Matrices

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. The number of possible orders of a matrix with 18 elements is:

(a) 7 **(b)** 5 **(c)** 12 **(d)** 6

2. $A = [a_{ij}]$ is a 2×2 matrix with $a_{ij} = 4i - 4j$. Then A is:

(a) $\begin{bmatrix} -16 & -32 \\ -32 & -64 \end{bmatrix}$ **(b)** $\begin{bmatrix} 0 & 4 \\ -4 & 0 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & -3 \\ 5 & 1 \end{bmatrix}$ **(d)** $\begin{bmatrix} 0 & -4 \\ 4 & 0 \end{bmatrix}$

3. If $A = \begin{bmatrix} -4 & 2 \\ -5 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 5 \\ 0 & -2 \end{bmatrix}$, then $-3A + B$ is:

(a) $\begin{bmatrix} -10 & 11 \\ -15 & 13 \end{bmatrix}$ **(b)** $\begin{bmatrix} 14 & -1 \\ 15 & -17 \end{bmatrix}$

(c) $\begin{bmatrix} -10 & -13 \\ -5 & 11 \end{bmatrix}$ **(d)** $\begin{bmatrix} 10 & -11 \\ 15 & -13 \end{bmatrix}$

4. If $A = \begin{bmatrix} 2 & -2 \\ 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 4 & -1 \\ 1 & -3 \end{bmatrix}$, then AB is:

(a) $\begin{bmatrix} 6 & 4 \\ 5 & -4 \end{bmatrix}$ **(b)** $\begin{bmatrix} 6 & -3 \\ 2 & -2 \end{bmatrix}$

(c) $\begin{bmatrix} 7 & -9 \\ -1 & -5 \end{bmatrix}$ **(d)** $\begin{bmatrix} 8 & 2 \\ 1 & -3 \end{bmatrix}$

5. A matrix with m rows and n columns has order:

(a) m + n **(b)** n × m **(c)** m × n **(d)** mn × 1

6. If $A = \begin{bmatrix} 9 & -3 & 7 \\ 9 & 6 & 2 \end{bmatrix}$, then A^T is:

(a) $\begin{bmatrix} 9 & 9 \\ -3 & 6 \\ 7 & 2 \end{bmatrix}$ **(b)** $\begin{bmatrix} 7 & 2 \\ -3 & 6 \\ 9 & 9 \end{bmatrix}$

(c) $\begin{bmatrix} 9 & 9 \\ 6 & -3 \\ 2 & 7 \end{bmatrix}$ **(d)** $\begin{bmatrix} 2 & 7 \\ 6 & -3 \\ 9 & 9 \end{bmatrix}$

7. If $\begin{bmatrix} x + y & -9 \\ 9 & x - y \end{bmatrix} = \begin{bmatrix} 14 & -9 \\ 9 & 0 \end{bmatrix}$, then:

(a) x = 7, y = −7 **(b)** x = −7, y = −7 **(c)** x = 7, y = 7 **(d)** x = 14, y = 0

8. Assertion (A): The matrix $\begin{bmatrix} 6 & 3 & 5 \\ 3 & 6 & 4 \\ 5 & 4 & -3 \end{bmatrix}$ is symmetric.

Reason (R): A square matrix A is symmetric when $A^T = A$.

(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 the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. If $A = \begin{bmatrix} 5 & 6 & 2 \\ 5 & 2 & 6 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & -1 & 3 \\ 1 & 5 & -1 \end{bmatrix}$, find A + B and A − B.

10. Find AB if $A = \begin{bmatrix} 4 & 3 & 3 \\ 0 & 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} -3 & -3 \\ -1 & 4 \\ 4 & 2 \end{bmatrix}$.

11. If $A = \begin{bmatrix} -1 & 0 \\ 3 & 3 \end{bmatrix}$, find A^2 and show that $A^2 - 2A - 3I = O$.

12. Construct the 2 × 3 matrix $A = [a_{ij}]$ with $a_{ij} = i^2 + 4j$.

13. Express $A = \begin{bmatrix} 5 & -5 & -1 \\ 0 & 2 & 7 \\ -4 & 2 & 6 \end{bmatrix}$ as the sum of a symmetric matrix P and a skew-symmetric matrix Q.

14. Find x, y, z and w if $3\begin{bmatrix} x & y \\ z & w \end{bmatrix} + \begin{bmatrix} -3 & 1 \\ 6 & 2 \end{bmatrix} = \begin{bmatrix} 15 & 22 \\ 15 & -1 \end{bmatrix}$.

15. Find the matrix X such that 3X + A = B, where $A = \begin{bmatrix} 0 & -4 \\ -2 & 6 \end{bmatrix}$ and $B = \begin{bmatrix} -12 & 11 \\ -5 & 12 \end{bmatrix}$.

16. If $A = \begin{bmatrix} -1 & 4 \\ -3 & -2 \end{bmatrix}$ and $B = \begin{bmatrix} -3 & 4 \\ -2 & 0 \end{bmatrix}$, find AB and BA. Is AB = BA?

Section C — Word problems — 4 × 4 = 16 marks

17. Shop R sold 52 notebooks, 58 pens, 50 files; Shop Q sold 32 notebooks, 19 pens, 10 files. The prices are Rs 12 per notebook, Rs 23 per pen, Rs 20 per file. Use matrix multiplication to find each shop's sales.

18. For $A = \begin{bmatrix} 5 & 3 & -2 \\ 4 & -1 & 3 \\ 5 & -2 & 5 \end{bmatrix}$, find A^T, $A + A^T$ and $A - A^T$. Show that $A + A^T$ is symmetric and $A - A^T$ is skew-symmetric, and write A as their combination.

19. If $f(x) = x^2 + 2x - 5$ and $A = \begin{bmatrix} 1 & -2 \\ 3 & -1 \end{bmatrix}$, find f(A).

20. A trust has Rs 52,000 to invest in two bonds paying 8% and 10% interest a year. Using matrix multiplication, find how the money should be split to earn Rs 4,920 a year.

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Answer key

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Q	Answer	Working
1	**(d) 6**	the orders are m × n with mn = 18: one for each divisor of 18
2	**(d)** $\begin{bmatrix} 0 & -4 \\ 4 & 0 \end{bmatrix}$	$a_{12} = 4(1) - 4(2) = -4$
3	**(b)** $\begin{bmatrix} 14 & -1 \\ 15 & -17 \end{bmatrix}$	multiply each entry of A by −3, then add B
4	**(a)** $\begin{bmatrix} 6 & 4 \\ 5 & -4 \end{bmatrix}$	row of A times column of B
5	**(c) m × n**	—
6	**(a)** $\begin{bmatrix} 9 & 9 \\ -3 & 6 \\ 7 & 2 \end{bmatrix}$	rows become columns
7	**(c) x = 7, y = 7**	x + y = 14 and x − y = 0
8	**(a) Both A and R are true, and R is the correct explanation of A.**	A is true: $a_{ij} = a_{ji}$ for every i and j. R is true and explains A.
9	**A + B =** $\begin{bmatrix} 8 & 5 & 5 \\ 6 & 7 & 5 \end{bmatrix}$**; A − B =** $\begin{bmatrix} 2 & 7 & -1 \\ 4 & -3 & 7 \end{bmatrix}$	add or subtract matching entries
10	$\begin{bmatrix} -3 & 6 \\ 3 & 6 \end{bmatrix}$	$a_{11} = 4(-3) + 3(-1) + 3(4)$
11	$A^2 = \begin{bmatrix} 1 & 0 \\ 6 & 9 \end{bmatrix}$; $A^2 - 2A - 3I = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$	$2A = \begin{bmatrix} -2 & 0 \\ 6 & 6 \end{bmatrix}$, $-3I = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$
12	$\begin{bmatrix} 5 & 9 & 13 \\ 8 & 12 & 16 \end{bmatrix}$	$a_{23} = 16$
13	$P = \begin{bmatrix} 5 & -5/2 & -5/2 \\ -5/2 & 2 & 9/2 \\ -5/2 & 9/2 & 6 \end{bmatrix}$, $Q = \begin{bmatrix} 0 & -5/2 & 3/2 \\ 5/2 & 0 & 5/2 \\ -3/2 & -5/2 & 0 \end{bmatrix}$	$P = (A + A^T)/2$, $Q = (A - A^T)/2$
14	**x = 6, y = 7, z = 3, w = −1**	3x − 3 = 15
15	$X = \begin{bmatrix} -4 & 5 \\ -1 & 2 \end{bmatrix}$	X = (B − A)/3
16	$AB = \begin{bmatrix} -5 & -4 \\ 13 & -12 \end{bmatrix}$; $BA = \begin{bmatrix} -9 & -20 \\ 2 & -8 \end{bmatrix}$; **AB ≠ BA**	multiply both ways
17	**Shop R: Rs 2,958; Shop Q: Rs 1,021**	$\begin{bmatrix} 52 & 58 & 50 \\ 32 & 19 & 10 \end{bmatrix} \times \begin{bmatrix} 12 \\ 23 \\ 20 \end{bmatrix} = \begin{bmatrix} 2958 \\ 1021 \end{bmatrix}$

Q	Answer	Working
18	$A^T = \begin{bmatrix} 5 & 4 & 5 \\ 3 & -1 & -2 \\ -2 & 3 & 5 \end{bmatrix}$; $A + A^T = \begin{bmatrix} 10 & 7 & 3 \\ 7 & -2 & 1 \\ 3 & 1 & 10 \end{bmatrix}$; $A - A^T = \begin{bmatrix} 0 & -1 & -7 \\ 1 & 0 & 5 \\ 7 & -5 & 0 \end{bmatrix}$; $A = \begin{bmatrix} 5 & 7/2 & 3/2 \\ 7/2 & -1 & 1/2 \\ 3/2 & 1/2 & 5 \end{bmatrix} + \begin{bmatrix} 0 & -1/2 & -7/2 \\ 1/2 & 0 & 5/2 \\ 7/2 & -5/2 & 0 \end{bmatrix}$	$A = ½(A + A^T) + ½(A - A^T)$
19	$f(A) = \begin{bmatrix} -8 & -4 \\ 6 & -12 \end{bmatrix}$	$A^2 = \begin{bmatrix} -5 & 0 \\ 0 & -5 \end{bmatrix}$; $f(A) = A^2 + 2A - 5I$
20	**Rs 14,000 at 8% and Rs 38,000 at 10%**	$[x, 52000 - x] \times \begin{bmatrix} 8/100 \\ 10/100 \end{bmatrix} = 4920$