EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 05

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 15 elements is

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

2. If $A = \begin{bmatrix} 10 & -6 & -7 \\ 3 & -8 & -4 \\ 7 & 4 & 9 \end{bmatrix}$, then $a_{13} =$

A. 7 **B.** -7 **C.** -6 **D.** 10

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = \frac{i}{j}$, then $a_{21} =$

A. -2 **B.** 2 **C.** $\frac{1}{2}$ **D.** 3

4. The matrix $\begin{bmatrix} 4 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & -2 \end{bmatrix}$ is

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

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

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

A. 6 **B.** 16 **C.** 12 **D.** 15

6. $\operatorname{tr}(6I_4) =$

A. 4 **B.** 24 **C.** 96 **D.** 6

7. If $A = \begin{bmatrix} 2 & 4 \\ 4 & -4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 \\ -3 & 3 \end{bmatrix}$, then $\operatorname{tr}(AB) =$

A. -14 **B.** 32 **C.** 2 **D.** -8

8. If $\begin{bmatrix} x-y & 6 \\ 2x+y & 7 \end{bmatrix} = \begin{bmatrix} -4 & 6 \\ -2 & 7 \end{bmatrix}$, then $x + y =$

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

9. If $A = \begin{bmatrix} 3 & 4 \\ 0 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} -3 & 3 \\ -4 & 0 \end{bmatrix}$, then $4A - 3B =$

A. $\begin{bmatrix} 3 & 25 \\ -12 & -4 \end{bmatrix}$ **B.** $\begin{bmatrix} 15 & 13 \\ 4 & -4 \end{bmatrix}$

C. $\begin{bmatrix} 21 & 7 \\ 12 & -4 \end{bmatrix}$ **D.** $\begin{bmatrix} 21 & 0 \\ 16 & -3 \end{bmatrix}$

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

A. -2 **B.** -14 **C.** -19 **D.** 0

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

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

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

A. -5 **B.** 3 **C.** -15 **D.** -14

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13. If $A = \begin{bmatrix} -4 & 0 \\ 0 & -4 \end{bmatrix}$, then $A^3 =$

A. $\begin{bmatrix} -64 & 0 \\ 0 & -64 \end{bmatrix}$ **B.** $\begin{bmatrix} -12 & 0 \\ 0 & -12 \end{bmatrix}$

C. $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$ **D.** $\begin{bmatrix} 16 & 0 \\ 0 & 16 \end{bmatrix}$

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14. If $A = \operatorname{diag}(-2, -1, 1)$, then $A^2 =$

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

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

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15. If $A = \begin{bmatrix} -2 & -7 & 2 \\ 5 & -3 & 5 \\ 4 & 3 & -9 \end{bmatrix}$, the $(2,1)$ element of A^T is

A. -3 **B.** 5 **C.** -7 **D.** 7

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16. If A is a skew-symmetric matrix, then A^{11} is

A. a null matrix **B.** skew-symmetric

C. symmetric **D.** an identity matrix

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

A. 1 **B.** -1 **C.** $\frac{3}{2}$ **D.** $-\frac{3}{2}$

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

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

B. $\begin{bmatrix} 12 & -1 \\ -1 & -10 \end{bmatrix}$

C. $\begin{bmatrix} 6 & -\frac{1}{2} \\ -\frac{1}{2} & -5 \end{bmatrix}$

D. $\begin{bmatrix} 0 & \frac{11}{2} \\ -\frac{11}{2} & 0 \end{bmatrix}$

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19. If $\begin{bmatrix} \frac{12}{13} & x \\ \frac{5}{13} & \frac{12}{13} \end{bmatrix}$ is orthogonal, then $x =$

A. $-\frac{5}{13}$ **B.** $\frac{12}{13}$ **C.** $\frac{5}{13}$ **D.** $-\frac{12}{13}$

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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 $k =$

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

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21. The matrix $\begin{bmatrix} -4 & -15 \\ 1 & 4 \end{bmatrix}$ is

A. orthogonal

B. idempotent

C. nilpotent of index 2

D. involutory

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22. If A is idempotent and $(I + A)^6 = I + kA$, then $k =$

A. 64 **B.** 6 **C.** 63 **D.** 32

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23. If $\begin{bmatrix} -5 & -4 + yi \\ x + 5i & -6 \end{bmatrix}$ is Hermitian, then $x + y =$

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

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

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

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

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

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

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25. If $A = \begin{bmatrix} 7 & 2 \\ -2 & 1 \end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k, l) =$

A. $(-8, 11)$ **B.** $(8, 11)$ **C.** $(11, 8)$ **D.** $(8, -11)$

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 15 elements is

An $m \times n$ matrix has $mn = 15$ elements, so m can be any divisor of 15.

15 has 4 divisors, so there are 4 orders.

Ans: (D) 4

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2. If $A = \begin{bmatrix} 10 & -6 & -7 \\ 3 & -8 & -4 \\ 7 & 4 & 9 \end{bmatrix}$, then $a_{13} =$

a_{13} is the element in row 1 and column 3.

$a_{13} = -7$

Ans: (B) -7

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = \frac{i}{j}$, then $a_{21} =$

Put $i = 2, j = 1$ in $a_{ij} = \frac{i}{j}$.

$a_{21} = 2$

Ans: (B) 2

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4. The matrix $\begin{bmatrix} 4 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & -2 \end{bmatrix}$ is

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

It is a diagonal matrix.

Ans: (D) a diagonal matrix

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

It has $4^2 = 16$ elements, of which 4 are on the principal diagonal.

$16 - 4 = 12$

Ans: (C) 12

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6. $\mathrm{tr}(6I_4) =$

$\mathrm{tr}(I_4) = 4$

$\mathrm{tr}(6I_4) = 6 \times 4 = 24$

Ans: (B) 24

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7. If $A = \begin{bmatrix} 2 & 4 \\ 4 & -4 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 \\ -3 & 3 \end{bmatrix}$, then $\mathrm{tr}(AB) =$

$AB = \begin{bmatrix} -10 & 16 \\ 16 & -4 \end{bmatrix}$

$\mathrm{tr}(AB) = -14$

Ans: (A) -14

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8. If $\begin{bmatrix} x-y & 6 \\ 2x+y & 7 \end{bmatrix} = \begin{bmatrix} -4 & 6 \\ -2 & 7 \end{bmatrix}$, then $x+y=$

$x-y=-4,\ 2x+y=-2$

So $x=-2$, $y=2$ and $x+y=0$.

Ans: (A) 0

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9. If $A=\begin{bmatrix} 3 & 4 \\ 0 & -1 \end{bmatrix}$ and $B=\begin{bmatrix} -3 & 3 \\ -4 & 0 \end{bmatrix}$, then $4A-3B=$

$4A-3B=\begin{bmatrix} 12 & 16 \\ 0 & -4 \end{bmatrix}-\begin{bmatrix} -9 & 9 \\ -12 & 0 \end{bmatrix}$

$=\begin{bmatrix} 21 & 7 \\ 12 & -4 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 21 & 7 \\ 12 & -4 \end{bmatrix}$

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

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

$=-2$

Ans: (A) -2

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

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

So AB is 3×1.

Ans: (D) 3×1

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

Row 2 of A times column 2 of B:

$(5)(-1)+(-1)(2)+(2)(-4)=-15$

Ans: (C) -15

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13. If $A=\begin{bmatrix} -4 & 0 \\ 0 & -4 \end{bmatrix}$, then $A^3=$

$A=-4I$

$A^3=(-4)^3 I=\begin{bmatrix} -64 & 0 \\ 0 & -64 \end{bmatrix}$

Ans: (A) $\begin{bmatrix} -64 & 0 \\ 0 & -64 \end{bmatrix}$

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14. If $A = \text{diag}(-2, -1, 1)$, then $A^2 =$

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

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

Ans: (D) $\begin{bmatrix} 4 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

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15. If $A = \begin{bmatrix} -2 & -7 & 2 \\ 5 & -3 & 5 \\ 4 & 3 & -9 \end{bmatrix}$, the $(2,1)$ element of A^T is

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

$a_{12} = -7$

Ans: (C) -7

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16. If A is a skew-symmetric matrix, then A^{11} is

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

With $k = 11$ (odd), A^{11} is skew-symmetric.

Ans: (B) skew-symmetric

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

$a_{21} = -a_{12} \Rightarrow 4x + 5 = 1$

$x = -1$

Ans: (B) -1

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

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

$= \begin{bmatrix} 6 & -\frac{1}{2} \\ -\frac{1}{2} & -5 \end{bmatrix}$

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

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19. If $\begin{bmatrix} \frac{12}{13} & x \\ \frac{5}{13} & \frac{12}{13} \end{bmatrix}$ is orthogonal, then $x =$

The two rows must be perpendicular:

$\frac{12}{13}\left(\frac{5}{13}\right) + x \cdot \frac{12}{13} = 0$

$x = -\frac{5}{13}$

Ans: (A) $-\frac{5}{13}$

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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 $k=$

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

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

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

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21. The matrix $\begin{bmatrix}-4 & -15\\ 1 & 4\end{bmatrix}$ is

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

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

Ans: (D) involutory

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22. If A is idempotent and $(I+A)^6 = I + kA$, then $k=$

$A^r = A$ for every $r \geq 1$, so $(I+A)^6 = I + \left(\binom{6}{1} + \cdots + \binom{6}{6}\right)A$.

$k = 2^6 - 1 = 63$

Ans: (C) 63

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23. If $\begin{bmatrix}-5 & -4+yi\\ x+5i & -6\end{bmatrix}$ 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: (D) -9

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

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

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

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

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25. If $A = \begin{bmatrix}7 & 2\\ -2 & 1\end{bmatrix}$ and $A^2 - kA + lI = O$, then $(k,l) =$

$k = a + d = 8$

$l = ad - bc = 11$

Ans: (B) $(8, 11)$
