EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 01

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 10 elements is

A. 3 **B.** 5 **C.** 4 **D.** 2

2. If $A = \begin{bmatrix} 7 & -3 \\ -7 & -2 \\ -4 & 6 \end{bmatrix}$, then $a_{12} =$

A. -2 **B.** -7 **C.** 3 **D.** -3

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = i + j^2$, then $a_{13} =$

A. 11 **B.** -10 **C.** 10 **D.** 4

4. The number of elements outside the principal diagonal of a square matrix of order 6 is

A. 35 **B.** 30 **C.** 36 **D.** 15

5. In an upper triangular matrix of order 7, the number of elements that must be zero is

A. 21 **B.** 42 **C.** 7 **D.** 28

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

A. 3 **B.** -4 **C.** -1 **D.** 0

7. If $\operatorname{tr}(A) = -5$ and $\operatorname{tr}(B) = 6$, then $\operatorname{tr}(3A - 3B) =$

A. -11 **B.** -33 **C.** -270 **D.** 3

8. If $\begin{bmatrix} 3x - y & 2 \\ 3x + 2y & 3 \end{bmatrix} = \begin{bmatrix} -7 & 2 \\ -13 & 3 \end{bmatrix}$, then $x + y =$

A. -5 **B.** -1 **C.** 1 **D.** 5

9. If $A = \begin{bmatrix} 2 & 2 \\ -3 & -5 \end{bmatrix}$ and $B = \begin{bmatrix} 6 & -6 \\ -4 & 0 \end{bmatrix}$, then $3A - 4B =$

A. $\begin{bmatrix} -10 & 26 \\ 0 & -20 \end{bmatrix}$ **B.** $\begin{bmatrix} 30 & -18 \\ -25 & -15 \end{bmatrix}$

C. $\begin{bmatrix} 0 & 12 \\ -5 & -15 \end{bmatrix}$ **D.** $\begin{bmatrix} -18 & 30 \\ 7 & -15 \end{bmatrix}$

10. If $A = \begin{bmatrix} 3 & 0 \\ -2 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & -6 \\ -1 & 5 \end{bmatrix}$, the element in row 2, column 1 of $3A + 4B$ is

A. -10 **B.** -24 **C.** -2 **D.** -3

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11. If A is a 5×2 matrix and B is a 2×3 matrix, the order of AB is

A. 5×3 **B.** 3×5 **C.** 5×2 **D.** 2×2

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12. If $A = \begin{bmatrix} 2 & 5 & -3 \\ 5 & 0 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & 0 \\ -2 & -1 \\ 0 & -4 \end{bmatrix}$, the $(1,1)$ element of AB is

A. -4 **B.** -14 **C.** 0 **D.** -13

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13. If $A = \operatorname{diag}(4, -1, 3)$, then $A^4 =$

A. $\begin{bmatrix} 16 & 0 & 0 \\ 0 & -4 & 0 \\ 0 & 0 & 12 \end{bmatrix}$ **B.** $\begin{bmatrix} 8 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 7 \end{bmatrix}$

C. $\begin{bmatrix} 256 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 81 \end{bmatrix}$ **D.** $\begin{bmatrix} 17 & 0 & 0 \\ 0 & -3 & 0 \\ 0 & 0 & 13 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 6 \\ 0 & 1 \end{bmatrix}$, then $A^6 =$

A. $\begin{bmatrix} 1 & 36 \\ 0 & 1 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & 30 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 6 & 36 \\ 0 & 6 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & 46656 \\ 0 & 1 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -3 & -9 & 3 \\ 5 & -4 & 5 \\ -4 & 1 & 4 \end{bmatrix}$, the $(1,2)$ element of A^T is

A. -3 **B.** -5 **C.** -9 **D.** 5

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16. If $\begin{bmatrix} 0 & 3 & -5 \\ 2x+5 & 0 & -8 \\ 5 & 8 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

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

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17. If $A = \begin{bmatrix} 5 & -1 \\ 4 & 7 \end{bmatrix}$, then $A + A^T =$

A. $\begin{bmatrix} 10 & -2 \\ 8 & 14 \end{bmatrix}$ **B.** $\begin{bmatrix} 0 & 5 \\ -5 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 10 & 3 \\ 3 & 14 \end{bmatrix}$ **D.** $\begin{bmatrix} 0 & -5 \\ 5 & 0 \end{bmatrix}$

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18. If $A = \begin{bmatrix} 2 & 1 \\ -4 & -3 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

A. $\begin{bmatrix} 2 & -4 \\ 1 & -3 \end{bmatrix}$ **B.** $\begin{bmatrix} 0 & \frac{5}{2} \\ -\frac{5}{2} & 0 \end{bmatrix}$

C. $\begin{bmatrix} 2 & -\frac{3}{2} \\ -\frac{3}{2} & -3 \end{bmatrix}$ **D.** $\begin{bmatrix} 4 & -3 \\ -3 & -6 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{4}{5} & x \\ -\frac{3}{5} & \frac{4}{5} \end{bmatrix}$ is orthogonal, then $x =$

A. $-\frac{4}{5}$ **B.** $\frac{3}{5}$ **C.** $\frac{4}{5}$ **D.** $-\frac{3}{5}$

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

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

21. If A is idempotent and $(I + A)^8 = I + kA$, then $k =$

A. 8 **B.** 256 **C.** 128 **D.** 255

22. If A is involutory and $(I + A)^8 = k(I + A)$, then $k =$

A. 128 **B.** 255 **C.** 8 **D.** 256

23. If $\begin{bmatrix} 1 & 4 + yi \\ x - 5i & 4 \end{bmatrix}$ is Hermitian, then $x + y =$

A. -1 **B.** 9 **C.** -9 **D.** 1

24. If $A = \begin{bmatrix} 2 + 7i & 1 + i \\ 1 - 6i & 5i - 6 \end{bmatrix}$, then $A^\theta =$

A. $\begin{bmatrix} 2 + 7i & 1 - 6i \\ 1 + i & 5i - 6 \end{bmatrix}$ **B.** $\begin{bmatrix} 7i - 2 & -1 - 6i \\ i - 1 & 6 + 5i \end{bmatrix}$

C. $\begin{bmatrix} 2 - 7i & 1 - i \\ 1 + 6i & -6 - 5i \end{bmatrix}$ **D.** $\begin{bmatrix} 2 - 7i & 1 + 6i \\ 1 - i & -6 - 5i \end{bmatrix}$

25. If $A = \begin{bmatrix} 2 & 1 \\ 3 & 1 \end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k, l) =$

A. $(-1, 3)$ **B.** $(3, -1)$ **C.** $(-3, -1)$ **D.** $(3, 1)$

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 10 elements is

An $m \times n$ matrix has $mn = 10$ elements, so m can be any divisor of 10.

10 has 4 divisors, so there are 4 orders.

Ans: (C) 4

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2. If $A = \begin{bmatrix} 7 & -3 \\ -7 & -2 \\ -4 & 6 \end{bmatrix}$, then $a_{12} =$

a_{12} is the element in row 1 and column 2.

$a_{12} = -3$

Ans: (D) -3

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = i + j^2$, then $a_{13} =$

Put $i = 1$, $j = 3$ in $a_{ij} = i + j^2$.

$a_{13} = 10$

Ans: (C) 10

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4. The number of elements outside the principal diagonal of a square matrix of order 6 is

It has $6^2 = 36$ elements, of which 6 are on the principal diagonal.

$36 - 6 = 30$

Ans: (B) 30

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5. In an upper triangular matrix of order 7, the number of elements that must be zero is

The elements below the principal diagonal ($i > j$) must be zero.

$1 + 2 + \cdots + 6 = \frac{7\cdot 6}{2} = 21$

Ans: (A) 21

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

$AB = \begin{bmatrix} 0 & 0 \\ 0 & -1 \end{bmatrix}$

$\operatorname{tr}(AB) = -1$

Ans: (C) -1

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7. If $\operatorname{tr}(A) = -5$ and $\operatorname{tr}(B) = 6$, then $\operatorname{tr}(3A - 3B) =$

$\operatorname{tr}(3A - 3B) = 3\operatorname{tr}(A) - 3\operatorname{tr}(B)$

$= 3(-5) - 3(6) = -33$

Ans: (B) -33

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8. If $\begin{bmatrix} 3x-y & 2 \\ 3x+2y & 3 \end{bmatrix} = \begin{bmatrix} -7 & 2 \\ -13 & 3 \end{bmatrix}$, then $x+y=$

$3x-y=-7,\ 3x+2y=-13$

So $x=-3$, $y=-2$ and $x+y=-5$.

Ans: (A) -5

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9. If $A=\begin{bmatrix} 2 & 2 \\ -3 & -5 \end{bmatrix}$ and $B=\begin{bmatrix} 6 & -6 \\ -4 & 0 \end{bmatrix}$, then $3A-4B=$

$3A-4B=\begin{bmatrix} 6 & 6 \\ -9 & -15 \end{bmatrix}-\begin{bmatrix} 24 & -24 \\ -16 & 0 \end{bmatrix}$

$=\begin{bmatrix} -18 & 30 \\ 7 & -15 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} -18 & 30 \\ 7 & -15 \end{bmatrix}$

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10. If $A=\begin{bmatrix} 3 & 0 \\ -2 & 0 \end{bmatrix}$ and $B=\begin{bmatrix} -2 & -6 \\ -1 & 5 \end{bmatrix}$, the element in row 2, column 1 of $3A+4B$ is

$3a_{21}+4b_{21}=3(-2)+4(-1)$

$=-10$

Ans: (A) -10

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11. If A is a 5×2 matrix and B is a 2×3 matrix, the order of AB is

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

So AB is 5×3.

Ans: (A) 5×3

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12. If $A=\begin{bmatrix} 2 & 5 & -3 \\ 5 & 0 & 3 \end{bmatrix}$ and $B=\begin{bmatrix} -2 & 0 \\ -2 & -1 \\ 0 & -4 \end{bmatrix}$, the $(1,1)$ element of AB is

Row 1 of A times column 1 of B:

$(2)(-2)+(5)(-2)+(-3)(0)=-14$

Ans: (B) -14

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13. If $A=\operatorname{diag}(4,-1,3)$, then $A^4=$

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

$A^4=\begin{bmatrix} 256 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 81 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 256 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 81 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 6 \\ 0 & 1 \end{bmatrix}$, then $A^6 =$

$A^2 = \begin{bmatrix} 1 & 12 \\ 0 & 1 \end{bmatrix}$, $A^3 = \begin{bmatrix} 1 & 18 \\ 0 & 1 \end{bmatrix}$

Each multiplication adds 6 to the top right element, so $A^6 = \begin{bmatrix} 1 & 36 \\ 0 & 1 \end{bmatrix}$.

Ans: (A) $\begin{bmatrix} 1 & 36 \\ 0 & 1 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -3 & -9 & 3 \\ 5 & -4 & 5 \\ -4 & 1 & 4 \end{bmatrix}$, the $(1,2)$ element of A^T is

The (i,j) element of A^T is the (j,i) element of A.

$a_{21} = 5$

Ans: (D) 5

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16. If $\begin{bmatrix} 0 & 3 & -5 \\ 2x+5 & 0 & -8 \\ 5 & 8 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

$a_{21} = -a_{12} \Rightarrow 2x + 5 = -3$

$x = -4$

Ans: (A) -4

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17. If $A = \begin{bmatrix} 5 & -1 \\ 4 & 7 \end{bmatrix}$, then $A + A^T =$

$A^T = \begin{bmatrix} 5 & 4 \\ -1 & 7 \end{bmatrix}$

$A + A^T = \begin{bmatrix} 10 & 3 \\ 3 & 14 \end{bmatrix}$

It is symmetric, as it must be.

Ans: (C) $\begin{bmatrix} 10 & 3 \\ 3 & 14 \end{bmatrix}$

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18. If $A = \begin{bmatrix} 2 & 1 \\ -4 & -3 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

$P = \frac{1}{2}(A + A^T) = \frac{1}{2}\begin{bmatrix} 4 & -3 \\ -3 & -6 \end{bmatrix}$

$= \begin{bmatrix} 2 & -\frac{3}{2} \\ -\frac{3}{2} & -3 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 2 & -\frac{3}{2} \\ -\frac{3}{2} & -3 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{4}{5} & x \\ -\frac{3}{5} & \frac{4}{5} \end{bmatrix}$ is orthogonal, then $x =$

The two rows must be perpendicular:

$\frac{4}{5}\left(-\frac{3}{5}\right) + x \cdot \frac{4}{5} = 0$

$x = \frac{3}{5}$

Ans: (B) $\frac{3}{5}$

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

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

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

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

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21. If A is idempotent and $(I+A)^8 = I + kA$, then $k=$

$A^r = A$ for every $r \geq 1$, so $(I+A)^8 = I + \left(\binom{8}{1} + \cdots + \binom{8}{8}\right)A$.

$k = 2^8 - 1 = 255$

Ans: (D) 255

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22. If A is involutory and $(I+A)^8 = k(I+A)$, then $k=$

$(I+A)^2 = I + 2A + A^2 = 2(I+A)$

$(I+A)^8 = 2^7(I+A) = 128(I+A)$

Ans: (A) 128

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23. If $\begin{bmatrix}1 & 4+yi\\ x-5i & 4\end{bmatrix}$ is Hermitian, then $x+y=$

Hermitian: $a_{21} = \overline{a_{12}} = 4 - yi$.

$x - 5i = 4 - yi \Rightarrow x = 4,\ y = 5$

$x + y = 9$

Ans: (B) 9

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24. If $A = \begin{bmatrix}2+7i & 1+i\\ 1-6i & 5i-6\end{bmatrix}$, then $A^\theta =$

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

$= \begin{bmatrix}2-7i & 1+6i\\ 1-i & -6-5i\end{bmatrix}$

Ans: (D) $\begin{bmatrix}2-7i & 1+6i\\ 1-i & -6-5i\end{bmatrix}$

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25. If $A = \begin{bmatrix}2 & 1\\ 3 & 1\end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k,l) =$

$k = a + d = 3$

$l = ad - bc = -1$

Ans: (B) $(3,-1)$