EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 04

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 48 elements is

A. 8 **B.** 11 **C.** 5 **D.** 10

2. If $A = \begin{bmatrix} -1 & -4 & 0 \\ 9 & 7 & 2 \\ 9 & 7 & 10 \end{bmatrix}$, then $a_{12} \cdot a_{21} =$

A. 5 **B.** -36 **C.** 36 **D.** -7

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = (-1)^{i+j}(i + 4j)$, then $a_{31} =$

A. 13 **B.** 8 **C.** -7 **D.** 7

4. The number of elements outside the principal diagonal of a square matrix of order 8 is

A. 56 **B.** 64 **C.** 63 **D.** 28

5. In an upper triangular matrix of order 8, the number of elements that must be zero is

A. 56 **B.** 28 **C.** 8 **D.** 36

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

A. 6 **B.** 49 **C.** 48 **D.** 5

7. If $\operatorname{tr}(A) = -2$ and $\operatorname{tr}(B) = 5$, then $\operatorname{tr}(2A - 5B) =$

A. -29 **B.** 21 **C.** -100 **D.** -7

8. If $\begin{bmatrix} x + 3y & -8 \\ x + 2y & -7 \end{bmatrix} = \begin{bmatrix} 12 & -8 \\ 6 & -7 \end{bmatrix}$, then $x + y =$

A. -36 **B.** 12 **C.** -12 **D.** 0

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

A. $\begin{bmatrix} 11 & -4 \\ -6 & -7 \end{bmatrix}$ **B.** $\begin{bmatrix} 2 & 14 \\ 0 & 8 \end{bmatrix}$

C. $\begin{bmatrix} 10 & -11 \\ -6 & -11 \end{bmatrix}$ **D.** $\begin{bmatrix} 14 & -10 \\ -8 & -12 \end{bmatrix}$

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

A. 11 **B.** -2 **C.** 30 **D.** 32

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11. If A is a 4×3 matrix and B is a 3×1 matrix, the order of AB is

A. 4×1 **B.** 4×3 **C.** 1×4 **D.** 3×3

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

A. 22 **B.** 36 **C.** 35 **D.** 3

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

A. $\begin{bmatrix} 16 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 9 \end{bmatrix}$ **B.** $\begin{bmatrix} 6 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & -1 \end{bmatrix}$

C. $\begin{bmatrix} 8 & 0 & 0 \\ 0 & 6 & 0 \\ 0 & 0 & -6 \end{bmatrix}$ **D.** $\begin{bmatrix} 9 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & -5 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$, then $A^{10} =$

A. $\begin{bmatrix} 1 & 20 \\ 0 & 1 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & 1024 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 10 & 20 \\ 0 & 10 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & 18 \\ 0 & 1 \end{bmatrix}$

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15. If A is 4×2 and B is 2×3, the order of $(AB)^T$ is

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

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16. If $\begin{bmatrix} 0 & -6 & 7 \\ 3x + 9 & 0 & -4 \\ -7 & 4 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

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

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17. If $A = \begin{bmatrix} -3 & -5 \\ 3 & 2 \end{bmatrix}$, then $A + A^T =$

A. $\begin{bmatrix} -6 & -10 \\ 6 & 4 \end{bmatrix}$ **B.** $\begin{bmatrix} 0 & -8 \\ 8 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 0 & 8 \\ -8 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} -6 & -2 \\ -2 & 4 \end{bmatrix}$

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18. If $A = \begin{bmatrix} 1 & -3 \\ -6 & 7 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

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

C. $\begin{bmatrix} 0 & \frac{3}{2} \\ -\frac{3}{2} & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & -\frac{9}{2} \\ -\frac{9}{2} & 7 \end{bmatrix}$

19. If $\begin{bmatrix} \frac{11}{61} & x \\ -\frac{60}{61} & \frac{11}{61} \end{bmatrix}$ is orthogonal, then $x =$

A. $-\frac{60}{61}$ **B.** $-\frac{11}{61}$ **C.** $\frac{11}{61}$ **D.** $\frac{60}{61}$

20. If $k\begin{bmatrix} 8 & -24 & -6 \\ -6 & -8 & 24 \\ -24 & -6 & -8 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

A. $\frac{1}{676}$ **B.** $\frac{1}{78}$ **C.** $\frac{1}{26}$ **D.** 26

21. If A is idempotent and $(I + A)^9 = I + kA$, then $k =$

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

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

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

23. If $\begin{bmatrix} 4 & -8 + yi \\ x - 6i & -3 \end{bmatrix}$ is Hermitian, then $x + y =$

A. 2 **B.** -2 **C.** 14 **D.** -14

24. If $A = \begin{bmatrix} 5 + 4i & 7i - 6 \\ 6 + i & 1 - 4i \end{bmatrix}$, then $A^\theta =$

A. $\begin{bmatrix} 5 + 4i & 6 + i \\ 7i - 6 & 1 - 4i \end{bmatrix}$ **B.** $\begin{bmatrix} 5 - 4i & -6 - 7i \\ 6 - i & 1 + 4i \end{bmatrix}$

C. $\begin{bmatrix} 4i - 5 & i - 6 \\ 6 + 7i & -1 - 4i \end{bmatrix}$ **D.** $\begin{bmatrix} 5 - 4i & 6 - i \\ -6 - 7i & 1 + 4i \end{bmatrix}$

25. If $A = \begin{bmatrix} 2 & 6 \\ 5 & -5 \end{bmatrix}$ satisfies $A^2 - kA + lI = O$, then $k + l =$

A. -37 **B.** -43 **C.** 37 **D.** 17

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 48 elements is

An $m \times n$ matrix has $mn = 48$ elements, so m can be any divisor of 48.

48 has 10 divisors, so there are 10 orders.

Ans: (D) 10

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2. If $A = \begin{bmatrix} -1 & -4 & 0 \\ 9 & 7 & 2 \\ 9 & 7 & 10 \end{bmatrix}$, then $a_{12} \cdot a_{21} =$

$a_{12} = -4,\ a_{21} = 9$

Product $= -36$

Ans: (B) -36

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = (-1)^{i+j}(i + 4j)$, then $a_{31} =$

Put $i = 3$, $j = 1$ in $a_{ij} = (-1)^{i+j}(i + 4j)$.

$a_{31} = 7$

Ans: (D) 7

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4. The number of elements outside the principal diagonal of a square matrix of order 8 is

It has $8^2 = 64$ elements, of which 8 are on the principal diagonal.

$64 - 8 = 56$

Ans: (A) 56

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5. In an upper triangular matrix of order 8, the number of elements that must be zero is

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

$1 + 2 + \cdots + 7 = \frac{8 \cdot 7}{2} = 28$

Ans: (B) 28

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

$AB = \begin{bmatrix} 20 & 29 \\ 20 & 28 \end{bmatrix}$

$\operatorname{tr}(AB) = 48$

Ans: (C) 48

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7. If $\operatorname{tr}(A) = -2$ and $\operatorname{tr}(B) = 5$, then $\operatorname{tr}(2A - 5B) =$

$\operatorname{tr}(2A - 5B) = 2\operatorname{tr}(A) - 5\operatorname{tr}(B)$

$= 2(-2) - 5(5) = -29$

Ans: (A) -29

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8. If $\begin{bmatrix} x+3y & -8 \\ x+2y & -7 \end{bmatrix} = \begin{bmatrix} 12 & -8 \\ 6 & -7 \end{bmatrix}$, then $x + y =$

$x + 3y = 12,\ x + 2y = 6$

So $x = -6$, $y = 6$ and $x + y = 0$.

Ans: (D) 0

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

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

$= \begin{bmatrix} 14 & -10 \\ -8 & -12 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} 14 & -10 \\ -8 & -12 \end{bmatrix}$

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

$2a_{21} + 4b_{21} = 2(7) + 4(4)$

$= 30$

Ans: (C) 30

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11. If A is a 4×3 matrix and B is a 3×1 matrix, the order of AB is

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

So AB is 4×1.

Ans: (A) 4×1

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

Row 2 of A times column 2 of B:

$(4)(5) + (5)(3) + (0)(5) = 35$

Ans: (C) 35

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

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

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

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

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14. If $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$, then $A^{10} =$

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

Each multiplication adds 2 to the top right element, so $A^{10} = \begin{bmatrix} 1 & 20 \\ 0 & 1 \end{bmatrix}$.

Ans: (A) $\begin{bmatrix} 1 & 20 \\ 0 & 1 \end{bmatrix}$

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15. If A is 4×2 and B is 2×3, the order of $(AB)^T$ is

AB is 4×3.

So $(AB)^T = B^T A^T$ is 3×4.

Ans: (C) 3×4

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16. If $\begin{bmatrix} 0 & -6 & 7 \\ 3x+9 & 0 & -4 \\ -7 & 4 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

$a_{21} = -a_{12} \Rightarrow 3x + 9 = 6$

$x = -1$

Ans: (B) -1

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17. If $A = \begin{bmatrix} -3 & -5 \\ 3 & 2 \end{bmatrix}$, then $A + A^T =$

$A^T = \begin{bmatrix} -3 & 3 \\ -5 & 2 \end{bmatrix}$

$A + A^T = \begin{bmatrix} -6 & -2 \\ -2 & 4 \end{bmatrix}$

It is symmetric, as it must be.

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

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18. If $A = \begin{bmatrix} 1 & -3 \\ -6 & 7 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

$Q = \frac{1}{2}(A - A^T) = \frac{1}{2}\begin{bmatrix} 0 & 3 \\ -3 & 0 \end{bmatrix}$

$= \begin{bmatrix} 0 & \frac{3}{2} \\ -\frac{3}{2} & 0 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 0 & \frac{3}{2} \\ -\frac{3}{2} & 0 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{11}{61} & x \\ -\frac{60}{61} & \frac{11}{61} \end{bmatrix}$ is orthogonal, then $x =$

The two rows must be perpendicular:

$\frac{11}{61}\left(-\frac{60}{61}\right) + x \cdot \frac{11}{61} = 0$

$x = \frac{60}{61}$

Ans: (D) $\frac{60}{61}$

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20. If $k\begin{bmatrix} 8 & -24 & -6 \\ -6 & -8 & 24 \\ -24 & -6 & -8 \end{bmatrix}$ is orthogonal and $k > 0$, then $k =$

$(kM)(kM)^T = k^2 MM^T = 676k^2 I$

$676k^2 = 1 \Rightarrow k = \frac{1}{26}$

Ans: (C) $\frac{1}{26}$

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21. If A is idempotent and $(I + A)^9 = I + kA$, then $k =$

$A^r = A$ for every $r \geq 1$, so $(I + A)^9 = I + \left(\binom{9}{1} + \cdots + \binom{9}{9}\right) A$.

$k = 2^9 - 1 = 511$

Ans: (B) 511

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

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

$(I + A)^4 = 2^3(I + A) = 8(I + A)$

Ans: (A) 8

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23. If $\begin{bmatrix} 4 & -8 + yi \\ x - 6i & -3 \end{bmatrix}$ is Hermitian, then $x + y =$

Hermitian: $a_{21} = \overline{a_{12}} = -8 - yi$.

$x - 6i = -8 - yi \Rightarrow x = -8,\ y = 6$

$x + y = -2$

Ans: (B) -2

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24. If $A = \begin{bmatrix} 5 + 4i & 7i - 6 \\ 6 + i & 1 - 4i \end{bmatrix}$, then $A^\theta =$

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

$= \begin{bmatrix} 5 - 4i & 6 - i \\ -6 - 7i & 1 + 4i \end{bmatrix}$

Ans: (D) $\begin{bmatrix} 5 - 4i & 6 - i \\ -6 - 7i & 1 + 4i \end{bmatrix}$

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25. If $A = \begin{bmatrix} 2 & 6 \\ 5 & -5 \end{bmatrix}$ satisfies $A^2 - kA + lI = O$, then $k + l =$

$k = a + d = -3,\ l = ad - bc = -40$

$k + l = -43$

Ans: (B) -43
