# FUNCTIONS – I

## Class IX, Mathematics + IIT FOUNDATION

## SOLUTIONS

## TEACHING TASK

01. $f(x) = \dfrac{1}{\sqrt{|x| - x}}$

f is defined only when $|x| - x > 0$

$\Rightarrow |x| > x$

This is possible only when $x \in (-\infty, 0)$

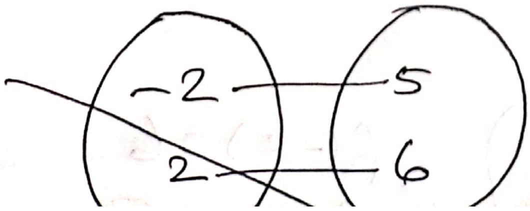
Ans : opt: A

02. $n(A) = n$, $n(B) = 2$

No. of Surjection $= 2^n - 2 = 62$

$\Rightarrow n = 5$

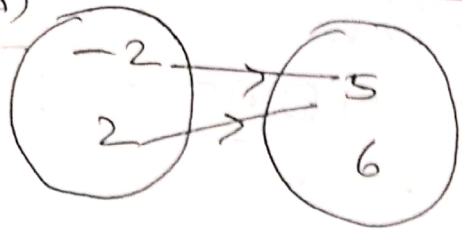
Ans : opt: A

03. 


~~here~~ $\cancel{f(-2) = 5}$

$\cancel{f(2) = 6}$

Q3 Case (i)




$f(-2) = 5$
$f(2) = 5$

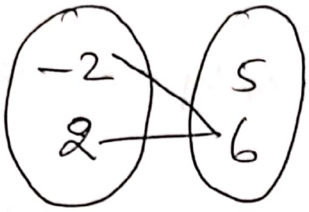


$f(x) = ax + b$

$f(-2) = 5 \Rightarrow$ $-2a + b = 5$
$\underline{\ \ 2a + b = 5}$
$-\ \ -\ \ -$
$a = 0$.

here $a = 0$, this is not possible

Case (ii)

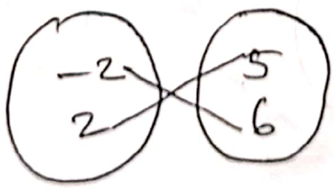



$f(-2) = 6$
$f(2) = 6$

$-2a + b = 6$
$\underline{\ \ 2a + b = 6}$
$-\ \ -\ \ -$
$a = 0$

here $a = 0$, this is not possible

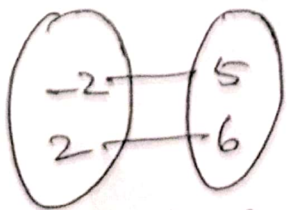
Case (iii)




$f(-2) = 6$
$f(2) = 5$

$\left.\begin{aligned} -2a + b &= 6 \\ 2a + b &= 5 \end{aligned}\right\}$ we can solve for $a$ & $b$

Case (iv)




$f(-2) = 5$
$f(2) = 6$

$\left.\begin{aligned} -2a + b &= 5 \\ 2a + b &= 6 \end{aligned}\right\}$ we can solve for $a$ & $b$

hence there only 2 linear functions ③

Ans : opt C

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04. $x_1, x_2, x_3 \rightarrow A.P$ let $f(x) = e^x$ or $a^x$

let $1, 2, 3 \rightarrow A.P.$

$e^1, e^2, e^3 \rightarrow G.P.$

Ans : B

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05 $f(x) = \cos(\log x)$

$f\left(\frac{x^2}{y^2}\right) = \cos\left(\log\left(\frac{x^2}{y^2}\right)\right)$

$= \cos(\log x^2 - \log y^2)$

$f(x^2y^2) = \cos(\log(x^2y^2))$

$= \cos(\log x^2 + \log y^2)$

$f\left(\frac{x^2}{y^2}\right) + f(x^2y^2) = \cos(\log x^2 - \log y^2) + \cos(\log x^2 + \log y^2)$

$= 2\cos(\log x^2).\cos(\log y^2)$

$\frac{1}{2}\left[f\left(\frac{x^2}{y^2}\right) + f(x^2y^2)\right] = f(x^2).\ f(y^2)$

$\therefore f(x^2).f(y^2) - \frac{1}{2}\left[f\left(\frac{x^2}{y^2}\right) + f(x^2y^2)\right] = 0$

Ans : B

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06 $f(x).g(y) + g(x).f(y)$

$= \frac{1}{2}(3^x + 3^{-x}).\frac{1}{2}(3^y - 3^{-y}) + \frac{1}{2}(3^x - 3^{-x}).\frac{1}{2}(3^y + 3^{-y})$

$= \frac{1}{4}\left[3^{x+y} - \cancel{3^{x-y}} + \cancel{3^{y-x}} - 3^{-(x+y)} + 3^{x+y} + \cancel{3^{x-y}} - \cancel{3^{-x+y}} - 3^{-(x+y)}\right]$

$= \frac{2}{4}\left[3^{x+y} - 3^{-(x+y)}\right] = \boxed{\cancel{\tfrac{1}{2}}\ \cancel{f(x+y)}} = g(x+y)$

~~op~~ Ans : B

07. $y = f(x) = 10x - 7$ ④

$10x - 7 = y \Rightarrow x = \frac{y+7}{10}$

$\therefore f^{-1}(x) = \frac{x+7}{10} = g(x)$ Ans : C

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08 $f(201) = -\left(\frac{201-1}{2}\right) = -100$

Ans : C

$\therefore f^{-1}(-100) = 201.$

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09. Given $\sin^{-1}(x) + \cos^{-1}(x) + \tan^{-1}(x)$

first we find the domain

$\sin^{-1}x \longrightarrow$ domain $[-1, 1]$

$\cos^{-1}x \longrightarrow$ domain $[-1, 1]$

$\tan^{-1}x \longrightarrow$ domain $(-\infty, \infty)$

$\therefore$ Domain of $f(x) = [-1, 1]$

Now $f(x) = \sin^{-1}x + \cos^{-1}x + \tan^{-1}x$

$f(x) = \frac{\pi}{2} + \tan^{-1}x$

$f'(x) = \frac{1}{1+x^2} > 0$

$\therefore$ f is an increasing function

$\therefore f(-1) = \frac{\pi}{2} + \tan^{-1}(-1) = \frac{\pi}{2} - \frac{\pi}{4} = \frac{\pi}{4}$

$f(1) = \frac{\pi}{2} + \tan^{-1}(1) = \frac{\pi}{2} + \frac{\pi}{4} = \frac{3\pi}{4}$

$\therefore$ Range $= \left[\frac{\pi}{4}, \frac{3\pi}{4}\right]$ Ans : B.

10 We have $(a+b+c)^2 \geq 0$ (5)

$\Rightarrow a^2+b^2+c^2+2(ab+bc+ca) \geq 0$

$\Rightarrow \quad ab+bc+ca \geq -\frac{1}{2} \longrightarrow (1)$

Also $a^2+b^2+c^2-(ab+bc+ca)$

$= \frac{1}{2}\left[(a-b)^2+(b-c)^2+(c-a)^2\right] \geq 0$

$= \quad 1-(ab+bc+ca) \geq 0$

$\Rightarrow \quad ab+bc+ca \leq 1 \longrightarrow (2)$

from (1) and (2) $-\frac{1}{2} \leq ab+bc+ca \leq 1$

Ans: A

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11. $f(n) = 1!+2!+3!+ \cdots +n! \longrightarrow (1)$

$f(n+1) = 1!+2!+3!+ \cdots n!+(n+1)! \rightarrow (2)$

$f(n+2) = 1!+2!+3!+ \cdots +(n+1)!+(n+2)! \rightarrow (3)$

$(2)-(1) \Rightarrow f(n+1)-f(n) = (n+1)!$

$(3)-(2) \Rightarrow f(n+2)-f(n+1) = (n+2)!$

$= (n+2)(n+1)!$

$= (n+2)\left[f(n+1)-f(n)\right]$

$= (n+2)f(n+1) - (n+2)f(n) \quad \cancel{f(n)}$

$\Rightarrow (n+3)f(n+1)-(n+2)f(n) = f(n+2)$

$\therefore f(n+2) = (n+3)f(n+1)-(n+2)f(n)$

$f(n+2) = P(n)f(n+1)+Q(n)\cdot f(n)$

$\therefore P(x) = x+3, \; Q(x) = -x-2$

Ans: A, B

12. Consider option: c

$f(x) = x^3 - 3x$

$\Rightarrow f\left(x+\frac{1}{x}\right) = \left(x+\frac{1}{x}\right)^3 - 3\left(x+\frac{1}{x}\right)$

$= x^3 + \frac{1}{x^3} + 3 \cdot x \cdot \frac{1}{x}\left(x+\frac{1}{x}\right) - 3\left(x+\frac{1}{x}\right)$

$= x^3 + \frac{1}{x^3}$

13. Statement I: $x^2 - 3x + 2 > 0$

$\Rightarrow (x-1)(x-2) > 0$

$\Rightarrow (-\infty, 1) \cup (2, \infty)$.

Statement II: $(x-a)(x-b) > 0$

$\Rightarrow (-\infty, a) \cup (b, \infty)$ Ans: A

14. Statement I: $n(A) = 4$, $n(B) = 8$.

No. of relations from A to B $= 2^{4\times 8} = 2^{32}$.

No. of functions from A to B $= 8^4 = 4096$.

No. of relations which are not functions

$\therefore$ No. of relations $= 2^{32} - 4096 \neq 4096$.

clearly statement I is false.

Statement II:

Many-one functions = total functions − one-one functions

$= 4^3 - {}^4P_3$

$= 64 - 24 = 40$.

Hence, statement II is True. Ans: C

15. Domain of $\sqrt{\dfrac{x-2}{x-3}} = (-\infty, 2] \cup (3, \infty)$

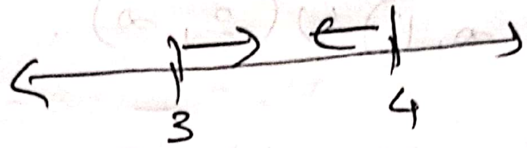
Ans: D

16. Domain of $\sqrt{\dfrac{3-x}{4-x}} =$

$\dfrac{3-x}{4-x} \geq 0$ and $4-x \neq 0$

$\Rightarrow (3-x)(4-x) \geq 0$ and $x \neq 4$

$\Rightarrow (x-4)(x-3) \leq 0$

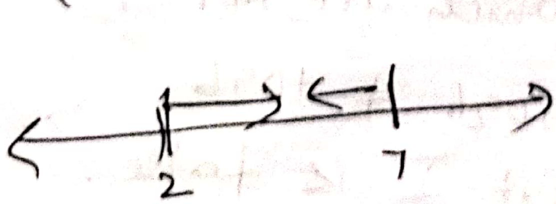



Domain $= [3, 4)$ Ans: B

17. $\dfrac{2-x}{x-7} \geq 0$ and $x-7 \neq 0$

$\Rightarrow (2-x)(x-7) \geq 0$ and $x \neq 7$

$\Rightarrow (x-2)(x-7) \leq 0$




Ans: B

Domain $= [2, 7)$

18 : $x^2+x+1>0$ and $x^2+x+1 \neq 1$

$\Delta < 0$

$\therefore \forall x \in R,\ x^2+x+1>0$

$x^2+x \neq 0$

$x(x+1) \neq 0$

$x \neq 0$ or $x+1 \neq 0$

$\Rightarrow x \neq -1$

Hence Domain $= R - \{0, -1\}$

Ans: B

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19. $f(x) = \log(x^2+x+1)$

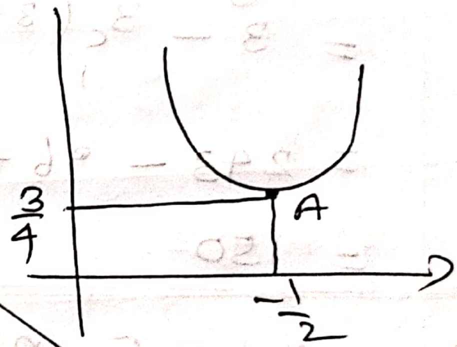
Domain $\rightarrow$ $x^2+x+1>0$

Since $\Delta<0 \Rightarrow x^2+x+1>0 \ \forall x \in R.$

$\therefore$ Domain $= R$.

$A = \left(\frac{-b}{2a}, \frac{4ac-b^2}{4a}\right)$

$= \left(\frac{-1}{2}, \frac{3}{4}\right)$




Lowest point $= \frac{3}{4}$.

Hence Range $= \left[\frac{3}{4}, \infty\right)$

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19. $f(x) = \log(x^2+x+1)$ Since $\Delta<0$.

$x^2+x+1>0 \ \forall x \in R$

Minimom value $= \frac{4ac-b^2}{4a} = \frac{3}{4}.$

minimom value of $\log(x^2+x+1) = \log\left(\frac{3}{4}\right)$

Hence Range $= \left[\log\left(\frac{3}{4}\right), \infty\right)$

Ans. A

20. $f(x) = \dfrac{2^x}{x+2}$

$\Rightarrow x+2 \neq 0$

$\Rightarrow x \neq -2$

$\therefore$ Domain $= R - \{-2\}$ Ans.. D

21. $n(x) = 5,\ n(y) = 3$

No. of Surjections $= n^m - {}^nC_1 (n-1)^m + {}^nC_2 \cdot (n-2)^m - \ldots$

here $m = 5,\ n = 3$

$= 3^5 - {}^3C_1 (3-1)^5 + {}^3C_2 (3-2)^5 - {}^3C_3 (3-3)^5.$

$= 243 - 96 + 3$

$= 150$

22. $n(A) = 5,\ n(B) = 2$

No. of Surjections $= 2^n - 1$

$= 2^5 - 1$

$= 31$

23. $f(x) = \cos[\pi^2]x + \cos[-\pi^2]x$

$= \cos[9.859]x + \cos[-9.859]x$

Since $\pi = 3.14$

$= \cos 9x + \cos(-10)x$

$= \cos 9x + \cos 10x$

a) $f\left(\frac{\pi}{2}\right) = \cos \frac{9\pi}{2} + \cos 10 \cdot \frac{\pi}{2}$

$= 0 - 1 = -1$

b) $f\left(\frac{\pi}{4}\right) = \cos 9\frac{\pi}{4} + \cos 10 \cdot \frac{\pi}{4}$

$= \cos 375^\circ + \cos 225^\circ$

$= \cos 15^\circ - \cos 45^\circ$

$= \frac{\sqrt{3}+1}{2\sqrt{2}} - \frac{1}{\sqrt{2}}$

$= \frac{\sqrt{3}+1-2}{2\sqrt{2}} = \frac{\sqrt{3}-1}{2\sqrt{2}}$

c) $f(\pi) = \cos 9\pi + \cos 10\pi$

$= \cos(2\times 2\pi - \pi) + \cos(2\times 5\pi)$

$= \cos\pi + \cos 0$

$= -1 + 1$

$= 0$

d) $f(0) = \cos 0 + \cos 0$

$= 1 + 1$

$= 2$

Ans: q, —, p, r.

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24 a) $1 + x > 0$

$\Rightarrow x > -1$ Domain $= (-1, \infty)$

b) $|x| - x > 0$

$\Rightarrow |x| > x$ Domain $= (-\infty, 0)$

c) $1 - |x| > 0$

$\Rightarrow |x| < 1$ Domain $= [-1, 1]$

d) $f(x) = \sqrt{-x^2}$ Domain $= \phi$

Ans: —, s, r —

# LEARNERS TASK



CUQ's

01. $A \times B = \{(1,x),(1,y),(2,x),(2,y),(3,x),(3,y)\}$

Ans: B

02. No. of relations $= 2^{m \times n}$

Ans: C

03. No. of functions $= n^{m}$

Ans: A

04. $f(x) = 3x^4 + 6x^3 - 7x^2 + 2$

Ans: C

05. Conceptual

Ans: B

06. ${}^{n}P_{m}$ $(n \geq m)$

Ans: B

07. $f(A) \neq B$

Ans: A

08. No. of Bijections $= n!$

Ans: D

09. $f(x) = 2x^2 + 3x - 5$

$f(1) = 2(1)^2 + 3(1) - 5$

$= 0$

Similarly other values follows.

Range $= \{0, 9, 22, 39, 60\}$

Ans: A

10. i) when $x$ is very Large and positive,

$e^{-x}$ approaches to $0$.

10 (i) when $x$ is very Large and positive, (12)

$10^{-x}$ approaches 0

(ii) when $x$ is very Large and negative,

$10^{-x}$ approaches infinity

(iii) when $x=0$, $10^{-x}=1$.

$\therefore$ Range $=(0,\infty)$

Ans : C

## JEE-MAIN LEVEL QUESTIONS

01. $f(2)+f(3)=(2^2-5.2+6)+(3^2-5.3+6)$

$=(4-10+6)+(9-15+6)$

$=0+0$

$=0$

Ans : C

02. $f(1+x)=x^2+1$

Let $1+x=y \Rightarrow x=y-1$

$\therefore f(y)=(y-1)^2+1$

$=y^2-2y+2 \quad \therefore f(x)=x^2-2x+2$

$f(2-h)=(2-h)^2-2(2-h)+2$

$=4+h^2-4h-4+2h+2$

$=h^2-2h+2$

Ans : B

03 $n(A)=100$, $n(B)=26$

No. of Constant functions $=n(B)=26$

Ans : D

04. $n(A)=n(B)=4$

No. of Bijections $=4!$

Ans : C

05 $f(x) = 2x + |x|$ 

$$f(x) = \begin{cases} 3x & x \geq 0 \\ x & x < 0 \end{cases}$$

Now given $f(3x) - f(-x) - 4x$

$$f(3x) = \begin{cases} 9x & x \geq 0 \\ 3x & x < 0 \end{cases} \Rightarrow \phi$$

$$f(-x) = \begin{cases} -3x & x \leq 0 \\ -x & x > 0 \end{cases}$$

Now, to calculate $f(3x) - f(-x) - 4x$

case (i) $x > 0$

$f(3x) = 9x$, $f(-x) = -x$

$f(3x) - f(-x) - 4x = 9x + x - 4x$
$= 6x$

case (i) $x < 0$

$f(3x) - f(-x) - 4x = 3x - (-3x) - 4x$
$= 2x$

$$\therefore f(3x) - f(-x) - 4x = \begin{cases} 6x & \text{if } x \geq 0 \\ 2x & \text{if } x < 0 \end{cases}$$

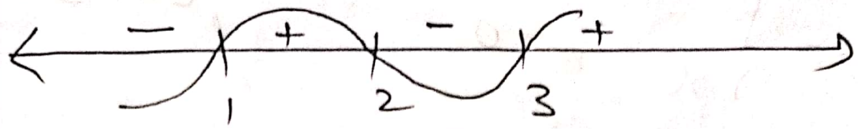
$= 2|x| + 4x$

$= 2[|x| + 2x]$

$= 2f(x)$

Ans : D

06. $(x-1)(x-2)(x-3) \geq 0$




Domain $= [1,2] \cup [3, \infty)$

Ans: D

07. $f(-3) = (-3)^2+1 = 10$

$f(2) = 2(2)-1 = 3$

$f(5) = 4(5)+3 = 23$

$f(1) = 2(1)-1 = 1$

$\therefore \dfrac{f(-3)+f(2)+f(5)}{f(1)} = \dfrac{10+3+23}{1} = 36$

Ans: B

08 $f(x) + 2 \cdot f\left(\frac{1}{x}\right) = 3x \longrightarrow (1)$

$f\left(\frac{1}{x}\right) + 2f(x) = \frac{3}{x} \longrightarrow (2)$

$(2) \times 2 \Rightarrow \quad 2f\left(\frac{1}{x}\right) + 4f(x) = \frac{6}{x}$

$(1) \Rightarrow \quad \underline{\underset{-}{}2f\left(\frac{1}{x}\right) \underset{-}{+} f(x) = \underset{-}{}3x}$

$3f(x) = \frac{6}{x} - 3x$

$\Rightarrow f(x) = \frac{2}{x} - x$

Now $f(x) = f(-x)$

$\Rightarrow \frac{2}{x} - x = \frac{-2}{x} + x$

$\Rightarrow \frac{4}{x} - 2x = 0$

$\Rightarrow \frac{2}{x} - x = 0$

$\Rightarrow 2 - x^2 = 0$

$x = \pm\sqrt{2}$

Ans: C

09. $-1 \le x \le 1$

$-5 \le 5x \le 5$

$-1 \le 5x+4 \le 9$ Ans: B

10 $f(x) = \sin^2 x + \cos^4 x$

$= \sin^2 x + (1-\sin^2 x)^2$

$= \sin^4 x - \sin^2 x + 1$

$= \sin^2 x(\sin^2 x - 1) + 1$

$= -\sin^2 x \cdot \cos^2 x + 1$

$= -\frac{1}{4}(2\sin x\cos x)^2 + 1$

$= -\frac{1}{4}\sin^2 2x + 1$

We know $0 \le \sin^2 2x \le 1$

$0 \ge -\frac{1}{4}\sin^2 2x \ge -\frac{1}{4}$

$-\frac{1}{4}+1 \le -\frac{1}{4}\sin^2 2x + 1 \le 1$

$\Rightarrow \frac{3}{4} \le f(x) \le 1$

$\therefore$ Range $= [\frac{3}{4}, 1]$ Ans: A

11. $f(x+y) = f(x) + f(y)$

$\Rightarrow f(x) = Kx \quad K \in R - \{0\}$

$\Rightarrow f(1) = K \cdot 1 = 2 \quad \Rightarrow K = 2$

$\therefore f(x) = 2x$ Ans: B

12 $f(x+y) = f(x) + f(y)$ (16)

$\Rightarrow f(x) = Kx$

$\Rightarrow f(1) = K \cdot 1 = 7 \Rightarrow K = 7$

$\therefore f(x) = 7x$

$\sum_{r=1}^{n} f(r) = f(1) + f(2) + f(3) + \cdots + f(n)$

$= 7 \cdot 1 + 7 \cdot 2 + 7 \cdot 3 + \cdots + 7 \cdot n$

$= 7(1+2+3+ \cdots + n)$

$= \frac{7 \cdot n(n+1)}{2}$ Ans: D

13. Statement I:

Domain of $f = R^+$

Domain of $g = N$.

hence the given functions are equal functions. (False)

Statement II: Conceptual (True)

Ans: D

14. Statement I:

$f(x) = \frac{1-x^2}{1+x^2}$

$f(\tan\theta) = \frac{1-\tan^2\theta}{1+\tan^2\theta}$

$= \cos 2\theta$ (True)

Statement II: False Ans: C

15 Statement I Conceptual (False)

Statement II:

No. of onto functions $= n^m - {}^nC_1 (n-1)^m + {}^nC_2 (n-2)^m - \dots$

$= 3^4 - {}^3C_1 (3-1)^4 + {}^3C_2 (3-2)^4$

$= 81 - 48 + 3$

$= 36$ (False)

Ans. B

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16 $f(x) = \cos 3x$

$f(-x) = \cos 3(-x)$

$= \cos 3x = f(x)$

Ans: A

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17 $f(x) = x^2 + x + 1$

$g(-x) = (-x)^2 + (-x) + 1$

$= x^2 - x + 1 \neq g(x)$

$g(x)$ is neither even nor odd

Ans: C

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18 $gof(x) = g(f(x))$

$= g(1-x^4)$

$= (1-x^4)^2 + 1$

$= 1 - 2x^4 + x^8 + 1$

$= x^8 - 2x^4 + 2$

$gof(-x) = x^8 - 2x^4 + 1 = gof(x)$

$gof(x)$ is even function

Ans: A

19. $A = \{a, e, i, o\} \Rightarrow n(A) = 4$

$B = \{2, 3, 5, 7\} \rightarrow n(B) = 4$

No of Bijections $= 4! = 24$ Ans: B

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20. $n(A) = 3$ Ans: B

No of bijections $= 3! = 6$

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21. Let $f(x) = x$

$f(x + f(x)) = f(x + x)$ | $x + f(x) = x + x$
$= 2x$

$= f(2x)$

$= 2x$, which is linear function

Let $f(x) = -x$

~~$f(-x-x) = f(-2x) =$~~

$f(x + f(x)) = f(x - x) = f(0) = 0$

$x + f(x) = x - x = 0$

hence, there only two linear functions satisfying the given condition. Ans: 2

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22. $n(A) = 5$, $n(B) = 3$

No. of Many to one-one function = total No. of functions − one-one functions

$= 3^5 - 0$

$= 243$ Ans. 243

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23 $f(x) = \dfrac{7^{1+\log_e^x}}{x^{\log_e^7}}$

$= \dfrac{7 \cdot \cancel{7^{\log_e^x}}}{\cancel{7^{\log_e^x}}} = 7$

$\therefore f(2014) = 7$

Ans: 7

24 a) $|x| - x \neq 0 \quad \forall x \in (-\infty, 0)$

$\Rightarrow |x| \neq x$

b) $|x|$ Domain $= R$

c) $\sec x$ Domain $= R - \{(2n+1)\frac{\pi}{2}\}$

d) $\sqrt{x}$ Domain $= [0, \infty)$

Ans: t, s, r, q

25 a) $-1 \leq \cos x \leq 1$

$-2 \leq 2\cos x \leq 2$

$2 \geq -2\cos x \geq -2$

$3 \geq 1 - 2\cos x \geq -1$

25 a) $-1 \le \cos x \le 1$

$-2 \le 2\cos x \le 2$

$2 \ge -2\cos x \ge -2$

$-2 \le -2\cos x \le 2$

$-1 \le 1-2\cos x \le 3$

$-1 \ge \dfrac{1}{1-2\cos x} \ge \dfrac{1}{3}$


~~Dom~~ Range $= (-\infty, -1] \cup [\frac{1}{3}, \infty)$

b) $-1 \le \cos 2x \le 1$

$-3 \le 3\cos 2x \le 3$

$-2 \le 1+3\cos 2x \le 4$

Range $= [-2, 4]$

c) $5\sin x + 12\cos x - 13$

max. value $= c + \sqrt{a^2+b^2}$

$= -13 + \sqrt{25+144}$

$= -13 + 13$

$= 0$

min. value $= -13-13$

$= -26$

Range $= \cancel{[0,-26)} = [-26, 0]$

d) $|x-2|$

Range $= [0, \infty)$

Ans: r, q, p, t

# ADDITIONAL PRACTICE QUESTIONS



01. No. of constant functions $= n(B) = n$

Ans : B

02. $n(A) = 10$, $n(B) = 20$

No. of functions $= 20^{10}$

Ans. D

03. $n(A) = 4$, $n(B) = 6$

No. of one-one function $= {}^6P_4$

Ans. C

04. $n(A) = 106$

No. of Bijections $= 106!$

Ans: C

05. $f(x) = |x|$, $g(x) = [x-3]$

$\therefore g(f(x)) = g(|x|)$

$= [|x|-3]$

Given $-\frac{8}{5} < x < \frac{8}{5}$

$\Rightarrow 0 < |x| < \frac{8}{5}$

$\Rightarrow -3 < |x|-3 < -\frac{7}{5}$

$\Rightarrow [-3] \leq [|x|-3] < [-\frac{7}{5}]$

05 $f(x) = |x|$, $g(x) = [x-3]$

(22)

$g(f(x)) = g(|x|)$

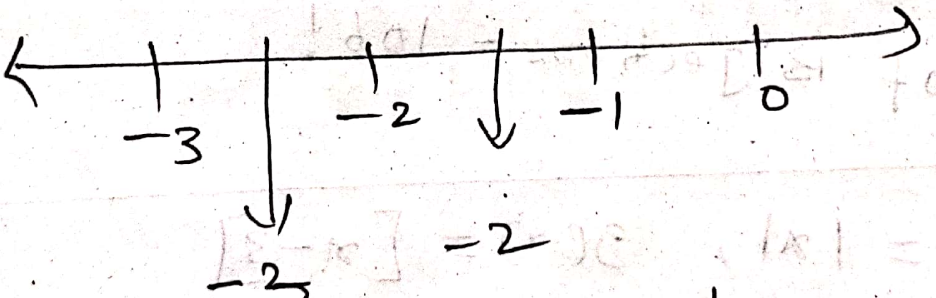
$= [|x|-3]$

Given $-\frac{8}{5} < x < \frac{8}{5}$

$0 < |x| < \frac{8}{5}$

$-3 < |x|-3 < -\frac{7}{5}$

$-3 < |x|-3 < -1.4$




Ans = C

$\therefore$ $[|x|-3] = \{-3, -2\}$

⇒ THE END ∈