EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 03

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 18 elements is

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

2. If $A = \begin{bmatrix} 2 & 1 & 8 & -6 \\ 6 & 10 & -7 & 1 \\ 7 & -5 & 5 & -2 \end{bmatrix}$, then $a_{21} =$

A. 7 **B.** 6 **C.** 1 **D.** -6

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = 2i + j$, then $a_{23} =$

A. -7 **B.** 8 **C.** 7 **D.** 6

4. In an upper triangular matrix of order 12, the number of elements that must be zero is

A. 66 **B.** 132 **C.** 78 **D.** 12

5. The matrix $\begin{bmatrix} 8 & 0 & 0 \\ 0 & 8 & 0 \\ 0 & 0 & 8 \end{bmatrix}$ is

A. a null matrix **B.** a rectangular matrix
C. an identity matrix **D.** a scalar matrix

6. If $\operatorname{tr}(A) = -6$ and $\operatorname{tr}(B) = 7$, then $\operatorname{tr}(6A - 4B) =$

A. -1008 **B.** -8 **C.** -64 **D.** -13

7. $\operatorname{tr}(8I_3) =$

A. 3 **B.** 72 **C.** 24 **D.** 8

8. If $\begin{bmatrix} 2x + 5y & -7 \\ 3x - y & -6 \end{bmatrix} = \begin{bmatrix} 24 & -7 \\ 2 & -6 \end{bmatrix}$, then $x + y =$

A. -2 **B.** -6 **C.** 2 **D.** 6

9. If $A = \begin{bmatrix} -4 & -2 \\ -4 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 5 \\ 2 & -6 \end{bmatrix}$, then $3A - 3B =$

A. $\begin{bmatrix} -3 & 9 \\ -6 & -21 \end{bmatrix}$ **B.** $\begin{bmatrix} -21 & -21 \\ -18 & 15 \end{bmatrix}$

C. $\begin{bmatrix} -15 & -11 \\ -14 & 3 \end{bmatrix}$ **D.** $\begin{bmatrix} -13 & -17 \\ -10 & 17 \end{bmatrix}$

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

A. 30 **B.** 0 **C.** 9 **D.** 24

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11. If A is a 1×3 matrix and B is a 3×2 matrix, the order of AB is

A. 3×3 **B.** 1×2 **C.** 1×3 **D.** 2×1

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

A. 24 **B.** -11 **C.** -3 **D.** 13

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13. If $A = \begin{bmatrix} 1 & -3 \\ 0 & 1 \end{bmatrix}$, then $A^5 =$

A. $\begin{bmatrix} 5 & -15 \\ 0 & 5 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & -12 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 1 & -15 \\ 0 & 1 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & -243 \\ 0 & 1 \end{bmatrix}$

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14. If $A = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$, then $A^7 =$

A. $\begin{bmatrix} -2187 & 0 \\ 0 & -2187 \end{bmatrix}$ **B.** $\begin{bmatrix} -21 & 0 \\ 0 & -21 \end{bmatrix}$

C. $\begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix}$ **D.** $\begin{bmatrix} 729 & 0 \\ 0 & 729 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -8 & 3 & 6 \\ 0 & 8 & 6 \\ -9 & -1 & 7 \end{bmatrix}$, the $(2,1)$ element of A^T is

A. 3 **B.** 0 **C.** -3 **D.** 8

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16. If $A = \begin{bmatrix} -3 & -1 \\ -6 & 2 \end{bmatrix}$, then $A + A^T =$

A. $\begin{bmatrix} 0 & -5 \\ 5 & 0 \end{bmatrix}$ **B.** $\begin{bmatrix} -6 & -2 \\ -12 & 4 \end{bmatrix}$

C. $\begin{bmatrix} 0 & 5 \\ -5 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} -6 & -7 \\ -7 & 4 \end{bmatrix}$

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17. If A is a skew-symmetric matrix, then A^{10} is

A. an identity matrix **B.** a null matrix

C. skew-symmetric **D.** symmetric

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18. If $A = \begin{bmatrix} 5 & 6 \\ 5 & 6 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

A. $\begin{bmatrix} 0 & \frac{1}{2} \\ -\frac{1}{2} & 0 \end{bmatrix}$

B. $\begin{bmatrix} 5 & \frac{11}{2} \\ \frac{11}{2} & 6 \end{bmatrix}$

C. $\begin{bmatrix} 10 & 11 \\ 11 & 12 \end{bmatrix}$

D. $\begin{bmatrix} 5 & 5 \\ 6 & 6 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{35}{37} & x \\ \frac{12}{37} & \frac{35}{37} \end{bmatrix}$ is orthogonal, then $x =$

A. $-\frac{35}{37}$ **B.** $\frac{12}{37}$ **C.** $-\frac{12}{37}$ **D.** $\frac{35}{37}$

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20. If $k \begin{bmatrix} -2 & -3 & -6 \\ -6 & -2 & 3 \\ -3 & 6 & -2 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

A. $\frac{1}{7}$ **B.** 7 **C.** $\frac{1}{49}$ **D.** $\frac{1}{21}$

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21. If A is involutory and $(I + A)^3 = k(I + A)$, then $k =$

A. 7 **B.** 4 **C.** 3 **D.** 8

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22. The matrix $\begin{bmatrix} -3 & 3 \\ -3 & 3 \end{bmatrix}$ is

A. orthogonal

B. idempotent

C. nilpotent of index 2

D. involutory

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23. If $\begin{bmatrix} -7 & 6 + yi \\ x - 2i & -2 \end{bmatrix}$ is Hermitian, then $x + y =$

A. -8 **B.** 8 **C.** -4 **D.** 4

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

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

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

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

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

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25. If $A = \begin{bmatrix} -4 & 5 \\ 2 & 2 \end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k, l) =$

A. $(-2, 18)$ **B.** $(-18, -2)$ **C.** $(2, -18)$ **D.** $(-2, -18)$

Key sheet

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

Solutions

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

An $m \times n$ matrix has $mn = 18$ elements, so m can be any divisor of 18.

18 has 6 divisors, so there are 6 orders.

Ans: (A) 6

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2. If $A = \begin{bmatrix} 2 & 1 & 8 & -6 \\ 6 & 10 & -7 & 1 \\ 7 & -5 & 5 & -2 \end{bmatrix}$, then $a_{21} =$

a_{21} is the element in row 2 and column 1.

$a_{21} = 6$

Ans: (B) 6

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = 2i + j$, then $a_{23} =$

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

$a_{23} = 7$

Ans: (C) 7

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4. In an upper triangular matrix of order 12, the number of elements that must be zero is

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

$1 + 2 + \cdots + 11 = \frac{12 \cdot 11}{2} = 66$

Ans: (A) 66

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5. The matrix $\begin{bmatrix} 8 & 0 & 0 \\ 0 & 8 & 0 \\ 0 & 0 & 8 \end{bmatrix}$ is

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

It is a scalar matrix.

Ans: (D) a scalar matrix

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6. If $\operatorname{tr}(A) = -6$ and $\operatorname{tr}(B) = 7$, then $\operatorname{tr}(6A - 4B) =$

$\operatorname{tr}(6A - 4B) = 6\operatorname{tr}(A) - 4\operatorname{tr}(B)$

$= 6(-6) - 4(7) = -64$

Ans: (C) -64

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7. $\operatorname{tr}(8I_3) =$

$\operatorname{tr}(I_3) = 3$

$\operatorname{tr}(8I_3) = 8 \times 3 = 24$

Ans: (C) 24

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8. If $\begin{bmatrix} 2x+5y & -7 \\ 3x-y & -6 \end{bmatrix} = \begin{bmatrix} 24 & -7 \\ 2 & -6 \end{bmatrix}$, then $x+y=$

$2x+5y=24,\ 3x-y=2$

So $x=2$, $y=4$ and $x+y=6$.

Ans: (D) 6

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9. If $A=\begin{bmatrix} -4 & -2 \\ -4 & -1 \end{bmatrix}$ and $B=\begin{bmatrix} 3 & 5 \\ 2 & -6 \end{bmatrix}$, then $3A-3B=$

$3A-3B=\begin{bmatrix} -12 & -6 \\ -12 & -3 \end{bmatrix}-\begin{bmatrix} 9 & 15 \\ 6 & -18 \end{bmatrix}$

$=\begin{bmatrix} -21 & -21 \\ -18 & 15 \end{bmatrix}$

Ans: (B) $\begin{bmatrix} -21 & -21 \\ -18 & 15 \end{bmatrix}$

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

$2a_{22}+4b_{22}=2(6)+4(3)$

$=24$

Ans: (D) 24

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11. If A is a 1×3 matrix and B is a 3×2 matrix, the order of AB is

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

So AB is 1×2.

Ans: (B) 1×2

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

Row 2 of A times column 1 of B:

$(-3)(1)+(5)(3)+(4)(3)=24$

Ans: (A) 24

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13. If $A=\begin{bmatrix} 1 & -3 \\ 0 & 1 \end{bmatrix}$, then $A^5=$

$A^2=\begin{bmatrix} 1 & -6 \\ 0 & 1 \end{bmatrix},\ A^3=\begin{bmatrix} 1 & -9 \\ 0 & 1 \end{bmatrix}$

Each multiplication adds -3 to the top right element, so $A^5=\begin{bmatrix} 1 & -15 \\ 0 & 1 \end{bmatrix}$.

Ans: (C) $\begin{bmatrix} 1 & -15 \\ 0 & 1 \end{bmatrix}$

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14. If $A = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$, then $A^7 =$

$A = -3I$

$A^7 = (-3)^7 I = \begin{bmatrix} -2187 & 0 \\ 0 & -2187 \end{bmatrix}$

Ans: (A) $\begin{bmatrix} -2187 & 0 \\ 0 & -2187 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -8 & 3 & 6 \\ 0 & 8 & 6 \\ -9 & -1 & 7 \end{bmatrix}$, the $(2,1)$ element of A^T is

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

$a_{12} = 3$

Ans: (A) 3

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16. If $A = \begin{bmatrix} -3 & -1 \\ -6 & 2 \end{bmatrix}$, then $A + A^T =$

$A^T = \begin{bmatrix} -3 & -6 \\ -1 & 2 \end{bmatrix}$

$A + A^T = \begin{bmatrix} -6 & -7 \\ -7 & 4 \end{bmatrix}$

It is symmetric, as it must be.

Ans: (D) $\begin{bmatrix} -6 & -7 \\ -7 & 4 \end{bmatrix}$

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17. If A is a skew-symmetric matrix, then A^{10} is

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

With $k = 10$ (even), A^{10} is symmetric.

Ans: (D) symmetric

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18. If $A = \begin{bmatrix} 5 & 6 \\ 5 & 6 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

$P = \frac{1}{2}(A + A^T) = \frac{1}{2}\begin{bmatrix} 10 & 11 \\ 11 & 12 \end{bmatrix}$

$= \begin{bmatrix} 5 & \frac{11}{2} \\ \frac{11}{2} & 6 \end{bmatrix}$

Ans: (B) $\begin{bmatrix} 5 & \frac{11}{2} \\ \frac{11}{2} & 6 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{35}{37} & x \\ \frac{12}{37} & \frac{35}{37} \end{bmatrix}$ is orthogonal, then $x =$

The two rows must be perpendicular:

$\frac{35}{37}\left(\frac{12}{37}\right) + x \cdot \frac{35}{37} = 0$

$x = -\frac{12}{37}$

Ans: (C) $-\frac{12}{37}$

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20. If $k\begin{bmatrix}-2 & -3 & -6\\ -6 & -2 & 3\\ -3 & 6 & -2\end{bmatrix}$ is orthogonal and $k>0$, then $k=$

$(kM)(kM)^T = k^2MM^T = 49k^2I$

$49k^2 = 1 \Rightarrow k = \frac{1}{7}$

Ans: (A) $\frac{1}{7}$

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21. If A is involutory and $(I+A)^3 = k(I+A)$, then $k=$

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

$(I+A)^3 = 2^2(I+A) = 4(I+A)$

Ans: (B) 4

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22. The matrix $\begin{bmatrix}-3 & 3\\ -3 & 3\end{bmatrix}$ is

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

$A^2 = O$, so A is nilpotent of index 2.

Ans: (C) nilpotent of index 2

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23. If $\begin{bmatrix}-7 & 6+yi\\ x-2i & -2\end{bmatrix}$ is Hermitian, then $x+y=$

Hermitian: $a_{21} = \overline{a_{12}} = 6 - yi$.

$x - 2i = 6 - yi \Rightarrow x = 6,\ y = 2$

$x + y = 8$

Ans: (B) 8

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

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

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

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

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25. If $A = \begin{bmatrix}-4 & 5\\ 2 & 2\end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k,l) =$

$k = a + d = -2$

$l = ad - bc = -18$

Ans: (D) $(-2,-18)$
