EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 09

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 40 elements is

A. 9 **B.** 6 **C.** 8 **D.** 4

2. If $A = \begin{bmatrix} -3 & 8 & 3 \\ -8 & 5 & 6 \end{bmatrix}$, then $a_{21} =$

A. 5 **B.** 8 **C.** -7 **D.** -8

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

A. -8 **B.** 9 **C.** 8 **D.** 0

4. In an upper triangular matrix of order 10, the number of elements that must be zero is

A. 45 **B.** 55 **C.** 90 **D.** 10

5. The matrix $\begin{bmatrix} 5 & 0 & 0 \\ 6 & 2 & 0 \\ -6 & -5 & 2 \end{bmatrix}$ is

A. an upper triangular matrix **B.** a lower triangular matrix

C. a scalar matrix **D.** a diagonal matrix

6. If $\operatorname{tr}(A) = 1$ and $\operatorname{tr}(B) = 6$, then $\operatorname{tr}(5A - 6B) =$

A. -5 **B.** 41 **C.** -31 **D.** 180

7. $\operatorname{tr}(3I_8) =$

A. 8 **B.** 3 **C.** 24 **D.** 192

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

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

9. If $A = \begin{bmatrix} -5 & -4 \\ -3 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 7 & -3 \\ 4 & 1 \end{bmatrix}$, then $2A - 4B =$

A. $\begin{bmatrix} -38 & 4 \\ -22 & -2 \end{bmatrix}$ **B.** $\begin{bmatrix} -17 & -5 \\ -10 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 18 & -20 \\ 10 & 6 \end{bmatrix}$ **D.** $\begin{bmatrix} -34 & -10 \\ -20 & 2 \end{bmatrix}$

10. If $A = \begin{bmatrix} 7 & 6 \\ 6 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 5 \\ 4 & 6 \end{bmatrix}$, the element in row 2, column 2 of $3A + 2B$ is

A. 9 **B.** 5 **C.** -15 **D.** 16

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

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

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

A. -15 **B.** -24 **C.** 0 **D.** -25

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13. If $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$, then $A^7 =$

A. $\begin{bmatrix} 1 & 12 \\ 0 & 1 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & 128 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 14 \\ 0 & 1 \end{bmatrix}$ **D.** $\begin{bmatrix} 7 & 14 \\ 0 & 7 \end{bmatrix}$

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14. If $A = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$, then $A^8 =$

A. $\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$ **B.** $\begin{bmatrix} -24 & 0 \\ 0 & -24 \end{bmatrix}$

C. $\begin{bmatrix} 6561 & 0 \\ 0 & 6561 \end{bmatrix}$ **D.** $\begin{bmatrix} -2187 & 0 \\ 0 & -2187 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -4 & -7 & 9 \\ 10 & 3 & -7 \\ 1 & 0 & 2 \end{bmatrix}$, the $(2,3)$ element of A^T is

A. 3 **B.** 0 **C.** -7 **D.** 2

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

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

C. $\begin{bmatrix} 0 & 2 \\ -2 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 12 & 2 \\ 6 & -6 \end{bmatrix}$

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17. If A is a skew-symmetric matrix, then A^{13} is

A. symmetric **B.** skew-symmetric

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

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18. If $A = \begin{bmatrix} -3 & 4 \\ 0 & 4 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

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

C. $\begin{bmatrix} -6 & 4 \\ 4 & 8 \end{bmatrix}$ **D.** $\begin{bmatrix} -3 & 0 \\ 4 & 4 \end{bmatrix}$

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

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

20. If $k\begin{bmatrix} 1 & -2 & 2 \\ -2 & -2 & -1 \\ -2 & 1 & 2 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

A. 3 **B.** $\frac{1}{9}$ **C.** 1 **D.** $\frac{1}{3}$

21. If A is involutory and $(I + A)^7 = k(I + A)$, then $k =$

A. 127 **B.** 64 **C.** 128 **D.** 7

22. The matrix $\begin{bmatrix} 5 & 12 \\ -2 & -5 \end{bmatrix}$ is

A. involutory **B.** idempotent

C. nilpotent of index 2 **D.** orthogonal

23. If $\begin{bmatrix} 1 & 6+yi \\ x-9i & 4 \end{bmatrix}$ is Hermitian, then $x + y =$

A. 3 **B.** -15 **C.** -3 **D.** 15

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

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

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

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

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

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

A. $(-1, -21)$ **B.** $(-1, 21)$ **C.** $(-21, -1)$ **D.** $(1, -21)$

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 40 elements is

An $m \times n$ matrix has $mn = 40$ elements, so m can be any divisor of 40.

40 has 8 divisors, so there are 8 orders.

Ans: (C) 8

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2. If $A = \begin{bmatrix} -3 & 8 & 3 \\ -8 & 5 & 6 \end{bmatrix}$, then $a_{21} =$

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

$a_{21} = -8$

Ans: (D) -8

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

Put $i = 1$, $j = 3$ in $a_{ij} = |i - 3j|$.

$a_{13} = 8$

Ans: (C) 8

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4. In an upper triangular matrix of order 10, the number of elements that must be zero is

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

$1 + 2 + \cdots + 9 = \frac{10 \cdot 9}{2} = 45$

Ans: (A) 45

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5. The matrix $\begin{bmatrix} 5 & 0 & 0 \\ 6 & 2 & 0 \\ -6 & -5 & 2 \end{bmatrix}$ is

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

It is a lower triangular matrix.

Ans: (B) a lower triangular matrix

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6. If $\operatorname{tr}(A) = 1$ and $\operatorname{tr}(B) = 6$, then $\operatorname{tr}(5A - 6B) =$

$\operatorname{tr}(5A - 6B) = 5\operatorname{tr}(A) - 6\operatorname{tr}(B)$

$= 5(1) - 6(6) = -31$

Ans: (C) -31

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7. $\operatorname{tr}(3I_8) =$

$\operatorname{tr}(I_8) = 8$

$\operatorname{tr}(3I_8) = 3 \times 8 = 24$

Ans: (C) 24

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

$2x - 3y = 2,\ x + y = 6$

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

Ans: (D) 6

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9. If $A = \begin{bmatrix} -5 & -4 \\ -3 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 7 & -3 \\ 4 & 1 \end{bmatrix}$, then $2A - 4B =$

$2A - 4B = \begin{bmatrix} -10 & -8 \\ -6 & 2 \end{bmatrix} - \begin{bmatrix} 28 & -12 \\ 16 & 4 \end{bmatrix}$

$= \begin{bmatrix} -38 & 4 \\ -22 & -2 \end{bmatrix}$

Ans: (A) $\begin{bmatrix} -38 & 4 \\ -22 & -2 \end{bmatrix}$

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10. If $A = \begin{bmatrix} 7 & 6 \\ 6 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 5 \\ 4 & 6 \end{bmatrix}$, the element in row 2, column 2 of $3A + 2B$ is

$3a_{22} + 2b_{22} = 3(-1) + 2(6)$

$= 9$

Ans: (A) 9

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

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

So AB is 4×3.

Ans: (D) 4×3

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

Row 2 of A times column 2 of B:

$(2)(-1) + (-3)(1) + (5)(-4) = -25$

Ans: (D) -25

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13. If $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$, then $A^7 =$

$A^2 = \begin{bmatrix} 1 & 4 \\ 0 & 1 \end{bmatrix}$, $A^3 = \begin{bmatrix} 1 & 6 \\ 0 & 1 \end{bmatrix}$

Each multiplication adds 2 to the top right element, so $A^7 = \begin{bmatrix} 1 & 14 \\ 0 & 1 \end{bmatrix}$.

Ans: (C) $\begin{bmatrix} 1 & 14 \\ 0 & 1 \end{bmatrix}$

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14. If $A = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$, then $A^8 =$

$A = -3I$

$A^8 = (-3)^8 I = \begin{bmatrix} 6561 & 0 \\ 0 & 6561 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 6561 & 0 \\ 0 & 6561 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -4 & -7 & 9 \\ 10 & 3 & -7 \\ 1 & 0 & 2 \end{bmatrix}$, the $(2,3)$ element of A^T is

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

$a_{32} = 0$

Ans: (B) 0

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

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

$A + A^T = \begin{bmatrix} 12 & 4 \\ 4 & -6 \end{bmatrix}$

It is symmetric, as it must be.

Ans: (A) $\begin{bmatrix} 12 & 4 \\ 4 & -6 \end{bmatrix}$

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17. If A is a skew-symmetric matrix, then A^{13} is

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

With $k = 13$ (odd), A^{13} is skew-symmetric.

Ans: (B) skew-symmetric

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18. If $A = \begin{bmatrix} -3 & 4 \\ 0 & 4 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

$P = \frac{1}{2}(A + A^T) = \frac{1}{2}\begin{bmatrix} -6 & 4 \\ 4 & 8 \end{bmatrix}$

$= \begin{bmatrix} -3 & 2 \\ 2 & 4 \end{bmatrix}$

Ans: (B) $\begin{bmatrix} -3 & 2 \\ 2 & 4 \end{bmatrix}$

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

The two rows must be perpendicular:

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

$x = -\frac{35}{37}$

Ans: (A) $-\frac{35}{37}$

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20. If $k \begin{bmatrix} 1 & -2 & 2 \\ -2 & -2 & -1 \\ -2 & 1 & 2 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

$(kM)(kM)^T = k^2 M M^T = 9k^2 I$

$9k^2 = 1 \Rightarrow k = \frac{1}{3}$

Ans: (D) $\frac{1}{3}$

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21. If A is involutory and $(I+A)^7 = k(I+A)$, then $k =$

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

$(I+A)^7 = 2^6(I+A) = 64(I+A)$

Ans: (B) 64

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22. The matrix $\begin{bmatrix} 5 & 12 \\ -2 & -5 \end{bmatrix}$ is

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

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

Ans: (A) involutory

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23. If $\begin{bmatrix} 1 & 6+yi \\ x-9i & 4 \end{bmatrix}$ is Hermitian, then $x + y =$

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

$x - 9i = 6 - yi \Rightarrow x = 6,\ y = 9$

$x + y = 15$

Ans: (D) 15

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

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

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

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

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

$k = a + d = -1$

$l = ad - bc = -21$

Ans: (A) $(-1, -21)$
