EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 07

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 42 elements is

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

2. If $A = \begin{bmatrix} 7 & 9 \\ -8 & 1 \\ -6 & -6 \end{bmatrix}$, then $a_{21} =$

A. 8 **B.** -7 **C.** -8 **D.** 9

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = 3i + 2j$, then $a_{31} =$

A. 9 **B.** -11 **C.** 11 **D.** 12

4. The number of elements outside the principal diagonal of a square matrix of order 3 is

A. 6 **B.** 8 **C.** 9 **D.** 3

5. In an upper triangular matrix of order 11, the number of elements that must be zero is

A. 66 **B.** 110 **C.** 11 **D.** 55

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

A. 17 **B.** 12 **C.** -7 **D.** 15

7. If $\operatorname{tr}(A) = 6$ and $\operatorname{tr}(B) = 4$, then $\operatorname{tr}(5A - 5B) =$

A. 50 **B.** 2 **C.** 10 **D.** 600

8. If $\begin{bmatrix} 2x + y & -4 \\ 2x - 3y & -3 \end{bmatrix} = \begin{bmatrix} -9 & -4 \\ -13 & -3 \end{bmatrix}$, then $x + y =$

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

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

A. $\begin{bmatrix} -14 & 26 \\ 20 & -35 \end{bmatrix}$ **B.** $\begin{bmatrix} -3 & 17 \\ 10 & -20 \end{bmatrix}$

C. $\begin{bmatrix} 27 & 7 \\ -10 & 5 \end{bmatrix}$ **D.** $\begin{bmatrix} -21 & 23 \\ 22 & -35 \end{bmatrix}$

10. If $A = \begin{bmatrix} 3 & 2 \\ 7 & 0 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 6 \\ 5 & -1 \end{bmatrix}$, the element in row 2, column 2 of $2A + 3B$ is

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

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11. If A is a 4×2 matrix and B is a 2×3 matrix, the order of AB is

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

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

A. -2 **B.** 6 **C.** -15 **D.** 3

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13. If $A = \operatorname{diag}(-3, -3, 4)$, then $A^2 =$

A. $\begin{bmatrix} -5 & 0 & 0 \\ 0 & -5 & 0 \\ 0 & 0 & 9 \end{bmatrix}$ **B.** $\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 6 \end{bmatrix}$

C. $\begin{bmatrix} -6 & 0 & 0 \\ 0 & -6 & 0 \\ 0 & 0 & 8 \end{bmatrix}$ **D.** $\begin{bmatrix} 9 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 16 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}$, then $A^9 =$

A. $\begin{bmatrix} 1 & 27 \\ 0 & 1 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & 24 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 9 & 27 \\ 0 & 9 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & 19683 \\ 0 & 1 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -3 & -3 & 1 \\ 0 & 5 & 5 \\ -9 & -7 & 7 \end{bmatrix}$, the $(3,1)$ element of A^T is

A. -1 **B.** 7 **C.** 1 **D.** -9

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16. If $\begin{bmatrix} 0 & 4 & 1 \\ 3x + 8 & 0 & 5 \\ -1 & -5 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

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

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

A. $\begin{bmatrix} -4 & 1 \\ 1 & 6 \end{bmatrix}$ **B.** $\begin{bmatrix} -4 & 14 \\ -12 & 6 \end{bmatrix}$

C. $\begin{bmatrix} 0 & -13 \\ 13 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 0 & 13 \\ -13 & 0 \end{bmatrix}$

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18. If $A = \begin{bmatrix} -3 & -6 \\ 5 & 4 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

A. $\begin{bmatrix} -3 & 5 \\ -6 & 4 \end{bmatrix}$ **B.** $\begin{bmatrix} -6 & -1 \\ -1 & 8 \end{bmatrix}$

C. $\begin{bmatrix} 0 & -\frac{11}{2} \\ \frac{11}{2} & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} -3 & -\frac{1}{2} \\ -\frac{1}{2} & 4 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{24}{25} & x \\ \frac{7}{25} & \frac{24}{25} \end{bmatrix}$ is orthogonal, then $x =$

A. $\frac{24}{25}$ **B.** $-\frac{7}{25}$ **C.** $\frac{7}{25}$ **D.** $-\frac{24}{25}$

20. If $k \begin{bmatrix} -3 & -4 & -12 \\ -4 & 12 & -3 \\ -12 & -3 & 4 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

A. 13 **B.** $\frac{1}{13}$ **C.** $\frac{1}{39}$ **D.** $\frac{1}{169}$

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

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

22. If A is involutory and $(I + A)^9 = k(I + A)$, then $k =$

A. 9 **B.** 512 **C.** 256 **D.** 511

23. If $\begin{bmatrix} -5 & -3 + yi \\ x - 3i & -4 \end{bmatrix}$ is Hermitian, then $x + y =$

A. 1 **B.** 0 **C.** -6 **D.** 6

24. If $A = \begin{bmatrix} 5i - 1 & -5 - 5i \\ -4 - 3i & -2 - 6i \end{bmatrix}$, then $A^\theta =$

A. $\begin{bmatrix} 1 + 5i & 4 - 3i \\ 5 - 5i & 2 - 6i \end{bmatrix}$

B. $\begin{bmatrix} 5i - 1 & -4 - 3i \\ -5 - 5i & -2 - 6i \end{bmatrix}$

C. $\begin{bmatrix} -1 - 5i & 3i - 4 \\ 5i - 5 & 6i - 2 \end{bmatrix}$

D. $\begin{bmatrix} -1 - 5i & 5i - 5 \\ 3i - 4 & 6i - 2 \end{bmatrix}$

25. If $A = \begin{bmatrix} 2 & 6 \\ 7 & 6 \end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k, l) =$

A. $(-30, 8)$ **B.** $(8, 30)$ **C.** $(-8, -30)$ **D.** $(8, -30)$

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 42 elements is

An $m \times n$ matrix has $mn = 42$ elements, so m can be any divisor of 42.

42 has 8 divisors, so there are 8 orders.

Ans: (D) 8

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2. If $A = \begin{bmatrix} 7 & 9 \\ -8 & 1 \\ -6 & -6 \end{bmatrix}$, then $a_{21} =$

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

$a_{21} = -8$

Ans: (C) -8

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = 3i + 2j$, then $a_{31} =$

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

$a_{31} = 11$

Ans: (C) 11

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4. The number of elements outside the principal diagonal of a square matrix of order 3 is

It has $3^2 = 9$ elements, of which 3 are on the principal diagonal.

$9 - 3 = 6$

Ans: (A) 6

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5. In an upper triangular matrix of order 11, the number of elements that must be zero is

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

$1 + 2 + \cdots + 10 = \frac{11 \cdot 10}{2} = 55$

Ans: (D) 55

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

$AB = \begin{bmatrix} 17 & -1 \\ 16 & 0 \end{bmatrix}$

$\operatorname{tr}(AB) = 17$

Ans: (A) 17

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7. If $\operatorname{tr}(A) = 6$ and $\operatorname{tr}(B) = 4$, then $\operatorname{tr}(5A - 5B) =$

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

$= 5(6) - 5(4) = 10$

Ans: (C) 10

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8. If $\begin{bmatrix} 2x+y & -4 \\ 2x-3y & -3 \end{bmatrix} = \begin{bmatrix} -9 & -4 \\ -13 & -3 \end{bmatrix}$, then $x+y=$

$2x+y=-9,\ 2x-3y=-13$

So $x=-5$, $y=1$ and $x+y=-4$.

Ans: (B) -4

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

$3A-4B=\begin{bmatrix} 3 & 15 \\ 6 & -15 \end{bmatrix}-\begin{bmatrix} 24 & -8 \\ -16 & 20 \end{bmatrix}$

$=\begin{bmatrix} -21 & 23 \\ 22 & -35 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} -21 & 23 \\ 22 & -35 \end{bmatrix}$

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10. If $A=\begin{bmatrix} 3 & 2 \\ 7 & 0 \end{bmatrix}$ and $B=\begin{bmatrix} 3 & 6 \\ 5 & -1 \end{bmatrix}$, the element in row 2, column 2 of $2A+3B$ is

$2a_{22}+3b_{22}=2(0)+3(-1)$

$=-3$

Ans: (B) -3

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11. If A is a 4×2 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 4×3.

Ans: (A) 4×3

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

Row 2 of A times column 1 of B:

$(-2)(-3)+(-1)(4)+(4)(1)=6$

Ans: (B) 6

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13. If $A=\mathrm{diag}(-3,-3,4)$, then $A^2=$

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

$A^2=\begin{bmatrix} 9 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 16 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} 9 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 16 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}$, then $A^9 =$

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

Each multiplication adds 3 to the top right element, so $A^9 = \begin{bmatrix} 1 & 27 \\ 0 & 1 \end{bmatrix}$.

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

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15. If $A = \begin{bmatrix} -3 & -3 & 1 \\ 0 & 5 & 5 \\ -9 & -7 & 7 \end{bmatrix}$, the $(3,1)$ element of A^T is

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

$a_{13} = 1$

Ans: (C) 1

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16. If $\begin{bmatrix} 0 & 4 & 1 \\ 3x+8 & 0 & 5 \\ -1 & -5 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

$a_{21} = -a_{12} \Rightarrow 3x + 8 = -4$

$x = -4$

Ans: (A) -4

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

$A^T = \begin{bmatrix} -2 & -6 \\ 7 & 3 \end{bmatrix}$

$A + A^T = \begin{bmatrix} -4 & 1 \\ 1 & 6 \end{bmatrix}$

It is symmetric, as it must be.

Ans: (A) $\begin{bmatrix} -4 & 1 \\ 1 & 6 \end{bmatrix}$

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18. If $A = \begin{bmatrix} -3 & -6 \\ 5 & 4 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $P =$

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

$= \begin{bmatrix} -3 & -\frac{1}{2} \\ -\frac{1}{2} & 4 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} -3 & -\frac{1}{2} \\ -\frac{1}{2} & 4 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{24}{25} & x \\ \frac{7}{25} & \frac{24}{25} \end{bmatrix}$ is orthogonal, then $x =$

The two rows must be perpendicular:

$\frac{24}{25}\left(\frac{7}{25}\right) + x \cdot \frac{24}{25} = 0$

$x = -\frac{7}{25}$

Ans: (B) $-\frac{7}{25}$

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20. If $k\begin{bmatrix} -3 & -4 & -12 \\ -4 & 12 & -3 \\ -12 & -3 & 4 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

$(kM)(kM)^T = k^2MM^T = 169k^2I$

$169k^2 = 1 \Rightarrow k = \frac{1}{13}$

Ans: (B) $\frac{1}{13}$

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

$A^r = A$ for every $r \geq 1$, so $(I + A)^3 = I + \left(\binom{3}{1} + \cdots + \binom{3}{3}\right) A$.

$k = 2^3 - 1 = 7$

Ans: (C) 7

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22. If A is involutory and $(I + A)^9 = k(I + A)$, then $k =$

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

$(I + A)^9 = 2^8(I + A) = 256(I + A)$

Ans: (C) 256

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23. If $\begin{bmatrix} -5 & -3 + yi \\ x - 3i & -4 \end{bmatrix}$ is Hermitian, then $x + y =$

Hermitian: $a_{21} = \overline{a_{12}} = -3 - yi$.

$x - 3i = -3 - yi \Rightarrow x = -3,\ y = 3$

$x + y = 0$

Ans: (B) 0

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24. If $A = \begin{bmatrix} 5i - 1 & -5 - 5i \\ -4 - 3i & -2 - 6i \end{bmatrix}$, then $A^\theta =$

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

$= \begin{bmatrix} -1 - 5i & 3i - 4 \\ 5i - 5 & 6i - 2 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} -1 - 5i & 3i - 4 \\ 5i - 5 & 6i - 2 \end{bmatrix}$

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25. If $A = \begin{bmatrix} 2 & 6 \\ 7 & 6 \end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k, l) =$

$k = a + d = 8$

$l = ad - bc = -30$

Ans: (D) $(8, -30)$
