Sample Question Paper - 5
CLASS: XII
Session: 2021-22
Mathematics (Code-041)
Term - 1

Time Allowed: 1 hour and 30 minutes **Maximum Marks: 40**

General Instructions:

1. This question paper contains three sections - A, B and C. Each part is compulsory.
2. Section - A has 20 MCQs, attempt any 16 out of 20.
3. Section - B has 20 MCQs, attempt any 16 out of 20
4. Section - C has 10 MCQs, attempt any 8 out of 10.
5. There is no negative marking.
6. All questions carry equal marks.

Section A

Attempt any 16 questions

1. f : $\left[\frac{-\pi}{2}, \frac{\pi}{2}\right] \rightarrow$ [-1, 1] : f(x) = sin x is **[1]**

   a) many one and into
   b) one one and into
   c) many one and onto
   d) one one and onto

2. Maximize Z = 100x + 120y , subject to constraints 2x + 3y ≤ 30, 3x + y ≤ 17, x ≥ 0, y ≥ 0. **[1]**

   a) 1260
   b) 1280
   c) 1300
   d) 1200

3. The derivative of $\cos^{-1}\left(2x^2 - 1\right)$ w.r.t. $\cos^{-1} x$ is **[1]**

   a) $1 - x^2$
   b) 2
   c) $\frac{-1}{2\sqrt{1-x^2}}$
   d) $\frac{2}{x}$

4. If A is an invertible matrix of order 3, then which of the following information is NOT true? **[1]**

   a) $(AB)^{-1} = B^{-1} A^{-1}$, where B = $[b_{ij}]_{3\times 3}$ and $|B| \neq 0$
   b) $(A^{-1})^{-1} = A$
   c) $|\text{adj } A| = |A|^2$
   d) If BA = CA, then B $\neq$ C, where B and C are square matrices of order 3

5. The region represented by the inequation system x, y $\geq$ 0, y $\leq$ 6, x + y $\leq$ 3 is **[1]**

   a) unbounded in first and second quadrants
   b) bounded in first quadrant
   c) None of these
   d) unbounded in first quadrant

6. The function f(x) = $\frac{x}{1+|x|}$ is **[1]**

a) strictly increasing

b) strictly decreasing

c) none of these

d) neither increasing nor decreasing

7. For any 2-rowed square matrix A, if A · (adj A) = $\begin{bmatrix} 8 & 0 \\ 0 & 8 \end{bmatrix}$ then the value of |A| is **[1]**

a) 8

b) 4

c) 0

d) 64

8. If the function f(x) $= \begin{cases} \dfrac{1-\cos 4x}{8x^2}, x \neq 0 \\ k, x = 0 \end{cases}$ is continuous x = 0 then k = ? **[1]**

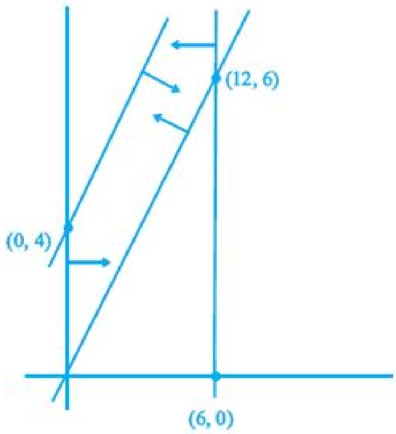
a) $\frac{-1}{2}$

b) $\frac{1}{2}$

c) 2

d) 1

9. The feasible region for an LPP is shown in the Figure. Let F = 3x - 4y be the objective function. Maximum value of F is. **[1]**



a) - 18

b) 0

c) 8

d) 12

10. If A = $\begin{bmatrix} 5 & x \\ y & 0 \end{bmatrix}$ and A = A^T, then x is **[1]**

a) x = 0, y = 5

b) none of these

c) x = y

d) x + y = 5

11. If $y = \log\left(\frac{1-x^2}{1+x^2}\right)$ then $\frac{dy}{dx}$ is equal to **[1]**

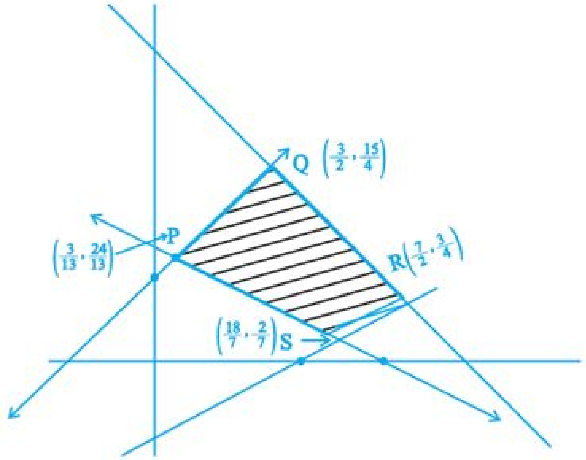
a) $\frac{4x^3}{1-x^4}$

b) $\frac{-4x^3}{1-x^4}$

c) $\frac{1}{4-x^4}$

d) $\frac{-4x}{1-x^4}$

12. In Figure, the feasible region (shaded) for a LPP is shown. Determine the maximum and minimum value of Z = x + 2y **[1]**



a) Maximum = 10, minimum = $3\frac{1}{4}$

b) Maximum = 8, minimum = $3\frac{1}{6}$

c) Maximum = 7, minimum = $3\frac{1}{9}$

d) Maximum = 9, minimum = $3\frac{1}{7}$

13. The minimum value of $f(x) = 3x^4 - 8x^3 - 48x + 25$ on [0, 3] is **[1]**

a) 25

b) 16

c) -39

d) None of these

14. In case of strict increasing functions, slope of the tangent and hence derivative is **[1]**

a) either positive or zero

b) zero

c) positive

d) negative

15. If $y = \frac{x}{2}\sqrt{x^2+1} + \frac{1}{2}\log(x + \sqrt{x^2+1})$, then $\frac{dy}{dx}$ is equal to **[1]**

a) $\sqrt{x^2+1}$

b) None of these

c) $2\sqrt{x^2+1}$

d) $\frac{1}{\sqrt{x^2+1}}$

16. The equation of the tangent to the curve $y^2 = 4ax$ at the point $(at^2, 2at)$ is **[1]**

a) $ty = x + at^2$

b) none of these

c) $tx + y = a t^3$

d) $ty = x - at^2$

17. If f(x) = $\begin{cases} \text{kx} + 5, \text{ when x} \le 2 \\ \text{x} + 1, \text{ when x} > 2 \end{cases}$ is continuous at x = 2 then k = ? **[1]**

a) -2

b) -1

c) 2

d) -3

18. If $\tan^{-1} x + \tan^{-1} y = \frac{4\pi}{5}$ then $\cot^{-1} x + \cot^{-1} y$ equals **[1]**

a) $\frac{3\pi}{5}$

b) $\frac{\pi}{5}$

c) $\frac{2\pi}{5}$

d) π

19. If f(x) = $|3 - x| + (3 + x)$, where (x) denotes the least integer **[1]**

a) neither differentiable nor continuous at x = 3

b) continuous but not differentiable at x = 3

c) differentiable but not continuous at x = 3

d) continuous and differentiable at x = 3

20. The equation of the normal to the curve y = x + sin x cos x at $x = \frac{\pi}{2}$ is **[1]**

a) x = 2
b) $x + \pi = 0$
c) $2x = \pi$
d) x = π

Section B

Attempt any 16 questions

21. Let f(x) = $\frac{\sin^{-1} x}{x}$ Then , dom (f) = ? **[1]**

a) [-1,1] - {0}
b) none of these
c) [-1,1]
d) (-1,1)

22. If $y = \sqrt{\sin x + \sqrt{\sin x + \sqrt{\sin x +}}} \ldots \infty$ then $\frac{dy}{dx}$ = ? **[1]**

a) $\frac{\sin x}{(2y-1)}$
b) $\frac{\cos x}{(y-1)}$
c) $\frac{\cos x}{(2y-1)}$
d) None of these

23. The corner points of the feasible region determined by the system of linear constraints are (0, 10), (5, 5), (15, 15), (0, 20). Let Z = px + qy, where p, q > 0. Condition on p and q so that the maximum of Z occurs at both the points (15, 15) and (0, 20) is **[1]**

a) q = 3p
b) q = 2p
c) p = q
d) p = 2q

24. If e^{x+y} = xy then $\frac{dy}{dx} = ?$ **[1]**

a) $\frac{(x-xy)}{(xy-y)}$
b) none of these
c) $\frac{y(1-x)}{x(y-1)}$
d) $\frac{x(1-y)}{y(x-1)}$

25. If $f(x) = \begin{cases} \frac{\sin(\cos x) - \cos x}{(\pi - 2x)^2} & , x \neq \frac{\pi}{2} \\ k & , x = \frac{\pi}{2} \end{cases}$ is continuous at $x = \frac{\pi}{2}$, then k is equal to **[1]**

a) 1
b) -1
c) 0
d) $\frac{1}{2}$

26. The value of cot $\left[\cos^{-1}\left(\frac{7}{25}\right)\right]$ is **[1]**

a) $\frac{25}{24}$
b) $\frac{24}{25}$
c) $\frac{7}{24}$
d) $\frac{25}{7}$

27. Consider the non – empty set consisting of children in a family and a relation R defined as aRb if a is brother of b. Then R is **[1]**

a) both symmetric and transitive
b) transitive but not symmetric
c) neither symmetric nor transitive
d) symmetric but not transitive

28. $\sin\left(\frac{1}{2}\cos^{-1}\frac{4}{5}\right)$ = ? **[1]**

a) $\frac{1}{\sqrt{10}}$
b) $\frac{2}{\sqrt{5}}$
c) $\frac{1}{\sqrt{5}}$
d) $\frac{2}{\sqrt{10}}$

29. Function $f(x) = 2x^3 - 9x^2 + 12x + 29$ is monotonically decreasing when **[1]**

a) $x > 2$
b) $1 < x < 2$
c) $x < 2$
d) $x > 3$

30. $\begin{vmatrix} 1 & 1 & 1 \\ 1 & 1+x & 1 \\ 1 & 1 & 1+y \end{vmatrix}$ = ? **[1]**

a) None of these
b) xy
c) (x - y)
d) (x + y)

31. If y = a sin mx + b cos m x, then $\frac{d^2y}{dx^2}$ is equal to **[1]**

a) my_1
b) None of these
c) $-m^2y$
d) m^2y

32. If $f(x) = |x^2 - 9x + 20|$, then f'(x) is equal to **[1]**

a) $-2x + 9$ for all $x \in R$
b) none of these
c) $2x - 9$ if $4 < x < 5$
d) $-2x + 9$ if $4 < x < 5$

33. Tangents to the curve $x^2 + y^2 = 2$ at the points (1, 1) and (– 1, 1) **[1]**

a) at right angles
b) intersecting but not at right angles
c) none of these
d) parallel

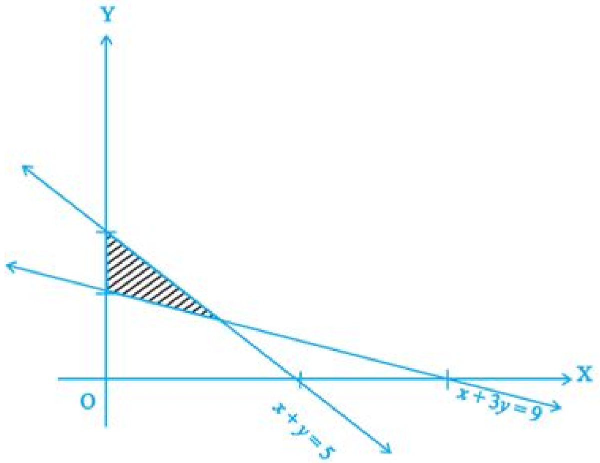
34. The domain of the function $\cos^{-1}(2x - 1)$ is **[1]**

a) $[0, \pi]$
b) [–1, 1]
c) [0, 1]
d) (–1, 0)

35. If $A = \begin{bmatrix} 1 & 2 & -1 \\ -1 & 1 & 2 \\ 2 & -1 & 1 \end{bmatrix}$, then det (adj(adj A)) is **[1]**

a) 14^3
b) 14
c) 14^4
d) 14^2

36. The feasible region for a LPP is shown in Figure. Find the minimum value of Z = 11x + 7y. **[1]**



a) 22

b) 21

c) 19

d) 20

37. If A and B are square matrices of same order and A’ denotes the transpose of A, then **[1]**

a) AB = O $\Rightarrow$|A| = 0 and |B| = 0

b) (AB)’ = A’B’

c) (AB)’ = B’A’

d) AB = O $\Rightarrow$ A = 0 or B = 0

38. If $y=\sqrt{\frac{1+x}{1-x}}$ then $\frac{dy}{dx}=$? **[1]**

a) $\frac{2}{(1-x)^2}$

b) $\frac{x}{(1-x)^{\frac{3}{2}}}$

c) None of these

d) $\frac{1}{(1-x)^{\frac{3}{2}}(1+x)^{\frac{1}{2}}}$

39. Let f be a function satisfying f(x + y) = f(x) + f(y) for all x, y $\in \mathbf{R}$,then f ‘ (x) = **[1]**

a) f (0) for all $x \in \mathbf{R}$

b) None of these

c) 0 for all $x \in \mathbf{R}$

d) f ‘ (0) for all $x \in \mathbf{R}$

40. A relation R is defined from {2, 3, 4, 5} to {3, 6, 7, 10} by x Ry $\Leftrightarrow$ x is relatively prime to y. Then, domain of R is **[1]**

a) {3, 5}

b) {2, 3, 4, 5}

c) {2, 3, 5}

d) {2, 3, 4}

Section C

Attempt any 8 questions

41. $\cos^{-1}(\cos\frac{2\pi}{3}) + \sin^{-1}(\sin\frac{2\pi}{3})$ = ? **[1]**

a) π

b) $\frac{\pi}{3}$

c) $\frac{3\pi}{4}$

d) $\frac{4\pi}{3}$

42. The solution set of the inequation 2x + y > 5 is **[1]**

a) None of these

b) open half plane not containing the origin

c) half plane that contains the origin

d) whole xy-plane except the points lying on the line 2x + y = 5

43. f(x) = $|\log_e|x||$, then **[1]**

a) f(x) is continuous and differentiable for all x in its domain

b) f(x) is continuous for all x in its domain but not differentiable at x = ± 1

c) none of these

d) f(x) is neither continuous nor differentiable at x = ± 1

44. If $A=\begin{bmatrix}1 & \lambda & 2\\ 1 & 2 & 5\\ 2 & 1 & 1\end{bmatrix}$ is not invertible then $\lambda \neq$? **[1]**

a) 1

b) 2

c) 0 d) -1

45. The relation R in N × N such that (a, b) R (c, d) ⇔ a + d = b + c is **[1]**

a) reflexive and transitive but not symmetric
b) an equivalence relation
c) reflexive but symmetric
d) none of these

Question No. 46 to 50 are based on the given text. Read the text carefully and answer the questions:

Three car dealers, say A, B and C, deals in three types of cars, namely Hatchback cars, Sedan cars, SUV cars. The sales figure of 2019 and 2020 showed that dealer A sold 120 Hatchback, 50 Sedan, 10 SUV cars in 2019 and 300 Hatchback, 150 Sedan, 20 SUV cars in 2020; dealer B sold 100 Hatchback, 30 Sedan, 5 SUV cars in 2019 and 200 Hatchback, 50 Sedan, 6 SUV cars in 2020; dealer C sold 90 Hatchback, 40 Sedan, 2 SUV cars in 2019 and 100 Hatchback, 60 Sedan, 5 SUV cars in 2020.



46. The matrix summarizing sales data of 2019 is **[1]**

a) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 100 & 30 & 5 \\ 120 & 50 & 10 \\ 90 & 40 & 2 \end{bmatrix} \end{array}$$

b) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 300 & 150 & 20 \\ 200 & 50 & 6 \\ 100 & 30 & 5 \end{bmatrix} \end{array}$$

c) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 120 & 50 & 10 \\ 100 & 30 & 5 \\ 90 & 40 & 2 \end{bmatrix} \end{array}$$

d) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 200 & 50 & 6 \\ 100 & 30 & 5 \\ 300 & 150 & 20 \end{bmatrix} \end{array}$$

47. The matrix summarizing sales data of 2020 is **[1]**

a) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 300 & 150 & 20 \\ 200 & 50 & 6 \\ 100 & 60 & 5 \end{bmatrix} \end{array}$$

b) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 200 & 50 & 6 \\ 100 & 60 & 5 \\ 300 & 150 & 20 \end{bmatrix} \end{array}$$

c) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 120 & 50 & 10 \\ 100 & 60 & 5 \\ 90 & 40 & 2 \end{bmatrix} \end{array}$$

d) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 100 & 60 & 5 \\ 120 & 50 & 10 \\ 90 & 40 & 2 \end{bmatrix} \end{array}$$

48. The total number of cars sold in two given years, by each dealer, is given by the matrix **[1]**

a) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 300 & 80 & 11 \\ 190 & 100 & 7 \\ 420 & 200 & 30 \end{bmatrix} \end{array}$$

b) $$\begin{array}{cc} & \begin{matrix} Hatchback & Sedan & SUV \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{bmatrix} 420 & 200 & 30 \\ 300 & 80 & 11 \\ 190 & 100 & 7 \end{bmatrix} \end{array}$$

c) None of these
d)

$$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 190 & 100 & 7 \\ 300 & 80 & 11 \\ 420 & 200 & 30 \end{bmatrix} \end{array}$$

49. The increase in sales from 2019 to 2020 is given by the matrix **[1]**

a) $$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 10 & 20 & 3 \\ 100 & 20 & 1 \\ 180 & 100 & 10 \end{bmatrix} \end{array}$$

b) $$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 100 & 20 & 3 \\ 180 & 100 & 10 \\ 10 & 20 & 3 \end{bmatrix} \end{array}$$

c) $$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 180 & 100 & 10 \\ 100 & 20 & 1 \\ 10 & 20 & 3 \end{bmatrix} \end{array}$$

d) $$\begin{array}{c} \\ A \\ B \\ C \end{array} \begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 180 & 100 & 10 \\ 10 & 20 & 1 \\ 100 & 20 & 3 \end{bmatrix} \end{array}$$

50. If each dealer receive profit of ₹ 50000 on sale of a Hatchback, ₹ 100000 on sale of a Sedan and ₹ 200000 on sale of an SUV, then the amount of profit received in the year 2020 by each dealer is given by the matrix. **[1]**

a) $$\begin{array}{c} A \\ B \\ C \end{array} \begin{bmatrix} 34000000 \\ 16200000 \\ 12000000 \end{bmatrix}$$

b) $$\begin{array}{c} A \\ B \\ C \end{array} \begin{bmatrix} 12000000 \\ 16200000 \\ 34000000 \end{bmatrix}$$

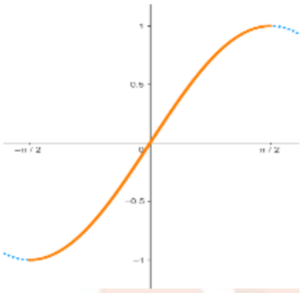
c) $$\begin{array}{c} A \\ B \\ C \end{array} \begin{bmatrix} 30000000 \\ 15000000 \\ 12000000 \end{bmatrix}$$

d) $$\begin{array}{c} A \\ B \\ C \end{array} \begin{bmatrix} 15000000 \\ 30000000 \\ 12000000 \end{bmatrix}$$

Solution

Section A

1. **(d)** one one and onto
   Explanation:
   f: $\left[\frac{-\pi}{2}, \frac{\pi}{2}\right] \to$ [-1, 1]: f(x) = sin (x)



As per graph for sin (x), for given range of $\left[\frac{-\pi}{2}, \frac{\pi}{2}\right]$, f(x) is not repeating its value.
Hence, its one-one.
Onto function
Range function f(x) is also the co-domain of the function, So it is onto.
Thus, f: $\left[\frac{-\pi}{2}, \frac{\pi}{2}\right] \to$ [-1, 1]: f(x) = sin(x) is one-one onto.

2. **(a)** 1260
   Explanation: We have , Maximize Z = 100x + 120y , subject to constraints 2x + 3y ≤ 30, 3x + y ≤ 17, x ≥ 0, y ≥ 0.

Corner points	Z = 100x +120 y
P(0 , 0)	0
Q(3 , 8)	1260......................(Max.)
R(0, 10)	1200
S(17/3 , 0)	1700/3

Hence the maximum value is 1260

3. **(b)** 2
   Explanation: let $u=\cos^{-1}\left(2x^2-1\right)$and $v=\cos^{-1}x$

$\therefore \frac{du}{dx}=\frac{-1}{\sqrt{1-\left(2x^2-1\right)^2}}.4x=\frac{-4x}{\sqrt{1-\left(4x^4+1-4x^2\right)}}$

$=\frac{-4x}{\sqrt{-4x^4+4x^2}}=\frac{-4x}{\sqrt{4x^2\left(1-x^2\right)}}$

$=\frac{-2}{\sqrt{1-x^2}}$

and $\frac{dv}{dx}=\frac{-1}{\sqrt{1-x^2}}$

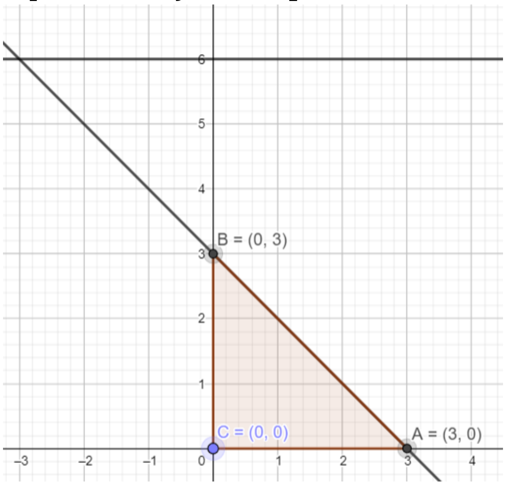
$\therefore \frac{du}{dv}=\frac{du/dx}{dv/dx}=\frac{-2/\sqrt{1-x^2}}{-1\sqrt{1-x^2}}=2.$

Which is the required solution.

4. **(d)** If BA = CA, then B $\neq$ C, where B and C are square matrices of order 3
   Explanation: BA = CA
   $\Rightarrow$ $BAA^{-1} = CAA^{-1}$
   $\Rightarrow$ BI = CI
   $\Rightarrow$ B = C

5. **(b)** bounded in first quadrant
   Explanation: Converting the given inequations into equations, we obtain

y = 6, x + y = 3, x = 0 and y = 0, y = 6 is the line passing through (0, 6) and parallel to the X axis.The region below the line y = 6 will satisfy the given inequation.
The line x + y = 3 meets the coordinate axis at A(3, 0) and B(0, 3). Join these points to obtain the line x + y = 3
Clearly, (0, 0) satisfies the inequation x + y $\leq$3 . So, the region in x y -plane that contains the origin represents the solution set of the given equation.
The region represented by x $\geq$ 0 and y $\geq$ 0 :
Since every point in the first quadrant satisfies these inequations. So, the first quadrant is the region represented by the inequations.



6. **(a)** strictly increasing
Explanation: strictly increasing
7. **(a)** 8
Explanation: $(\text{adj } A) = \begin{pmatrix} 8 & 0 \\ 0 & 8 \end{pmatrix}$
$= 8 \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
= |A| I
|A| = 8.
8. **(d)** 1
Explanation: Here, given
$\Rightarrow f(x) = \frac{1-\cos 4x}{8x^2}$ is continuous at x = 0
$\Rightarrow f(x) = \lim_{x\to 0} \frac{2\sin^2 2x}{8x^2}$
$\Rightarrow f(x) = \lim_{x\to 0} \frac{2\sin^2 2x}{2\times 4x^2}$
$\Rightarrow f(x) = \lim_{x\to 0} \left(\frac{\sin 2x}{2x}\right)^2$
$\Rightarrow$ f(x) = 1
$\therefore$ k = 1
9. **(d)** 12
Explanation:

Corner points	Z = 3x - 4y
(0, 0)	0
(0,4)	-16
(12,6)	12.........................(Max.)

10. **(c)** x = y
Explanation: A = A^T
$\begin{bmatrix} 5 & x \\ y & 0 \end{bmatrix} = \begin{bmatrix} 5 & y \\ x & 0 \end{bmatrix}$
x = y

11. **(d)** $\frac{-4x}{1-x^4}$

Explanation: We have, $y=\log\left(\frac{1-x^2}{1+x^2}\right)$

$\Rightarrow \frac{dy}{dx}=\frac{1}{\frac{1-x^2}{1+x^2}}\times\frac{d}{dx}\left(\frac{1-x^2}{1+x^2}\right)$

$\Rightarrow \frac{dy}{dx}=\frac{1+x^2}{1-x^2}\times\frac{\left[(1+x^2)(-2x)-(1-x^2)(+2x)\right]}{(1+x^2)^2}$

$\Rightarrow \frac{dy}{dx}=\frac{(1+x^2)}{(1-x^2)}\times\frac{\left[-2x-2x^3-2x+2x^3\right]}{(1+x^2)^2}$

$\Rightarrow \frac{dy}{dx}=\frac{1}{\frac{1-x^2}{1+x^2}}\cdot\frac{d}{dx}\left(\frac{1-x^2}{1+x^2}\right)$

$=\frac{-2x\left[1+x^2+1-x^2\right]}{(1-x^2)\cdot(1+x^2)}=\frac{-4x}{1-x^4}$

$\Rightarrow \frac{dy}{dx}=\frac{1\times-4x}{(1-x^2)(1+x^2)}$

$\therefore \frac{dy}{dx}=\frac{-4x}{1-x^4}$

12. **(d)** Maximum = 9, minimum = $3\frac{1}{7}$

Explanation:

Corner points	Z = x +2 y
P(3/13,24/13)	51/13
Q(3/2,15/4)	9........................(Max.)
R(7/2,3/4)	5
S(18/7,2/7)	22/7........................(Min.)

Hence the maximum value is 9 and the minimum value is $3\frac{1}{7}$

13. **(c)** -39

Explanation: Given function,

$f(x) = 3x^4 - 8x^3 - 48x + 25$

$F'(x) = 12x^3 - 24x^2 - 48 = 0$

$F'(x) = 12(x^3 - 2x^2 - 4) = 0$

Differentiating again, we obtain

$F''(x) = 3x^2 - 4x = 0$

$x(3x - 4) = 0$

x = 0 or x = $\frac{4}{3}$

Putting the value in equation, we obtain

f(x) = -39

14. **(a)** either positive or zero

Explanation: If f is strictly increasing function , then f ‘ (x) can be 0 also. For example, $f(x) = x^3$ is strictly increasing, but its derivative is 0 at x = 0. As another example, take f(x) = x + cosx; here f ‘(x) = 1 – sinx, which is either +ve or 0 and the function x + cos x is strictly increasing.

15. **(a)** $\sqrt{x^2+1}$

Explanation: $y=\frac{x}{2}\sqrt{x^2+1}+\frac{1}{2}\log\left(x+\sqrt{x^2+1}\right)$

$\Rightarrow \frac{dy}{dx}=\frac{1}{2}\left[x\frac{1}{2\sqrt{x^2+1}}(2x)+\sqrt{x^2+1}\right]+\frac{1}{2}\left[\frac{1}{x+\sqrt{x^2+1}}\left\{1+\frac{1}{2\sqrt{x^2+1}}(2x)\right\}\right]$

$\Rightarrow \frac{dy}{dx}=\frac{1}{2}\left[\frac{x^2}{\sqrt{x^2+1}}+\sqrt{x^2+1}\right]+\frac{1}{2}\left[\frac{1}{x+\sqrt{x^2+1}}\left\{\frac{\sqrt{x^2+1}+x}{\sqrt{x^2+1}}\right\}\right]$

$\Rightarrow \frac{dy}{dx}=\frac{1}{2}\left[\frac{x^2+x^2+1}{\sqrt{x^2+1}}\right]+\frac{1}{2}\left[\frac{1}{\sqrt{x^2+1}}\right]$

$\Rightarrow \frac{dy}{dx} = \frac{1}{2}\left[\frac{2x^2+1}{\sqrt{x^2+1}} + \frac{1}{\sqrt{x^2+1}}\right]$
$\Rightarrow \frac{dy}{dx} = \frac{1}{2}\left[\frac{2x^2+1+1}{\sqrt{x^2+1}}\right]$
$\Rightarrow \frac{dy}{dx} = \frac{1}{2}\left[\frac{2x^2+2}{\sqrt{x^2+1}}\right]$
$\Rightarrow \frac{dy}{dx} = \left[\frac{x^2+1}{\sqrt{x^2+1}}\right]$
$\Rightarrow \frac{dy}{dx} = \sqrt{x^2+1}.$
Which is the required solution.

16. **(a)** ty = x +at^2
Explanation: $y^2 = 4ax$
$\Rightarrow 2y\frac{dy}{dx} = 4a$
$\Rightarrow \frac{dy}{dx} = \frac{2a}{y}$
$\Rightarrow \frac{dy}{dx}$ at $(at^2, 2at)$ is $\frac{2a}{2at} = \frac{1}{t}$
$\Rightarrow$Slope of tangent $= m = \frac{1}{t}$
Hence, equation of tangent is $y - y_1 = m(x - x_1)$
$\Rightarrow y - 2at = \frac{1}{t}(x - at^2)$
$\Rightarrow yt - 2at^2 = x - at^2$
$\Rightarrow yt = x + at^2$

17. **(b)** -1
Explanation: For continuity left hand limit must be equal to right hand limit and value at the point.
Continuous at x = 2..
L.H.L = $\lim_{x\to 2^-}(kx+5)$
$\Rightarrow \lim_{h\to 0}(k(2-h)+5)$
$\Rightarrow$ k(2 - 0) + 5 = 2k + 5
R.H.L = $\lim_{x\to 2^+}(x+1)$
$\Rightarrow \lim_{h\to 0}(2+h+1)$
$\Rightarrow$ 2 + 0 + 1
= 3
As f(x) is continuous,we get
$\because$ 2k + 5 = 3
k = -1.

18. **(b)** $\frac{\pi}{5}$
Explanation: We know that,
$\tan^{-1}$ x + $\cot^{-1}$ x = $\frac{\pi}{2}$
We have,
$\tan^{-1}$ x + $\tan^{-1}$ y = 4π/5 ... (1)
Let, $\cot^{-1}$x + $\cot^{-1}$ y = k ... (2)
Adding (1) and (2)
$\tan^{-1}$ x + $\tan^{-1}$ y + $\cot^{-1}$ x + $\cot^{-1}$ y = $\frac{4\pi}{5}$ + k ......(3)
Now, $\tan^{-1}$ A + $\cot^{-1}$ A = $\frac{\pi}{2}$ for all real numbers.
So, ($\tan^{-1}$ x + $\cot^{-1}$ x) + ($\tan^{-1}$y + $\cot^{-1}$ y) = π ... (4)
From (3) and (4), we get,
$\frac{4\pi}{5}$ + k = π
$\Rightarrow$ k = π - $\frac{4\pi}{5}$
$\Rightarrow$ k = $\frac{\pi}{5}$

19. **(a)** neither differentiable nor continuous at x = 3

Explanation: Given that f(x) = |3 – x| + (3 + x), where (x) denotes the least integer greater than or equal to x.

$f(x)=\left\{\begin{array}{l}3-x+3+3,2<x<3 \\ x-3+3+4,3<x<4\end{array}\right\}$

$\Rightarrow \mathrm{f}(\mathrm{x})=\left\{\begin{array}{l}9-\mathrm{x}, 2<\mathrm{x}<3 \\ \mathrm{x}+4,3<\mathrm{x}<4\end{array}\right\}$

Checking continuity at x =3,

Here, LHL at x = 3

$\lim_{x \rightarrow 3^{-}} 9-x=6$

RHL at x = 3

$\lim_{x \rightarrow 3^{+}} x+4=7$

$\because$ LHL $\neq$ RHL

$\therefore$ f(x) is neither continuous nor differentiable at x = 3.

20. **(c)** $2x=\pi$

Explanation: y = x + sinx cosx

$\frac{dy}{dx}=1-\sin^2 x+\cos^2 x$

Slope of the tangent at $x=\frac{\pi}{2}$ is 0.

Slope of the normal is $\frac{-1}{0}$

At $x=\frac{\pi}{2} \Rightarrow y=\frac{\pi}{2}$

$\Rightarrow$ Equation of normal,

$y-\frac{\pi}{2}=\frac{-1}{0}\left(x-\frac{\pi}{2}\right)$

$x=\frac{\pi}{2}$

$\Rightarrow 2x=\pi$

Section B

21. **(a)** [-1,1] - {0}

Explanation: f(x) = $\frac{\sin^{-1} x}{x}$

Domain of the function is defined for x $\neq$ 0

Domain of $\sin^{-1}$ x is [-1, 1]

Therefore, domain of f(x) is [-1, 1] - 0

22. **(c)** $\frac{\cos x}{(2y-1)}$

Explanation: Given:

$\Rightarrow y=\sqrt{\sin x+\sqrt{\sin x+\sqrt{\sin x+}}}$

We can write it as

$\Rightarrow y=\sqrt{\sin x+y}$

Squaring we get

$\Rightarrow y^2$ = sin x + y

Differentiating with respect to x,we get

$\Rightarrow 2y\frac{dy}{dx}=\cos x+\frac{dy}{dx}$

$\Rightarrow \frac{dy}{dx}=\frac{\cos x}{(2y-1)}$

23. **(a)** q = 3p

Explanation: Since Z occurs maximum at (15, 15) and (0, 20), therefore, 15p + 15q = 0p + 20q $\Rightarrow$ q = 3p.

24. **(c)** $\frac{y(1-x)}{x(y-1)}$

Explanation: Given that xy = e^{x+y}

Taking log both sides, we get

$\log_e xy$ = x + y (Since $\log_a b^c = c\log_a b$)

Since $\log_a bc = \log_a b + \log_a c$, we get

$\log_e x + \log_e y = x + y$

Differentiating with respect to x, we obtain

$\frac{1}{x} + \frac{1}{y}\frac{dy}{dx} = 1 + \frac{dy}{dx}$

Or

$\frac{dy}{dx}\left(\frac{y-1}{y}\right) = \frac{1-x}{x}$

Therefore, $\frac{dy}{dx} = \frac{y(1-x)}{x(y-1)}$

25. **(c)** 0

Explanation: Since, f is continuous at $x = \frac{\pi}{2}$

$\therefore\ f(\frac{\pi}{2}) = \lim\limits_{x\to\frac{\pi}{2}} \frac{\sin(\cos x - \cos x)}{(\pi-2x)^2}$

i.e. $k = \lim\limits_{x\to\frac{\pi}{2}} \frac{\sin(\cos x - \cos x)}{(\pi-2x)^2}$

Let $x = \frac{\pi}{2} - h$,

$\Rightarrow k = \lim\limits_{h\to 0} \frac{\sin(\cos(\frac{\pi}{2}-h) - \cos(\frac{\pi}{2}-h)}{\left(\pi-2(\frac{\pi}{2}-h)\right)^2}$

$= \lim\limits_{h\to 0} \frac{\sin(\sin\ h) - \sin\ h}{4h^2}$

Using $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} + \ldots\ldots$

$\Rightarrow k = \lim\limits_{h\to 0} \frac{(\sin\ h - \frac{\sin^3 h}{3!} + \frac{\sin^5 h}{5!}\ldots.) - \sin\ h}{4h^2}$

$= \lim\limits_{h\to 0}\left(\frac{-\sin^3 h}{3!\times 4h^2} + \frac{\sin^5 h}{5!\times 4h^2}\ldots.\right)$

$= 0$

$\therefore \lim\limits_{x\to\frac{\pi}{2}} f(x) = 0 = k$

$\Rightarrow k = 0$

26. **(c)** $\frac{7}{24}$

Explanation: We have to find,

$\cot(\cos^{-1})\ \frac{7}{25}$

Let, $\cos^{-1}(\frac{7}{25}) = A$

$\Rightarrow \cos A = \frac{7}{25}$

Also, $\cot A = \cot(\cos^{-1}(\frac{7}{25}))$

As, $\sin A = \sqrt{1-\cos^2 A}$

So, $\sin A = \sqrt{1-\left(\frac{7}{25}\right)^2}$

$\Rightarrow \sin A = \sqrt{1-\frac{49}{625}}$

$\Rightarrow \sin A = \sqrt{\frac{625-49}{625}}$

$\Rightarrow \sin A = \sqrt{\frac{576}{625}}$

$\Rightarrow \sin A = \frac{24}{25}$

We need to find cot A

$\cot A = \frac{\cos A}{\sin A}$

$\Rightarrow \cot A = \frac{\left(\frac{7}{25}\right)}{\left(\frac{24}{25}\right)}$

$\Rightarrow \cot A = \frac{7}{24}$

So, $\cot(\cos^{-1}(\frac{7}{25})) = \frac{7}{24}$

27. **(b)** transitive but not symmetric

Explanation: Consider the non – empty set consisting of children in a family and a relation R defined as aRb if a is brother of b. Then R is not symmetric, because aRb means a is brother of b, then, it is not necessary that b is also brother of a , it can be the sister of a. Therefore, bRa is not true. Therefore, the relation is not symmetric . Again, if aRb and bRc is true, then aRc is also true. Therefore, R is transitive only.

28. **(a)** $\frac{1}{\sqrt{10}}$

Explanation: The given equation is $\sin\left(\frac{1}{2}\cos^{-1}\frac{4}{5}\right)$

Let x = $\cos^{-1}\frac{4}{5}$

cos x = $\frac{4}{5}$

Therefore $\sin\left(\frac{1}{2}\cos^{-1}\frac{4}{5}\right)$ becomes $\sin\left(\frac{1}{2}x\right)$, i.e $\sin(\frac{x}{2})$

We know that $\sin(\frac{x}{2}) = \sqrt{\frac{1-\cos x}{2}}$

$= \sqrt{\frac{1-\frac{4}{5}}{2}}$

$= \sqrt{\frac{\frac{1}{5}}{2}}$

$\sin\left(\frac{x}{2}\right) = \frac{1}{\sqrt{10}}$

29. **(b)** 1 < x < 2

Explanation: 1 < x < 2

30. **(b)** xy

Explanation: Expanding along R_1

= 1 [(1 + x)(1 + y) - 1] -1 [(1 + y) - 1] + 1 [1 - 1 - x]

= xy

31. **(c)** $-m^2y$

Explanation: $y = a\sin mx + b\cos mx \Rightarrow y_1 = am\cos mx - bm\sin mx$

$\Rightarrow y_2 = -am^2\sin mx - bm^2\cos mx$

$\Rightarrow y_2 = -m^2(a\sin mx + b\cos mx) = -m^2y$

32. **(d)** -2x + 9 if 4 < x < 5

Explanation: We have, f(x) = $|x^2 - 9x + 20|$

$$f(x) = \left\{\begin{array}{c} x^2 - 9x + 20, -\infty < x \le 4 \\ -\left(x^2 - 9x + 20\right), 4 < x < 5 \\ x^2 - 9x + 20, 5 \le x < \infty \end{array}\right\}$$

$$\Rightarrow f'(x) = \left\{\begin{array}{c} 2x - 9, -\infty < x \le 4 \\ -2x + 9, 4 < x < 5 \\ 2x - 9, 5 \le x < \infty \end{array}\right\}$$

∴ f'(x) = -2x + 9 for 4 < x < 5

33. **(a)** at right angles

Explanation: $x^2 + y^2 = 2 \Rightarrow 2x + 2y\frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = \frac{-x}{y}$ therefore , slope of tangent at (1,1) = - 1 and the slope of tangent at (- 1 ,1)= 1 .

Now product of the slopes=1×-1= -1

Hence , the two tangents are at right angles.

34. **(c)** [0, 1]

Explanation: We have f(x) = $\cos^{-1}(2x - 1)$

Since, $-1 \le 2x - 1 \le 1$

$\Rightarrow 0 \le 2x \le 2$

$\Rightarrow 0 \le x \le 1$

$\therefore x \in [0,1]$

35. **(c)** 14^4

Explanation: $A = \begin{bmatrix} 1 & 2 & -1 \\ -1 & 1 & 2 \\ 2 & -1 & 1 \end{bmatrix}$

|A| = 14 det(adjA)= det(A)$^{3-1}$ = det(A)^2.Here the operation is done two times.so,

det (adj(adj A)) = $|A|^{(n-1)^2}$

det (adj(adj A)) = $14^{(3-1)^2} = 14^4$

36. **(b)** 21

Explanation:

Corner points	Z = 11x + 7y
(0, 5)	35
(0,3)	21
(3,2)	47

Hence the minimum value is 21

37. **(c)** (AB)’ = B’A’

Explanation: By the property of transpose of a matrix, (AB)’ = B’A’.

38. **(d)** $\frac{1}{(1-x)^{\frac{3}{2}}(1+x)^{\frac{1}{2}}}$

Explanation: Given that $y = \sqrt{\frac{1+x}{1-x}}$

Let x $= -\cos\theta \Rightarrow \theta = \cos^{-1}(-x)$

Using $1 - \cos\theta = 2\sin^2\frac{\theta}{2}$ and $1 + \cos\theta = 2\cos^2\frac{\theta}{2}$, we obtain

$y = \sqrt{\frac{2\sin^2\frac{\theta}{2}}{2\cos^2\frac{\theta}{2}}} = \tan\left(\frac{\theta}{2}\right)$

Differentiating with respect to x, we obtain

$\frac{dy}{dx} = \sec^2\left(\frac{\theta}{2}\right) \times \frac{1}{2}\frac{d\theta}{dx} - (1)$

Since $x = -\cos\theta \Rightarrow 2\cos^2\frac{\theta}{2} = 1 + \cos\theta = 1 - x$ or $\sec^2\left(\frac{\theta}{2}\right) = \frac{2}{1-x} - (2)$

Also, since $\theta = \cos^{-1}(-x)$, therefore $\frac{d\theta}{dx} = \frac{1}{\sqrt{1-x^2}} - (3)e$

Substituting (ii) and (iii) in (i), we obtain

$\frac{dy}{dx} = \frac{2}{1-x} \times \frac{1}{2} \times \frac{1}{\sqrt{1-x^2}} = \frac{1}{(1-x)\sqrt{1-x^2}} = \frac{1}{(1-x)^{\frac{3}{2}}(1+x)^{\frac{1}{2}}}$

39. **(d)** f ‘ (0) for all $x \in \mathbf{R}$

Explanation: $f'(x) = \lim\limits_{h\to 0}\frac{f(x+h)-f(x)}{h}$

= $\lim\limits_{h\to 0}\frac{f(x+h)-f(x+0)}{h} = \lim\limits_{h\to 0}\frac{f(x)+f(h)-(f(x)+f(0))}{h} = \lim\limits_{h\to 0}\frac{f(h)-f(0)}{h} = f'(0)$

40. **(b)** {2, 3, 4, 5}

Explanation: R: x R y ⇔ x is relatively prime to y.

Two numbers are relatively prime if their Highest Common Factor is 1.

Then, R = {(2, 3), (2, 7), (3, 7), (3, 10), (4, 3), (4, 7), (5, 3), (5, 6), (5, 7)}

Therefore, the domain of R is {2, 3, 4, 5}

Section C

41. **(a)** π

Explanation: The given equation is cos^{-1} (cos $\frac{2\pi}{3}$) + sin^{-1}(sin $\frac{2\pi}{3}$)

Let us consider cos^{-1} (cos ($\frac{2\pi}{3}$)) ($\because$ the principle value of cos lies in the range [0, π] and since $\frac{2\pi}{3} \in [0, \pi]$]

$\Rightarrow \cos^{-1}\left(\cos\left(\frac{2\pi}{3}\right)\right) = \frac{2\pi}{3}$

Also, consider $\sin^{-1}(\sin(\frac{2\pi}{3}))$

Since here the principle value of sine lies in range $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ and since $\frac{2\pi}{3} \notin \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$

$\Rightarrow \sin^{-1}(\sin(\frac{2\pi}{3})) = \sin^{-1}(\sin(\pi - \frac{\pi}{3}))$

$= \sin^{-1}(\sin(\frac{\pi}{3}))$

$= \frac{\pi}{3}$

Therefore,

$\cos^{-1}(\cos(\frac{2\pi}{3})) + \sin^{-1}(\sin(\frac{2\pi}{3})) = \frac{2\pi}{3} + \frac{\pi}{3}$

$= \frac{3\pi}{3}$

$= \pi$.

Which is the required solution.

42. **(b)** open half plane not containing the origin

Explanation: open half plane not containing the origin

On putting x = 0, y = 0 in the given inequality, we get 0 > 5, which is absurd.

Therefore, the solution set of the given inequality does not include the origin.

Thus, the solution set of the given inequality consists of the open half plane not containing the origin.

43. **(b)** f(x) is continuous for all x in its domain but not differentiable at x = ± 1

Explanation: Here,the given function is f(x) = |log|x|| where

$$|\mathrm{x}| = \begin{Bmatrix} -\mathrm{x}, -\infty < \mathrm{x} < -1 \\ -\mathrm{x}, -1 < \mathrm{x} < 0 \\ \mathrm{x}, 0 < \mathrm{x} < 1 \\ \mathrm{x}, 1 < \mathrm{x} < \infty \end{Bmatrix}$$

$$\log|\mathrm{x}| = \begin{Bmatrix} \log(-\mathrm{x}), -\infty < \mathrm{x} < -1 \\ \log(-\mathrm{x}), -1 < \mathrm{x} < 0 \\ \log \mathrm{x}, 0 < \mathrm{x} < 1 \\ \log \mathrm{x}, 1 < \mathrm{x} < \infty \end{Bmatrix}$$

$$|\log|\mathrm{x}|| = \begin{Bmatrix} \log(-\mathrm{x}), -\infty < \mathrm{x} < -1 \\ -\log(-\mathrm{x}), -1 < \mathrm{x} < 0 \\ -\log \mathrm{x}, 0 < \mathrm{x} < 1 \\ \log \mathrm{x}, 1 < \mathrm{x} < \infty \end{Bmatrix}$$

We can see that function is continuous for all x. Now, checking the points of non differentiability.

Now,L.H.D at x =1,we get

$$\lim_{x \to 1^-} \frac{f(x) - f(1)}{x - 1} = \lim_{h \to 0} \frac{f(1-h) - f(1)}{1 - h - 1}$$

$$= \lim_{\mathrm{h} \to 0} \frac{\log(1-\mathrm{h}) - \log 1}{-\mathrm{h}} = -1$$

RHD at x =1,

$$\lim_{x \to 1^+} \frac{f(x) - f(1)}{x - 1} = \lim_{h \to 0} \frac{f(1+h) - f(1)}{1 + h - 1}$$

$$= \lim_{h \to 0} \frac{\log(1+h) - \log 1}{h} = 1$$

$$\because \mathrm{L.H.D} \neq \mathrm{R.H.D}$$

Thus, function is not differentiable at x =1.

L.H.D at x =-1,

$$\lim_{x \to -1^-} \frac{f(x) - f(-1)}{x - (-1)} = \lim_{h \to 0} \frac{f(-1-h) - f(-1)}{-1 - h - (-1)}$$

$$= \lim_{h \to 0} \frac{\log(-1-h) - \log(-1)}{-h} = -1$$

R.H.D at x =-1,

$$\lim_{x \to -1^+} \frac{f(x) - f(-1)}{x - 1} = \lim_{h \to 0} \frac{f(-1+h) - f(-1)}{(-1) + h - (-1)}$$

$$= \lim_{h \to 0} \frac{\log(-1+h) - \log(-1)}{h} = 1$$

$\because$ L.H.D $\neq$ R.H.D

So, function is not differentiable at x =-1.

At x =0 function is not defined.

$\therefore$ Function is not differential at x = 0 and ±1.

44. **(a)** 1

Explanation: Solution.

$$= \begin{pmatrix} 1 & \lambda & 2 \\ 1 & 2 & 5 \\ 2 & 1 & 1 \end{pmatrix}$$

$|A| \neq 0$

$1(2 \times 1 - 5 \times 1) - \lambda (1 \times 1 - 5 \times 2) + 2 (1 \times 1 - 2 \times 2) \neq 0$

$-3 + 9\lambda - 6 \neq 0$

$9\lambda \neq 9$

$\lambda \neq 1$.

Which is the required solution.

45. **(b)** an equivalence relation

Explanation: Check: (a, b)R (a, b) as

a + b = b + a

hence R is reflexive.

Now,let

(a, b) R (c, d) ,then,

a + d = b + c

$\Rightarrow$ c + b = d + a

$\Rightarrow$ (c, d) R (a, b)

=> R is symmetric

Now,

(a, b) R (c, d) and (c,d)R(e,f)Then,

a + d = b + c and

c + f = d + e

Adding,we get,

a + d + c + f = b + c + d + e

$\Rightarrow$ a + f = b + e

So (a, b) R (e, f)

R is transitive.

Hence R is an equivalence relation.

46. **(c)** $\begin{matrix} & \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \\ A & 120 & 50 & 10 \\ B & 100 & 30 & 5 \\ C & 90 & 40 & 2 \end{matrix}$

Explanation: In 2019,

dealer A sold 120 Hatchback, 50 Sedan and 10 SUV;

dealer B sold 100 Hatchback, 30 Sedan and 5 SUV and

dealer C sold 90 Hatchback, 40 Sedan and 2 SUV

$\therefore$ Required matrix, say P, is given by

$$P = \begin{matrix} & \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \\ A & 120 & 50 & 10 \\ B & 100 & 30 & 5 \\ C & 90 & 40 & 2 \end{matrix}$$

47. **(a)** $\begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 300 & 150 & 20 \\ 200 & 50 & 6 \\ 100 & 60 & 5 \end{bmatrix} \end{array}$

Explanation: In 2020,

dealer A sold 300 Hatchback, 150 Sedan, 20 SUV

dealer B sold 200 Hatchback, 50 sedan, 6 SUV

dealer C sold 100 Hatchback, 60 sedan, 5 SUV

∴ Required matrix, say Q, is given by

$$Q = \begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 300 & 150 & 20 \\ 200 & 50 & 6 \\ 100 & 60 & 5 \end{bmatrix} \end{array}$$

48. **(b)** $\begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 420 & 200 & 30 \\ 300 & 80 & 11 \\ 190 & 100 & 7 \end{bmatrix} \end{array}$

Explanation: Total number of cars sold in two given years, by each dealer, is given by

$$P + Q = \begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 120+300 & 50+150 & 10+20 \\ 100+200 & 30+50 & 5+6 \\ 90+100 & 40+60 & 2+5 \end{bmatrix} \end{array}$$

$$= \begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 420 & 200 & 30 \\ 300 & 80 & 11 \\ 190 & 100 & 7 \end{bmatrix} \end{array}$$

49. **(c)** $\begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 180 & 100 & 10 \\ 100 & 20 & 1 \\ 10 & 20 & 3 \end{bmatrix} \end{array}$

Explanation: The increase in sales from 2019 to 2020 is given by

$$Q - P = \begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 300-120 & 150-50 & 20-10 \\ 200-100 & 50-30 & 6-5 \\ 100-90 & 60-40 & 5-2 \end{bmatrix} \end{array}$$

$$= \begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 180 & 100 & 10 \\ 100 & 20 & 1 \\ 10 & 20 & 3 \end{bmatrix} \end{array}$$

50. **(a)** $\begin{array}{c} A \\ B \\ C \end{array}\begin{bmatrix} 34000000 \\ 16200000 \\ 12000000 \end{bmatrix}$

Explanation: he amount of profit in 2020 received by each dealer is given by the matrix

$$\begin{array}{c} \\ A \\ B \\ C \end{array}\begin{array}{c} \begin{array}{ccc} \textit{Hatchback} & \textit{Sedan} & \textit{SUV} \end{array} \\ \begin{bmatrix} 300 & 150 & 20 \\ 200 & 50 & 6 \\ 100 & 60 & 5 \end{bmatrix} \end{array} \begin{bmatrix} 50000 \\ 100000 \\ 200000 \end{bmatrix}$$

$$
= \begin{matrix} A \\ B \\ C \end{matrix} \begin{bmatrix} 15000000 + 15000000 + 4000000 \\ 10000000 + 5000000 + 1200000 \\ 5000000 + 6000000 + 1000000 \end{bmatrix}
$$

$$
= \begin{matrix} A \\ B \\ C \end{matrix} \begin{bmatrix} 34000000 \\ 16200000 \\ 12000000 \end{bmatrix}
$$