $(-\infty,\infty)$ B) $R-\{n\pi : n\in Z\}$ C) $R-\{3n\pi : n\in Z\}$ D) $(0,\infty)$

58. The domain of f(x) = $\frac{1}{\sqrt{x^2+2x+9}}$ is

A) (1,9) B) (1,B) C) $(-\infty,\infty)$ D) $(0,\infty)$

59. The domain of f(x) = $\frac{1}{|x|+x}$ is

A) $(-\infty,0)$ B) $(0,\infty)$ C) $(-\infty,1)$ D) (-2,-A)

60. The domain of f(x) = $\frac{1}{\log|x|}$ is

A) $R-\{0\}$ B) $R-\{0,1\}$ C) R - {-1, 0, 1} D) $(-\infty,\infty)$

61. If $f(x)=(1-x)^{\frac{1}{2}}$ and g(x) = In (x) then the domain of (gof) (x) is

A) $(-\infty,2)$ B) (-1,1) C) $(-\infty,1]$ D) $(-\infty,1)$

62. The value of x for which the function $\frac{1}{2^x-5}$ is not defined

A) $\log_2 5$ B) $\log_5 2$ C) $\log_e 2$ D) $\log_e 5$

63. The range of f(x) = $\frac{1}{5-3\cos 2x}$ is

A) [0,1] B) $\left[\frac{3}{4},1\right]$ C) $\left[\frac{1}{4},1\right]$ D) $\left[\frac{1}{8},\frac{1}{2}\right]$

64. The range of f(x) = 6 sin x + 8 cos x + 3 is

A) [6,8] B) [6,13] C) [-7,13] D) [3,6]

65. The range of f(x) = $\sqrt{x^2+4x+29}$ is

A) $(-\infty,\infty)$ B) $(0,\infty)$ C) $[5,\infty)$ D) (0,5)

66. The range of f(x) = $\sin^{-1}x-\cos^{-1}x$ is

A) $[0,\pi]$ B) $\left[\frac{-3\pi}{2},\frac{\pi}{2}\right]$ C) $\left[\frac{-\pi}{2},\frac{\pi}{2}\right]$ D) $[-\pi,\pi]$

ASSERTION AND REASON

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

67. ***Assertion (A) :*** $f(x)=\frac{x^2-4}{x-2}$ and $g(x)=x+2$ are equal

Reason (R): Two functions f and g are said to be equal if their domains, ranges are equal and $f(x)=g(x)\forall x \in$domain

A) Both A and R are true and R is the correct explanation of A
B) Both A and R are true and R is not correct explanation of A
C) A is true but R is false D) A is false but R is true

68. The function $f: R \to R$ is defined by $f(x) = 3^{-x}$ then observe the following statements.
I: f is 1-1 **II:** f is onto **III:** f is a decreasing funtion out these, true statemtents are
A) only I, II B) only II, III C) only I, III D) I, II and III

69. If f(x) and g(x) are two functions such that $f(x) + g(x) = e^x$ and $f(x) - g(x) = e^{-x}$ then
I: f(x) is an even function **II:** g(x) is an odd function
III: both f(x) and g(x) are neither even nor odd
A) I and II are true B) only I is true C) only II si true D) only III is true

Match the following

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*
*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

70.

List - I	List - II
i) If $f: A \to B$ and $g: B \to C$ are two functions gof is 1-1 function then	a) g is necessarily onto funtion
ii) If $f: A \to B$ and $g: B \to C$ are two functions gof is onto function then	b) 3^x
iii) $f: R \to R^+$, $f(x) = 3^x$ then $f^{-1}(x) =$	c) $\log_3^x$
iv) $f: R^+ \to R$, $f(x) = \log_3^x$ then $f^{-1}(x) =$	d) f is necessarily 1-1
	e) g is necessarily 1-1

A) i-e,ii-a,iii-b,iv-c B) i-d,ii-a,iii-c,iv-b
C) i-e,ii-a,iii-c,iv-b D) i-b,ii-c,iii-a,iv-d,

LEARNER'S TASK

BEGINNERS (Level - I)

I. MCQs with single correct answer

1. If $f(x) = \alpha x + \beta$ and $f = \{(1,1), (2,3), (3,5), (4,7)\}$ then the values of α, β are
A) 2, -1 B) -2, 1 C) 3, -1 D) -2, -1

2. The number of one-one functions that can be defined from $A = \{4,8,12,16\}$ to B is 5040, then n(B)=
A) 7 B) 8 C) 9 D) 10

3. The number of injections that are possible from A to itself is 720, then n (A) =
A) 5 B) 6 C) 7 D) 8

4. The total number of function from A to itself is 256, then n(A) =
A) 2 B) 3 C) 4 D) 5

5. The number of injections possible from A = $\{1,3,5,6\}$ to B = $\{2,8,11\}$ is

A) 8 B) 64 C) 2^{12} D) 0

6. The number of possible surjection from A= $\{1,2,3,...n\}$ to B = $\{1,2\}$ (where n $\geq$ B) is 62, then n=

A) 5 B) 6 C) 7 D) 8

7. If n (A) = 4 and n(B) = 6, then the number of surjections from A to B is

A) 4^6 B) 6^4 C) 0 D) 24

8. If n(A) = 3 and n(B) = 5 then the number of non-injective mappings possible from B to A is

A) 125 B) 243 C) 15 D) 90

9. The number of non-bijective mappings that can be defined from A = $\{1,2,7\}$ to itself is

A) 21 B)27 C) 6 D) 9

10. If n(A) = 5, n(B) =3 then the number of bijections from A to B is

A) 15 B) 125 C) 243 D) 0

11. A constant function f : A $\rightarrow$ B will be one-one if

A) n (A) = n(B) B) n(A) = 1 C) n (B) = 1 D) n (A) <n (B)

12. Let A = [-1,1]= B then which of the following function from A to B is bijective function

A) $f(x)=\frac{x}{2}$ B) $g(x)=|x|$ C) $h(x)=x^2$ D) $k(x)=\sin\frac{\pi x}{2}$

13. $f: R \rightarrow R$ such that f(x) = e^x then f is

A) only one-one B) only into C) one-one into D) not a function

14. If f(x) = x, g(x) = $2x^2$ + 1 and h(x) = x +1 then (hogof) (x) =

A) $x^2 + 2$ B) $2x^2+1$ C) x^2+1 D) $2(x^2+1)$

15. If $f: R \rightarrow R, g: R \rightarrow R$ are defined by f(x) = x^2, g(x) = cos x then (gof) (x) =

A) cos 2x B) x^2 cos x C) cos x^2 D) $\cos^2 x^2$

16. If $f:(-\infty,\infty) \rightarrow (-\infty,\infty)$ is defined by f(x) = 5x-6 then f^{-1} (x) =

A) $\frac{x+5}{6}$ B) $\frac{x-5}{6}$ C) $\frac{x-6}{5}$ D) $\frac{x+6}{5}$

17. If $f:(0,\infty) \rightarrow (0,\infty)$ is defined by f(x) = x^2 then f^{-1} (x) =

A) $\sqrt{x}$ B) $\frac{1}{\sqrt{x}}$ C) x D) $\frac{2}{\sqrt{x}}$

18. If f(x) = 2 + x^3 then f^{-1} (x) =

A) $\sqrt[3]{x}+2$ B) $\sqrt[3]{x}-2$ C) $\sqrt[3]{x-2}$ D) $\sqrt[3]{x+2}$

19. If f(x) = $\frac{e^x+e^{-x}}{2}$ then the inverse of f(x) is

A) $\log_e\left(x+\sqrt{x^2+1}\right)$ B) $\log_e \sqrt{x^2+1}$

C) $\log_e\left(x+\sqrt{x^2-1}\right)$ D) $\log_e\left(x-\sqrt{x^2-1}\right)$

20. If $f: R \rightarrow R^+$ then $f(x)=(1/3)^x, then\ f^{-1}(x)=$

1. $(1/3)^{-x}$ 2. 3^x 3. $\log_{1/3} x$ 4. $\log_x (1/3)$

21. If $f(x)=x^4+5x^2+1$, then $f(1/x)=$

A) $\frac{f(x)}{x^4}$ B) $\frac{f(x)}{x^3}$ C) $x^2 f(x)$ D) $x^4 f(x)$

22. $f(x)=\sin x$ and $g(x)=\sec x$ then $\frac{f(\pi)-f\left(\frac{3\pi}{2}\right)+f(0)}{g(\pi)+g(0)+g\left(\frac{\pi}{3}\right)}$

A) $\frac{1}{2}$ B) 1 C) 2 D) $\frac{1}{3}$

23. If $f(x)=3x+1, g(x)=x^3+2,$ then $(f+g)(0)-fg(0)=$

A) x B) $\frac{3}{2}$ C) 3 D) 1

24. If $f(x)=x^2, g(x)=x^2-5x+6$ then $g(2)+g(3)+g(0)-f(0)-f(1)-f(-2)$

A) 2 B) 6/5 C) 5/6 D) 1

25. If $f(x)$ is a polynomial in $x(>0)$ satisfying the equation $f(x)+f(1/x)=f(x).f(1/x)$ and $f(2)=-7$, then $f(3)=$

A) -26 B) -27 C) -28 D) -29

26. If $f(x)$ is a polynomial function such that $f(x)f\left(\frac{1}{x}\right)=f(x)+f\left(\frac{1}{x}\right)$ and $f(3)=-80$ then $f(x)=$

A) x^4+1 B) x^4-1 C) $1-x^4$ D) $-1-x^4$

27. If $f(x)=3x+1, g(x)=x^3+2,$ then $\frac{f+g}{fg}(0)=$

A) x B) 1 C) 3 D) 3/2

28. If $f(x)=x^2, g(x)=x^2-5x+6$ then $\frac{g(2)+g(3)+g(0)}{f(0)+f(1)+f(-2)}=$

A) 2 B) 1 C) 5/6 D) 6/5

29. If $f(x)=2^x$ then $f(0), f(1), f(2)$....... are in

A) A.P B) G.P. C) H.P. D) A.G.P

30. The domain of f(x) = tan 2x is

A) $(-\infty,\infty)$ B) $R-\left\{(2n+1)\frac{\pi}{4,} n\in Z\right\}$

C) $R-\left\{(2n+1)\frac{\pi}{2,} : n\in Z\right\}$ D) $R-\{n\pi : n\in Z\}$

31. The domain of f(x) = log $|x-2|$ is

A) $(-\infty,2)$ B) $(2,\infty)$ C) $(-\infty,2)\cup(2,\infty)$ D) $(-\infty,\infty)$

32. The domain of f(x) = x! is

A) IR B) Z C)Q D) {0,1,2,3,...}

33. The domain of f(x) = $\sqrt{x-2}+\frac{1}{\log(5-x)}$ is

A) $[2,\infty)$ B) [2,5] C) $[2,4)\cup(4,5)$ D) $(-\infty,2)$

34. The domain of f(x) = $\frac{x^2-5x-16}{x^2-x-6}$ is

A) R – $\{2,3\}$ B) R – $\{-2,-3\}$ C) R – $\{-2,3\}$ D) R – $\{2,-3\}$

35. The domain of f(x) = $\frac{3^x+3^{-x}}{3^x-3^{-x}}$ is

A) $(-\infty,\infty)$ B) $(-\infty,0)\cup(0,\infty)$ C) $(0,\infty)$ D) $(0,1)$

36. The domain of f(x) = $|x-2|-|x-5|$ is

A) R - (2,5) B) R - {0} C) $(0,\infty)$ D) R

37. Let $f:R\to R$ be defined by $f(x)=\begin{cases} x+2 & (x\le -1) \\ x^2 & (-1<x<1) \\ 2-x & (x\ge 1) \end{cases}$ then the value of f(–1.75)+f(0.5) + f(1.5) is

A) 0 B) 2 C) 1 D) -1

38. Let $f:R\to R$ be fined by $f(x)=\begin{cases} x+2 & (x\le -1) \\ x^2 & (-1<x<1) \\ 2-x & (x\le 1) \end{cases}$. then the value of $f(-1)+f(0)+f(1)$ is

A) 0 B) 1 C) 2 D) -1

39. If $f(x)=3^{-x}-1$, for $-1\le x<0$

= $\tan(x/2)$, for $0\le x<\pi$

= $\frac{x}{x^2-2}$ for $\pi\le x\le 6$

then $f(-1)+f(\pi/6)+f(5)=$

A) 0 B) $\frac{27}{23}-\sqrt{3}$ C) $\frac{27}{13}+\sqrt{13}$ D) $\frac{97}{23}-\sqrt{3}$

40. If $f(x)=\frac{3x-x^3}{1-3x^2}$, $\tan\theta\ne\frac{1}{\sqrt{3}}$ then $f(\tan\theta)$ =

A) 3 tan θ B) tan 3θ C) $\tan^3\theta$ D) $\tan^4\theta$

41. If f(x) = $Sin([\pi^2]x)+\sin([-\pi^2]x)$ then $f\left(\frac{\pi}{2}\right)$ =

A) -1 B) 1 C) 0 D) 2

42. If If $f\left(x\right)=x^2, g\left(x\right)=x^2-5x+6$ then $\dfrac{g\left(2\right)+g\left(3\right)+g\left(0\right)}{f\left(0\right)+f\left(-1\right)+f\left(2\right)}=$

A) 2 B) 1 C) 5/6 D) 6/5

ACHIEVERS (Level - II)

Solve the following

1. If $f:R\to R, g:R\to R$ are defind by f(x) =4x-1 and g(x) = x^2+2 then find

(i) (gof) (x) ii) (gof)$\left(\dfrac{a+1}{4}\right)$ iii) (f0f) iv) (go(fof))(0)

2. If f = {(1,2),(2, -3), (3, -1)} then find i) 2f ii) 2+f iii) f^2 iv) $\sqrt{f}$

3. If f(x) = $\dfrac{\sin^2 x+\cos^4 x}{\cos^2 x+\sin^4 x}$ then show that f(2015)=1.

4. Determine whether the function f(x) = $x\left(\dfrac{e^x-1}{e^x+1}\right)$ is even or odd.

5. If f(x) = cos (logx) then show that $f\left(\dfrac{1}{x}\right)f\left(\dfrac{1}{y}\right)-\dfrac{1}{2}\left(f(xy)+f\left(\dfrac{x}{y}\right)\right)=0$

6. If A ={0, $\dfrac{\pi}{6},\dfrac{\pi}{4},\dfrac{\pi}{3},\dfrac{\pi}{2}$ } and $f:A\to B$ f(x)=cosx is surjection then find B.

EXPLORERS (Level - III)

ASSERTION AND REASON

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of* which ***ONLY ONE*** *is correct Choose the correct option.*

1. ***A:*** $f\left(x\right)=\log\left(x-2\right)+\log\left(x-3\right)$ and $g\left(x\right)=\log\left(x-2\right)\log\left(x-3\right)$ then $f\left(x\right)=g\left(x\right)$

R: Two functions $f\left(x\right) and g\left(x\right)$ are said to be equal if they aredefined on the same domain A and the codomain B as $f\left(x\right)=g\left(x\right)\forall x\in A$

A) Both A and R are true and R is the correct explanation of A
B) Both A and R are true but R is not correct explanation of A
C) A is true but R is false D) A is false but R is true

2. **A :** f(x) = 1+x^2 is a 1-1 function from $R^+\to R$
R : Every strictly monotonic function is a 1-1 function.
A) Both A and R are true and R is the correct explanation of A
B) Both A and R are true but R is not correct explanation of A
C) A is true but R is false D) A is false but R is true

3. **A :** f(x) = $\frac{x+1}{x-1}, x \neq 1$ then (fofofofof)(x) = f(x)

R: If f(x) = $\frac{ax+b}{cx+d}$ then (fofof..... (odd no of times))(x) = f(x)

A) Both A and R are true and R is the correct explanation of A
B) Both A and R are true but R is not correct explanation of A
C) A is true but R is false D) A is false but R is true

4. **I :** Every function must be either even or odd function

II: The function f(x) = log$\left(x+\sqrt{x^2+1}\right)$ is an odd function

A) only I is true B) only II is true
C) both I & II are true D) neither I nor II are true

5. **I :** If $f: A \to B$ is bijection then only f has inverse function

II : the inverse function $f: R^+ \to R^+$ defined by f(x)=x^2 is $f^{-1}(x) = \sqrt{x}$

A) only I is true B) only II is true

MATCH THE FOLLOWING

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*
  *If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

6.

List - I	List - II
i) The number of relations from A={1,3,5} to B = {a,b,c} is	a) 15
ii) The number of 1-1 functions from A to A is 720 then n(A)	b) 512
iii) The number of constant functions that can be defined	c) 1
iv) The number of identity functions on the set A = {1,2,3,4,5,6}	d) 14

A)i-c,ii-e,iii-a,iv- d, B) i-c,ii-a,iii-e,iv-d
C)i-c,ii-b,iii-a,iv-d D) i-c,ii-e,iii-a,iv-b

7. If $f: R \to R$ is defined by f(x)= $\begin{cases} x+4, for\ x < -4 \\ 3x+2, for\ x \leq x < 4 \\ x-4, for\ x \geq 4 \end{cases}$ then the correct matching

List - I	List - II
i) f(-5) +f(-D)	a) 14
ii) f(|f(-8)|) =	b) 4
ii) f[f(-7)+f(C)]	c) -11
iv) f[f(f(f(0)))]+1	d) -1
	e) 1
	f) 0

A)i-c,ii-f,iii-b,iv-e B)i-c,ii-d,iii-b,iv-f C)i-d,ii-c,iii-b,iv-a D)i-d,ii-e,iii-b,iv-c

RESEARCHERS (Level - IV)

MCQs with single correct answer

1. To have inverse for the function f, f should be **(E-98)**

A) one-one B) onto C) one-one and onto D) Identity function

2. If $n \geq 2$ then the number of surjections that can be defined from {1,2,3,....n} onto {1, 2} is **(EAM-92)**

A) $n^2 - n$ B) n^2 C) 2^n D) $2^n - 2$

3. $n(A) = 3, n(B) = 2$ then the number of surjections from A to B **(EAM-94)**

A) 3 B) 6 C) 8 D) 9

4. The number of bijection from the set A to itself when A contains 106 elements is **(EAM-93)**

A) 106 B) 106^2 C) 106! D) 2^{106}

5. $f: Z \to Z$ and $f(x) = x^2$ then f is **(EAM-95)**

A) bijection B) injection C) surijection D) not bijection

6. $f: R \to R$ is defined as $f(x) = 3^x$ then which of the following is correct **(EAM-01)**

I) f is one-one II) f is onto III) f is a increasing function

A) I, II only B) II, III only C) I, III only D) I, II, III

7. If $f: R \to R, f(x) = 3x - 2$ then $(fof)(x) + 2 =$ **(EAM-99)**

A) $f(x)$ B) $2f(x)$ C) $3f(x)$ D) $-f(x)$

8. $f: R \to R,\ g: R \to R$ and $f(x) = Sin\,x$ $g(x) = x^2$ then $fog(x) =$ **(EAM-99)**

A) $x^2 + Sin\,x$ B) $x^2\, Sin\,x$ C) $Sin^2\,x$ D) $Sin\,x^2$

9. If $f: R^+ \to R$ such that $f(x) = \log_5 x$ then $f^{-1}(x) =$ **(EAM-97)**

A) $\log_x 10$ B) 5^x C) 3^{-x} D) $3^{1/x}$

10. $f(1) = 1, n \geq 1 \Rightarrow f(n+1) = 2f(n) + 1$ then $f(n)$ = **(EAM-92)**

A) 2^{n+1} B) 2^n C) $2^n - 1$ D) $2^{n-1} - 1$

11. $f(a) = \log\left(\frac{2+a}{2-a}\right), 0 < a < 2$ then $\frac{1}{2} f\left(\frac{8a}{4+a^2}\right) =$ **(EAM-96)**

A) $f(a)$ B) $2f(a)$ C) $\frac{1}{2}f(a)$ D) $-f(a)$

12. $f: R \to R$ is defined as $f(x) = 2x + |x|$ then $f(3x) - f(-x) - 4x =$ **(EAM-97)**

A) $f(x)$ B) $-f(x)$ C) $f(-x)$ D) $2f(x)$

13. If f:[2,3] $\to$ R is defined by f(x) = x^2 +3x-2, then the range of f(x) is contained in the interval **(EAM-2009)**

A) [1,12] B) [12, 34] C) [35,50] D) [-12,12]

14. Domain of f(x)= $\frac{2x-1}{x^3 + 4x^2 + 3x}; x \in R$ **(EAM-2009)**

A) R-{0} B) R-{0,1,3} C) R-{0,-1,-3} D) R-{0,-1,-3,1/2}

15. The no.of subsets of {1,2,3,.......9} containing at least one odd number is **(EAM-2009)**
A)324 B)396 C)496 D)512

16. $f:[-6,6]\to R$ defined by f(x) = x^2-3 for $x\in R$ then(fofof)(-1) +(f0f0f)(0)+(f0f0f)(1)= **(EAM-2008)**

A) $f(4\sqrt{2})$ B) $f(3\sqrt{2})$ C) $f(2\sqrt{2})$ D) $f(\sqrt{2})$

17. $f:R\to R$ is a function defined by f(x) = 10x - 7. If g=f^{-1} then g(x) = **(EAM-92)**

A) $\frac{1}{10x-7}$ B) $\frac{1}{10x+7}$ C) $\frac{x+7}{10}$ D) $\frac{x-7}{10}$

KEY

ΦΦ TEACHING TASK :

1.C	2.A	3.C	4.D	5.A	6.B	7.B	8.C	9.D	10.A
11.C	12.C	13.C	14.D	15.C	16.D	17.B	18.B	19.B	20.C
21.B	22.A	23.D	24.C	25.D	26.B	27.C	28.B	29.B	30.C
31.A	32.A	33.B	34.A	35.D	36.A	37.A	38.A	39.C	40.C
41.C	42.C	43.D	44.C	45.C	46.D	47.C	48.C	49.B	50.D
51.B	52.B	53.D	54.D	55.C	56.C	57.A	58.C	59.B	60.C
61.D	62.A	63.D	64.C	65.C	66.B	67.D	68.C	69.A	70.B

ΦΦ LEARNER'S TASK :

☐ **BEGINNERS :**

1.A	2.D	3.B	4.C	5.D	6.B	7.C	8.B	9.A	10.D
11.B	12.D	13.C	14.D	15.C	16.D	17.A	18.C	19.C	20.C
21.A	22.A	23.D	24.D	25.A	26.C	27.D	28.D	29.B	30.B
31.C	32.D	33.C	34.C	35.B	36.D	37.C	38.B	39.D	40.B
41.B	42.D								

☐ **ACHIEVERS:**

1) i) $16x^2$ -8x+3 ii) a^2+2 iii) 16x-5 iv) 27
2) i) {(1,4),(2,-6), (3,-2)} ii) {(1,4), (2,-1), (3,1)
iii) {(1,4), (2,9), (3,1)} iv) {(1, $\sqrt{2}$)}

4. Even function 6.B= $\left\{1,\frac{\sqrt{3}}{2},\frac{1}{\sqrt{2}},0,\frac{1}{2}\right\}$

☐ **EXPLORERS:** 1.B 2.A 3.B 4.B 5.C 6.C 7.A

☐ **RESEARCHERS:**

1.C	2.D	3.B	4.C	5.D	6.C	7.C	8.D	9.D	10.C
11.A	12.D	13.B	14.C	15.C	16.A	17.C			