EXPRESSWALA ACADEMY

Maths 1A: Algebra of Matrices

MCQ Test, Set 10

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 20 elements is

A. 3 **B.** 6 **C.** 7 **D.** 4

2. If $A = \begin{bmatrix} -9 & 6 & 10 \\ -1 & 7 & 3 \\ -1 & -5 & -3 \end{bmatrix}$, then $a_{32} \cdot a_{23} =$

A. -15 **B.** -2 **C.** -21 **D.** 15

3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = |i - 3j|$, then $a_{12} =$

A. 5 **B.** 1 **C.** -5 **D.** 6

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

A. 10 **B.** 25 **C.** 20 **D.** 24

5. In an upper triangular matrix of order 9, the number of elements that must be zero is

A. 9 **B.** 36 **C.** 72 **D.** 45

6. If $A = \begin{bmatrix} -1 & -4 \\ -2 & -3 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & -2 \\ 0 & -3 \end{bmatrix}$, then $\operatorname{tr}(AB) =$

A. 18 **B.** 20 **C.** 15 **D.** -9

7. If $\operatorname{tr}(A) = -4$ and $\operatorname{tr}(B) = -4$, then $\operatorname{tr}(2A - 2B) =$

A. 0 **B.** -16 **C.** 64 **D.** -4

8. If $\begin{bmatrix} x + 3y & 6 \\ 2x - 3y & 7 \end{bmatrix} = \begin{bmatrix} 24 & 6 \\ -15 & 7 \end{bmatrix}$, then $x + y =$

A. 4 **B.** 10 **C.** -4 **D.** -10

9. If $A = \begin{bmatrix} 7 & -1 \\ 7 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 0 & -2 \\ 1 & -1 \end{bmatrix}$, then $4A - 4B =$

A. $\begin{bmatrix} 7 & 7 \\ 3 & 8 \end{bmatrix}$ **B.** $\begin{bmatrix} 28 & 4 \\ 24 & 20 \end{bmatrix}$

C. $\begin{bmatrix} 28 & -12 \\ 32 & 12 \end{bmatrix}$ **D.** $\begin{bmatrix} 28 & -2 \\ 27 & 17 \end{bmatrix}$

10. If $A = \begin{bmatrix} 1 & -6 \\ 5 & -4 \end{bmatrix}$ and $B = \begin{bmatrix} 0 & 3 \\ -2 & 3 \end{bmatrix}$, the element in row 2, column 1 of $4A + 3B$ is

A. -15 **B.** 3 **C.** 26 **D.** 14

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11. If A is a 1×5 matrix and B is a 5×2 matrix, the order of AB is

A. 1×2 **B.** 5×5 **C.** 2×1 **D.** 1×5

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

A. 25 **B.** 8 **C.** -21 **D.** 10

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

A. $\begin{bmatrix} -6 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & -4 \end{bmatrix}$ **B.** $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 9 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ **D.** $\begin{bmatrix} -5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & -3 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 6 \\ 0 & 1 \end{bmatrix}$, then $A^{10} =$

A. $\begin{bmatrix} 1 & 60 \\ 0 & 1 \end{bmatrix}$ **B.** $\begin{bmatrix} 1 & 54 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 10 & 60 \\ 0 & 10 \end{bmatrix}$ **D.** $\begin{bmatrix} 1 & 60466176 \\ 0 & 1 \end{bmatrix}$

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

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

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

A. 7 **B.** -7 **C.** -6 **D.** 0

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17. If $A = \begin{bmatrix} 0 & 5 \\ 6 & -4 \end{bmatrix}$, then $A + A^T =$

A. $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ **B.** $\begin{bmatrix} 0 & 11 \\ 11 & -8 \end{bmatrix}$

C. $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} 0 & 10 \\ 12 & -8 \end{bmatrix}$

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18. If $A = \begin{bmatrix} -4 & 1 \\ 4 & -5 \end{bmatrix}$ is written as $P + Q$ with P symmetric and Q skew-symmetric, then $Q =$

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

C. $\begin{bmatrix} 0 & -3 \\ 3 & 0 \end{bmatrix}$ **D.** $\begin{bmatrix} -4 & \frac{5}{2} \\ \frac{5}{2} & -5 \end{bmatrix}$

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

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

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

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

21. If A is idempotent and $(I + A)^5 = I + kA$, then $k =$

A. 32 **B.** 5 **C.** 16 **D.** 31

22. If A is involutory and $(I + A)^5 = k(I + A)$, then $k =$

A. 5 **B.** 31 **C.** 16 **D.** 32

23. If $\begin{bmatrix} -7 & 6 + yi \\ x + 7i & -2 \end{bmatrix}$ is Hermitian, then $x + y =$

A. 1 **B.** 13 **C.** -13 **D.** -1

24. If $A = \begin{bmatrix} 2 - 2i & 2 + 7i \\ 2 - 4i & 5 + 3i \end{bmatrix}$, then $A^\theta =$

A. $\begin{bmatrix} 2 - 2i & 2 - 4i \\ 2 + 7i & 5 + 3i \end{bmatrix}$

B. $\begin{bmatrix} -2 - 2i & -2 - 4i \\ 7i - 2 & 3i - 5 \end{bmatrix}$

C. $\begin{bmatrix} 2 + 2i & 2 - 7i \\ 2 + 4i & 5 - 3i \end{bmatrix}$

D. $\begin{bmatrix} 2 + 2i & 2 + 4i \\ 2 - 7i & 5 - 3i \end{bmatrix}$

25. If $A = \begin{bmatrix} -4 & 2 \\ -6 & -4 \end{bmatrix}$ satisfies $A^2 - kA + lI = O$, then $k + l =$

A. -36 **B.** 36 **C.** 20 **D.** -4

Key sheet

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

Solutions

1. The number of possible orders of a matrix with 20 elements is

An $m \times n$ matrix has $mn = 20$ elements, so m can be any divisor of 20.

20 has 6 divisors, so there are 6 orders.

Ans: (B) 6

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2. If $A = \begin{bmatrix} -9 & 6 & 10 \\ -1 & 7 & 3 \\ -1 & -5 & -3 \end{bmatrix}$, then $a_{32} \cdot a_{23} =$

$a_{32} = -5,\ a_{23} = 3$

Product $= -15$

Ans: (A) -15

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3. If $A = [a_{ij}]_{3\times 3}$ with $a_{ij} = |i - 3j|$, then $a_{12} =$

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

$a_{12} = 5$

Ans: (A) 5

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

It has $5^2 = 25$ elements, of which 5 are on the principal diagonal.

$25 - 5 = 20$

Ans: (C) 20

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5. In an upper triangular matrix of order 9, the number of elements that must be zero is

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

$1 + 2 + \cdots + 8 = \frac{9 \cdot 8}{2} = 36$

Ans: (B) 36

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6. If $A = \begin{bmatrix} -1 & -4 \\ -2 & -3 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & -2 \\ 0 & -3 \end{bmatrix}$, then $\operatorname{tr}(AB) =$

$AB = \begin{bmatrix} 2 & 14 \\ 4 & 13 \end{bmatrix}$

$\operatorname{tr}(AB) = 15$

Ans: (C) 15

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7. If $\operatorname{tr}(A) = -4$ and $\operatorname{tr}(B) = -4$, then $\operatorname{tr}(2A - 2B) =$

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

$= 2(-4) - 2(-4) = 0$

Ans: (A) 0

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8. If $\begin{bmatrix} x+3y & 6 \\ 2x-3y & 7 \end{bmatrix} = \begin{bmatrix} 24 & 6 \\ -15 & 7 \end{bmatrix}$, then $x+y=$

$x+3y=24,\ 2x-3y=-15$

So $x=3$, $y=7$ and $x+y=10$.

Ans: (B) 10

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9. If $A=\begin{bmatrix} 7 & -1 \\ 7 & 4 \end{bmatrix}$ and $B=\begin{bmatrix} 0 & -2 \\ 1 & -1 \end{bmatrix}$, then $4A-4B=$

$4A-4B=\begin{bmatrix} 28 & -4 \\ 28 & 16 \end{bmatrix}-\begin{bmatrix} 0 & -8 \\ 4 & -4 \end{bmatrix}$

$=\begin{bmatrix} 28 & 4 \\ 24 & 20 \end{bmatrix}$

Ans: (B) $\begin{bmatrix} 28 & 4 \\ 24 & 20 \end{bmatrix}$

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10. If $A=\begin{bmatrix} 1 & -6 \\ 5 & -4 \end{bmatrix}$ and $B=\begin{bmatrix} 0 & 3 \\ -2 & 3 \end{bmatrix}$, the element in row 2, column 1 of $4A+3B$ is

$4a_{21}+3b_{21}=4(5)+3(-2)$

$=14$

Ans: (D) 14

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11. If A is a 1×5 matrix and B is a 5×2 matrix, the order of AB is

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

So AB is 1×2.

Ans: (A) 1×2

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

Row 2 of A times column 1 of B:

$(1)(3)+(-1)(4)+(5)(-4)=-21$

Ans: (C) -21

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

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

$A^2=\begin{bmatrix} 9 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$

Ans: (C) $\begin{bmatrix} 9 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$

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14. If $A = \begin{bmatrix} 1 & 6 \\ 0 & 1 \end{bmatrix}$, then $A^{10} =$

$A^2 = \begin{bmatrix} 1 & 12 \\ 0 & 1 \end{bmatrix}$, $A^3 = \begin{bmatrix} 1 & 18 \\ 0 & 1 \end{bmatrix}$

Each multiplication adds 6 to the top right element, so $A^{10} = \begin{bmatrix} 1 & 60 \\ 0 & 1 \end{bmatrix}$.

Ans: (A) $\begin{bmatrix} 1 & 60 \\ 0 & 1 \end{bmatrix}$

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

AB is 3×2.

So $(AB)^T = B^T A^T$ is 2×3.

Ans: (D) 2×3

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

$a_{21} = -a_{12} \Rightarrow 2x + 7 = -7$

$x = -7$

Ans: (B) -7

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17. If $A = \begin{bmatrix} 0 & 5 \\ 6 & -4 \end{bmatrix}$, then $A + A^T =$

$A^T = \begin{bmatrix} 0 & 6 \\ 5 & -4 \end{bmatrix}$

$A + A^T = \begin{bmatrix} 0 & 11 \\ 11 & -8 \end{bmatrix}$

It is symmetric, as it must be.

Ans: (B) $\begin{bmatrix} 0 & 11 \\ 11 & -8 \end{bmatrix}$

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18. If $A = \begin{bmatrix} -4 & 1 \\ 4 & -5 \end{bmatrix}$ 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: (A) $\begin{bmatrix} 0 & -\frac{3}{2} \\ \frac{3}{2} & 0 \end{bmatrix}$

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

The two rows must be perpendicular:

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

$x = \frac{11}{61}$

Ans: (C) $\frac{11}{61}$

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

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

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

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

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21. If A is idempotent and $(I+A)^5 = I + kA$, then $k=$

$A^r = A$ for every $r \geq 1$, so $(I+A)^5 = I + \left(\binom{5}{1} + \cdots + \binom{5}{5}\right)A$.

$k = 2^5 - 1 = 31$

Ans: (D) 31

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22. If A is involutory and $(I+A)^5 = k(I+A)$, then $k=$

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

$(I+A)^5 = 2^4(I+A) = 16(I+A)$

Ans: (C) 16

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23. If $\begin{bmatrix}-7 & 6+yi\\ x+7i & -2\end{bmatrix}$ is Hermitian, then $x+y=$

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

$x + 7i = 6 - yi \Rightarrow x = 6,\ y = -7$

$x + y = -1$

Ans: (D) -1

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24. If $A = \begin{bmatrix}2-2i & 2+7i\\ 2-4i & 5+3i\end{bmatrix}$, then $A^\theta =$

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

$= \begin{bmatrix}2+2i & 2+4i\\ 2-7i & 5-3i\end{bmatrix}$

Ans: (D) $\begin{bmatrix}2+2i & 2+4i\\ 2-7i & 5-3i\end{bmatrix}$

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25. If $A = \begin{bmatrix}-4 & 2\\ -6 & -4\end{bmatrix}$ satisfies $A^2 - kA + lI = O$, then $k+l=$

$k = a + d = -8,\ l = ad - bc = 28$

$k + l = 20$

Ans: (C) 20