EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 02

Time: 30 minutes | Maximum marks: 25

Name: _____ Class: _____ Date: _____

1. There are 25 questions. Each has exactly one correct answer: choose A, B, C or D.
2. Each correct answer carries 1 mark. There is no negative marking.
3. The key sheet and worked solutions are at the end of this test.

1. The number of possible orders of a matrix with 28 elements is

A. 6 **B.** 3 **C.** 7 **D.** 4

2. If $A = \begin{bmatrix} 6 & 0 \\ 10 & -9 \\ -6 & -1 \end{bmatrix}$, then $a_{21} \cdot a_{12} =$

A. 10 **B.** -54 **C.** 2 **D.** 0

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = (-1)^{i+j}(i + 2j)$, then $a_{12} =$

A. -5 **B.** -6 **C.** -4 **D.** 5

4. The matrix $\begin{bmatrix} -5 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 5 \end{bmatrix}$ is

A. a diagonal matrix **B.** a null matrix

C. an identity matrix **D.** a scalar matrix

5. The number of elements outside the principal diagonal of a square matrix of order 9 is

A. 81 **B.** 72 **C.** 80 **D.** 36

6. $\operatorname{tr}(9I_7) =$

A. 7 **B.** 9 **C.** 63 **D.** 441

7. If $A = \begin{bmatrix} 5 & -3 \\ 4 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 4 & -1 \\ -1 & -4 \end{bmatrix}$, then $\operatorname{tr}(AB) =$

A. 19 **B.** 0 **C.** 23 **D.** 5

8. If $\begin{bmatrix} 2x + 5y & 1 \\ x + 3y & 2 \end{bmatrix} = \begin{bmatrix} -7 & 1 \\ -5 & 2 \end{bmatrix}$, then $x + y =$

A. -1 **B.** 7 **C.** -7 **D.** 1

9. If $A = \begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} -3 & -4 \\ 6 & 3 \end{bmatrix}$, then $4A - 4B =$

A. $\begin{bmatrix} -4 & -12 \\ 28 & 24 \end{bmatrix}$ **B.** $\begin{bmatrix} 20 & 20 \\ -20 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 11 & 8 \\ -2 & 9 \end{bmatrix}$ **D.** $\begin{bmatrix} 14 & 17 \\ -23 & -9 \end{bmatrix}$

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10. If $A = \begin{bmatrix} -6 & 7 \\ 0 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 \\ 1 & 6 \end{bmatrix}$, the element in row 2, column 1 of $4A + 4B$ is

A. 1 **B.** 36 **C.** -4 **D.** 4

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11. If A is a 5×3 matrix and B is a 3×4 matrix, the order of AB is

A. 4×5 **B.** 3×3 **C.** 5×3 **D.** 5×4

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12. If $A = \begin{bmatrix} -1 & -2 & 5 \\ 2 & -1 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 0 & -1 \\ -1 & 4 \\ 4 & 4 \end{bmatrix}$, the $(1,2)$ element of AB is

A. 9 **B.** 17 **C.** 13 **D.** 1

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13. If $A = \begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix}$, then $A^3 =$

A. $\begin{bmatrix} 64 & 0 \\ 0 & 64 \end{bmatrix}$ **B.** $\begin{bmatrix} 12 & 0 \\ 0 & 12 \end{bmatrix}$

C. $\begin{bmatrix} 16 & 0 \\ 0 & 16 \end{bmatrix}$ **D.** $\begin{bmatrix} 7 & 0 \\ 0 & 7 \end{bmatrix}$

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14. If $A = \operatorname{diag}(1, -3, 1)$, then $A^3 =$

A. $\begin{bmatrix} 3 & 0 & 0 \\ 0 & -9 & 0 \\ 0 & 0 & 3 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -27 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 4 & 0 & 0 \\ 0 & -8 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 27 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

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15. If A is 5×2 and B is 2×4, the order of $(AB)^T$ is

A. 4×5 **B.** 2×5 **C.** 5×4 **D.** 4×2

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16. If A is a skew-symmetric matrix, then A^9 is

A. a null matrix **B.** skew-symmetric

C. an identity matrix **D.** symmetric

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17. If $\begin{bmatrix} 0 & -1 & -6 \\ 2x - 5 & 0 & -1 \\ 6 & 1 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

A. -3 **B.** 2 **C.** -2 **D.** 3

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18. If $A = \begin{bmatrix} 6 & -6 \\ 1 & -3 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

A. $\begin{bmatrix} 0 & \frac{7}{2} \\ -\frac{7}{2} & 0 \end{bmatrix}$ **B.** $\begin{bmatrix} 6 & -\frac{5}{2} \\ -\frac{5}{2} & -3 \end{bmatrix}$

C. $\begin{bmatrix} 0 & -7 \\ 7 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 0 & -\frac{7}{2} \\ \frac{7}{2} & 0 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{8}{17} & x \\ \frac{15}{17} & \frac{8}{17} \end{bmatrix}$ is orthogonal, then $x =$

A. $\frac{8}{17}$ **B.** $-\frac{15}{17}$ **C.** $\frac{15}{17}$ **D.** $-\frac{8}{17}$

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20. If $k \begin{bmatrix} 4 & -4 & 2 \\ -4 & -2 & 4 \\ -2 & -4 & -4 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

A. $\frac{1}{36}$ **B.** $\frac{1}{18}$ **C.** $\frac{1}{6}$ **D.** 6

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21. The matrix $\begin{bmatrix} -3 & -4 \\ 2 & 3 \end{bmatrix}$ is

A. nilpotent of index 2 **B.** orthogonal

C. involutory **D.** idempotent

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22. If A is idempotent and $(I + A)^4 = I + kA$, then $k =$

A. 8 **B.** 15 **C.** 16 **D.** 4

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23. If $\begin{bmatrix} 8 & 5 + yi \\ x + 7i & 3 \end{bmatrix}$ is Hermitian, then $x + y =$

A. -2 **B.** -12 **C.** 12 **D.** 2

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24. If $A = \begin{bmatrix} -5 - 6i & 5i - 4 \\ -6 - 3i & 2 - 5i \end{bmatrix}$, then $A^\theta =$

A. $\begin{bmatrix} 6i - 5 & -4 - 5i \\ 3i - 6 & 2 + 5i \end{bmatrix}$

B. $\begin{bmatrix} 5 - 6i & 6 - 3i \\ 4 + 5i & -2 - 5i \end{bmatrix}$

C. $\begin{bmatrix} 6i - 5 & 3i - 6 \\ -4 - 5i & 2 + 5i \end{bmatrix}$

D. $\begin{bmatrix} -5 - 6i & -6 - 3i \\ 5i - 4 & 2 - 5i \end{bmatrix}$

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25. If $A = \begin{bmatrix} 3 & -4 \\ -2 & 2 \end{bmatrix}$ satisfies $A^2 - kA + lI = O$, then $k + l =$

A. 7 **B.** 19 **C.** 3 **D.** -7

Key sheet

1. A	**2.** D	**3.** A	**4.** A	**5.** B
6. C	**7.** A	**8.** D	**9.** B	**10.** D
11. D	**12.** C	**13.** A	**14.** B	**15.** A
16. B	**17.** D	**18.** D	**19.** B	**20.** C
21. C	**22.** B	**23.** A	**24.** C	**25.** C

Solutions

1. The number of possible orders of a matrix with 28 elements is

An $m \times n$ matrix has $mn = 28$ elements, so m can be any divisor of 28.

28 has 6 divisors, so there are 6 orders.

Ans: (A) 6

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2. If $A = \begin{bmatrix} 6 & 0 \\ 10 & -9 \\ -6 & -1 \end{bmatrix}$, then $a_{21} \cdot a_{12} =$

$a_{21} = 10,\ a_{12} = 0$

Product $= 0$

Ans: (D) 0

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = (-1)^{i+j}(i + 2j)$, then $a_{12} =$

Put $i = 1$, $j = 2$ in $a_{ij} = (-1)^{i+j}(i + 2j)$.

$a_{12} = -5$

Ans: (A) -5

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4. The matrix $\begin{bmatrix} -5 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 5 \end{bmatrix}$ is

Look at the elements off the principal diagonal and on it.

It is a diagonal matrix.

Ans: (A) a diagonal matrix

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5. The number of elements outside the principal diagonal of a square matrix of order 9 is

It has $9^2 = 81$ elements, of which 9 are on the principal diagonal.

$81 - 9 = 72$

Ans: (B) 72

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6. $\mathrm{tr}(9I_7) =$

$\mathrm{tr}(I_7) = 7$

$\mathrm{tr}(9I_7) = 9 \times 7 = 63$

Ans: (C) 63

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7. If $A = \begin{bmatrix} 5 & -3 \\ 4 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 4 & -1 \\ -1 & -4 \end{bmatrix}$, then $\mathrm{tr}(AB) =$

$AB = \begin{bmatrix} 23 & 7 \\ 16 & -4 \end{bmatrix}$

$\mathrm{tr}(AB) = 19$

Ans: (A) 19

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8. If $\begin{bmatrix} 2x+5y & 1 \\ x+3y & 2 \end{bmatrix} = \begin{bmatrix} -7 & 1 \\ -5 & 2 \end{bmatrix}$, then $x+y=$

$2x+5y=-7,\ x+3y=-5$

So $x=4$, $y=-3$ and $x+y=1$.

Ans: (D) 1

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9. If $A=\begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix}$ and $B=\begin{bmatrix} -3 & -4 \\ 6 & 3 \end{bmatrix}$, then $4A-4B=$

$4A-4B=\begin{bmatrix} 8 & 4 \\ 4 & 12 \end{bmatrix}-\begin{bmatrix} -12 & -16 \\ 24 & 12 \end{bmatrix}$

$=\begin{bmatrix} 20 & 20 \\ -20 & 0 \end{bmatrix}$

Ans: (B) $\begin{bmatrix} 20 & 20 \\ -20 & 0 \end{bmatrix}$

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10. If $A=\begin{bmatrix} -6 & 7 \\ 0 & 4 \end{bmatrix}$ and $B=\begin{bmatrix} 1 & 2 \\ 1 & 6 \end{bmatrix}$, the element in row 2, column 1 of $4A+4B$ is

$4a_{21}+4b_{21}=4(0)+4(1)$

$=4$

Ans: (D) 4

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11. If A is a 5×3 matrix and B is a 3×4 matrix, the order of AB is

The product of $m\times p$ and $p\times n$ matrices is $m\times n$.

So AB is 5×4.

Ans: (D) 5×4

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12. If $A=\begin{bmatrix} -1 & -2 & 5 \\ 2 & -1 & 4 \end{bmatrix}$ and $B=\begin{bmatrix} 0 & -1 \\ -1 & 4 \\ 4 & 4 \end{bmatrix}$, the $(1,2)$ element of AB is

Row 1 of A times column 2 of B:

$(-1)(-1)+(-2)(4)+(5)(4)=13$

Ans: (C) 13

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13. If $A=\begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix}$, then $A^3=$

$A=4I$

$A^3=(4)^3I=\begin{bmatrix} 64 & 0 \\ 0 & 64 \end{bmatrix}$

Ans: (A) $\begin{bmatrix} 64 & 0 \\ 0 & 64 \end{bmatrix}$

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14. If $A = \text{diag}(1, -3, 1)$, then $A^3 =$

$A^n = \text{diag}(d_1^n, d_2^n, d_3^n)$

$A^3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -27 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

Ans: (B) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -27 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

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15. If A is 5×2 and B is 2×4, the order of $(AB)^T$ is

AB is 5×4.

So $(AB)^T = B^T A^T$ is 4×5.

Ans: (A) 4×5

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16. If A is a skew-symmetric matrix, then A^9 is

$(A^k)^T = (A^T)^k = (-A)^k = (-1)^k A^k$.

With $k = 9$ (odd), A^9 is skew-symmetric.

Ans: (B) skew-symmetric

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17. If $\begin{bmatrix} 0 & -1 & -6 \\ 2x - 5 & 0 & -1 \\ 6 & 1 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

$a_{21} = -a_{12} \Rightarrow 2x - 5 = 1$

$x = 3$

Ans: (D) 3

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18. If $A = \begin{bmatrix} 6 & -6 \\ 1 & -3 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

$Q = \frac{1}{2}(A - A^T) = \frac{1}{2}\begin{bmatrix} 0 & -7 \\ 7 & 0 \end{bmatrix}$

$= \begin{bmatrix} 0 & -\frac{7}{2} \\ \frac{7}{2} & 0 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} 0 & -\frac{7}{2} \\ \frac{7}{2} & 0 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{8}{17} & x \\ \frac{15}{17} & \frac{8}{17} \end{bmatrix}$ is orthogonal, then $x =$

The two rows must be perpendicular:

$\frac{8}{17}\left(\frac{15}{17}\right) + x \cdot \frac{8}{17} = 0$

$x = -\frac{15}{17}$

Ans: (B) $-\frac{15}{17}$

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20. If $k\begin{bmatrix}4 & -4 & 2\\ -4 & -2 & 4\\ -2 & -4 & -4\end{bmatrix}$ is orthogonal and $k>0$, then $k=$

$(kM)(kM)^T = k^2MM^T = 36k^2I$

$36k^2 = 1 \Rightarrow k = \frac{1}{6}$

Ans: (C) $\frac{1}{6}$

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21. The matrix $\begin{bmatrix}-3 & -4\\ 2 & 3\end{bmatrix}$ is

$A^2 = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$

$A^2 = I$, so A is involutory.

Ans: (C) involutory

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22. If A is idempotent and $(I+A)^4 = I + kA$, then $k=$

$A^r = A$ for every $r \geq 1$, so $(I+A)^4 = I + \left(\binom{4}{1} + \cdots + \binom{4}{4}\right)A$.

$k = 2^4 - 1 = 15$

Ans: (B) 15

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23. If $\begin{bmatrix}8 & 5+yi\\ x+7i & 3\end{bmatrix}$ is Hermitian, then $x+y=$

Hermitian: $a_{21} = \overline{a_{12}} = 5 - yi$.

$x + 7i = 5 - yi \Rightarrow x = 5,\ y = -7$

$x + y = -2$

Ans: (A) -2

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24. If $A = \begin{bmatrix}-5-6i & 5i-4\\ -6-3i & 2-5i\end{bmatrix}$, then $A^\theta =$

$A^\theta = (\bar{A})^T$

$= \begin{bmatrix}6i-5 & 3i-6\\ -4-5i & 2+5i\end{bmatrix}$

Ans: (C) $\begin{bmatrix}6i-5 & 3i-6\\ -4-5i & 2+5i\end{bmatrix}$

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25. If $A = \begin{bmatrix}3 & -4\\ -2 & 2\end{bmatrix}$ satisfies $A^2 - kA + lI = O$, then $k+l=$

$k = a + d = 5,\ l = ad - bc = -2$

$k + l = 3$

Ans: (C) 3
