EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 08

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 24 elements is

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

2. If $A = \begin{bmatrix} 3 & 0 & -3 & 8 \\ -8 & -5 & -6 & 3 \\ -4 & -1 & 2 & -9 \end{bmatrix}$, then $a_{12} \cdot a_{21} =$

A. -8 **B.** 0 **C.** 2 **D.** -15

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

A. 3 **B.** $\frac{1}{3}$ **C.** -3 **D.** 4

4. The matrix $\begin{bmatrix} 1 & 0 & 0 \\ 3 & 5 & 0 \\ -6 & 7 & 2 \end{bmatrix}$ is

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

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

5. The number of elements outside the principal diagonal of a square matrix of order 7 is

A. 48 **B.** 21 **C.** 49 **D.** 42

6. $\operatorname{tr}(7I_5) =$

A. 175 **B.** 5 **C.** 35 **D.** 7

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

A. 0 **B.** -1 **C.** -8 **D.** -2

8. If $\begin{bmatrix} 2x+5y & -2 \\ 2x-3y & -1 \end{bmatrix} = \begin{bmatrix} 22 & -2 \\ -26 & -1 \end{bmatrix}$, then $x + y =$

A. -2 **B.** 2 **C.** -10 **D.** 10

9. If $A = \begin{bmatrix} 0 & -4 \\ 2 & -3 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & 4 \\ 3 & -4 \end{bmatrix}$, then $3A - 2B =$

A. $\begin{bmatrix} 4 & -20 \\ 0 & -1 \end{bmatrix}$ **B.** $\begin{bmatrix} 2 & -16 \\ 3 & -5 \end{bmatrix}$

C. $\begin{bmatrix} -4 & -4 \\ 12 & -17 \end{bmatrix}$ **D.** $\begin{bmatrix} 6 & -20 \\ -5 & 6 \end{bmatrix}$

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

A. 5 **B.** -19 **C.** 17 **D.** 25

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

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

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

A. -13 **B.** 5 **C.** -10 **D.** -6

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

A. $\begin{bmatrix} 64 & 0 \\ 0 & 64 \end{bmatrix}$ **B.** $\begin{bmatrix} 9 & 0 \\ 0 & 9 \end{bmatrix}$

C. $\begin{bmatrix} 128 & 0 \\ 0 & 128 \end{bmatrix}$ **D.** $\begin{bmatrix} 14 & 0 \\ 0 & 14 \end{bmatrix}$

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

A. $\begin{bmatrix} -7 & 0 & 0 \\ 0 & -11 & 0 \\ 0 & 0 & -11 \end{bmatrix}$

B. $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} -8 & 0 & 0 \\ 0 & -12 & 0 \\ 0 & 0 & -12 \end{bmatrix}$

D. $\begin{bmatrix} 16 & 0 & 0 \\ 0 & 81 & 0 \\ 0 & 0 & 81 \end{bmatrix}$

15. If A is 3×2 and B is 2×5, the order of $(AB)^T$ is

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

16. If A is a skew-symmetric matrix, then A^{18} is

A. an identity matrix **B.** symmetric

C. skew-symmetric **D.** a null matrix

17. If $\begin{bmatrix} 0 & -3 & 5 \\ 2x-1 & 0 & -7 \\ -5 & 7 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

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

18. If $A = \begin{bmatrix} 2 & 4 \\ -2 & 6 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

A. $\begin{bmatrix} 0 & 6 \\ -6 & 0 \end{bmatrix}$ **B.** $\begin{bmatrix} 0 & 3 \\ -3 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 0 & -3 \\ 3 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 2 & 1 \\ 1 & 6 \end{bmatrix}$

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

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

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

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

21. The matrix $\begin{bmatrix} -4 & 5 \\ -3 & 4 \end{bmatrix}$ is

A. idempotent **B.** nilpotent of index 2

C. involutory **D.** orthogonal

22. If A is idempotent and $(I + A)^7 = I + kA$, then $k =$

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

23. If $\begin{bmatrix} 6 & 8 + yi \\ x + 5i & 5 \end{bmatrix}$ is Hermitian, then $x + y =$

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

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

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

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

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

A. 3 **B.** 19 **C.** -7 **D.** 7

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 24 elements is

An $m \times n$ matrix has $mn = 24$ elements, so m can be any divisor of 24.

24 has 8 divisors, so there are 8 orders.

Ans: (B) 8

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2. If $A = \begin{bmatrix} 3 & 0 & -3 & 8 \\ -8 & -5 & -6 & 3 \\ -4 & -1 & 2 & -9 \end{bmatrix}$, then $a_{12} \cdot a_{21} =$

$a_{12} = 0,\ a_{21} = -8$

Product $= 0$

Ans: (B) 0

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

Put $i = 3, j = 1$ in $a_{ij} = \frac{i}{j}$.

$a_{31} = 3$

Ans: (A) 3

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4. The matrix $\begin{bmatrix} 1 & 0 & 0 \\ 3 & 5 & 0 \\ -6 & 7 & 2 \end{bmatrix}$ is

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

It is a lower triangular matrix.

Ans: (A) a lower triangular matrix

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5. The number of elements outside the principal diagonal of a square matrix of order 7 is

It has $7^2 = 49$ elements, of which 7 are on the principal diagonal.

$49 - 7 = 42$

Ans: (D) 42

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6. $\mathrm{tr}(7I_5) =$

$\mathrm{tr}(I_5) = 5$

$\mathrm{tr}(7I_5) = 7 \times 5 = 35$

Ans: (C) 35

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

$AB = \begin{bmatrix} 10 & -8 \\ 0 & -12 \end{bmatrix}$

$\mathrm{tr}(AB) = -2$

Ans: (D) -2

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8. If $\begin{bmatrix} 2x+5y & -2 \\ 2x-3y & -1 \end{bmatrix} = \begin{bmatrix} 22 & -2 \\ -26 & -1 \end{bmatrix}$, then $x+y=$

$2x+5y=22,\ 2x-3y=-26$

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

Ans: (B) 2

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9. If $A=\begin{bmatrix} 0 & -4 \\ 2 & -3 \end{bmatrix}$ and $B=\begin{bmatrix} -2 & 4 \\ 3 & -4 \end{bmatrix}$, then $3A-2B=$

$3A-2B=\begin{bmatrix} 0 & -12 \\ 6 & -9 \end{bmatrix}-\begin{bmatrix} -4 & 8 \\ 6 & -8 \end{bmatrix}$

$=\begin{bmatrix} 4 & -20 \\ 0 & -1 \end{bmatrix}$

Ans: (A) $\begin{bmatrix} 4 & -20 \\ 0 & -1 \end{bmatrix}$

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

$3a_{21}+2b_{21}=3(7)+2(-2)$

$=17$

Ans: (C) 17

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

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

So AB is 5×3.

Ans: (D) 5×3

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

Row 2 of A times column 1 of B:

$(0)(-4)+(-3)(-3)+(1)(-4)=5$

Ans: (B) 5

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

$A=2I$

$A^7=(2)^7 I=\begin{bmatrix} 128 & 0 \\ 0 & 128 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 128 & 0 \\ 0 & 128 \end{bmatrix}$

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

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

$A^4 = \begin{bmatrix} 16 & 0 & 0 \\ 0 & 81 & 0 \\ 0 & 0 & 81 \end{bmatrix}$

Ans: (D) $\begin{bmatrix} 16 & 0 & 0 \\ 0 & 81 & 0 \\ 0 & 0 & 81 \end{bmatrix}$

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15. If A is 3×2 and B is 2×5, the order of $(AB)^T$ is

AB is 3×5.

So $(AB)^T = B^T A^T$ is 5×3.

Ans: (D) 5×3

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16. If A is a skew-symmetric matrix, then A^{18} is

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

With $k = 18$ (even), A^{18} is symmetric.

Ans: (B) symmetric

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17. If $\begin{bmatrix} 0 & -3 & 5 \\ 2x-1 & 0 & -7 \\ -5 & 7 & 0 \end{bmatrix}$ is skew-symmetric, then $x =$

$a_{21} = -a_{12} \Rightarrow 2x - 1 = 3$

$x = 2$

Ans: (A) 2

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18. If $A = \begin{bmatrix} 2 & 4 \\ -2 & 6 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

$Q = \frac{1}{2}(A - A^T) = \frac{1}{2}\begin{bmatrix} 0 & 6 \\ -6 & 0 \end{bmatrix}$

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

Ans: (B) $\begin{bmatrix} 0 & 3 \\ -3 & 0 \end{bmatrix}$

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

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: (D) $\frac{5}{13}$

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

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

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

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

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21. The matrix $\begin{bmatrix}-4 & 5\\ -3 & 4\end{bmatrix}$ is

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

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

Ans: (C) involutory

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22. If A is idempotent and $(I+A)^7 = I + kA$, then $k=$

$A^r = A$ for every $r \geq 1$, so $(I+A)^7 = I + \left(\binom{7}{1} + \cdots + \binom{7}{7}\right)A$.

$k = 2^7 - 1 = 127$

Ans: (B) 127

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23. If $\begin{bmatrix}6 & 8+yi\\ x+5i & 5\end{bmatrix}$ is Hermitian, then $x+y=$

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

$x + 5i = 8 - yi \Rightarrow x = 8,\ y = -5$

$x + y = 3$

Ans: (C) 3

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

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

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

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

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

$k = a + d = 5,\ l = ad - bc = -2$

$k + l = 3$

Ans: (A) 3
